The Good Muck

Toward an Excremental History of China

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Among the vivid memories of China shared by Western visitors is the pungent odor of human body wastes (*fenbian*, 粪) wafting out of public toilets, sewer manholes, and heavily fertilized fields in the countryside. That gagging, stomach-churning odor comes from gases like sulfur dioxide and methane. English speakers call the source of the odor "muck," meaning urine and feces in particular and all kinds of dirt and rubbish in general.

Muck is not unique to China, of course, and can be whiffed in the streets and subways of Western cities or on farm fields throughout the world. China, however, is exceptional for its longstanding dedication to putting *human* body wastes to good agricultural use. "Of all the peoples of the world," writes British journalist Rose George, "the Chinese are probably the most at home with their own excrement."[1] An old saying refers to those wastes as "a treasure to the land." Westerners, in contrast, find the presence of such wastes nauseating and try to avoid all contact with them. Excreta are not part of their notion of "treasure" or of "civilization." But rather than turning our noses away from excrement or associating its scent with barbarism or poverty, we should ask what significant role it has played in the rise of human civilization and whether the Chinese, more than other peoples, have set us an admirable example of seizing on a valuable resource and using it wisely, without shame or scruple.

In taking up the subject of muck use and muck attitudes, we should begin by noting that simple national stereotypes can be highly misleading. China and the United States may seem radically different, but in fact they have much in common and on many fronts.

Chemically, muck makes all of us humans alike, whatever our cultural differences. Excretion is common to our species and to life in general. Attitudes toward that excretion, to be sure, may vary from group to group, but then those differences do not remain stat-

1 Rose George, *The Big Necessity: The Unmentionable World of Human Waste and Why It Matters* (New York: Metropolitan Books / Henry Holt, 2008), 109. This is a breezy world tour of toilets, sewers, and public sanitation.

ic—they vary with time and levels of economic development. Today's Americans may boast about their flush toilets and bathroom ventilation, but our ancestors were more in touch with their body wastes than we are. Before large-scale urbanization and affluence, they lived close to their own excrement. For example, until the age of 10, this so-called "privileged white male" daily inhaled the familial stench of a backyard privy in western Kansas and knew the sight and smell of feces as intimately as any rural inhabitant of Szechuan or Mongolia. The Chinese, on the other hand, are not the same people culturally that they were 50 or a hundred years ago; today they are becoming as fastidious as bourgeois Americans and demanding a life free of muck. In Beijing or Shenzhen millions of middle-class citizens want the latest in good plumbing—shiny porcelain fixtures made in Japan by the famous Toto Company—and the removal of human wastes as far as possible from their lives.[2]

Changes in attitudes can create enormous environmental changes, and not always toward betterment. As we face global ecological limits, including limits on how much human waste the earth can bear, those of us in the West are forced to ask what we can learn from the past experience of others and from practices that we may have abandoned long ago, and where we might recover those discarded practices and make them useful again. How do other countries look on muck and how do they treat it? What was the value of muck in earlier times, and what have we lost in terms of conserving practices on our way to progress? Recovering an appreciation for muck, according to some observers, may offer hope of healing an overstressed planet and a chance to renew the most basic kind of recycling, closing the loop that connects farm fields to toilets. In the twenty-first century, muck has begun to matter once again.

To aid in our thinking about environmental problems, historians should uncover the past of muck production and consumption. They have not been giving this story its due, just as they have paid too little heed to the depth and quality of our soils, the life and death of organisms high or low on the food chain, the long-term changes that have occurred in the world's climate regimes, and indeed all the material connections between society and the ecosphere that surrounds and supports us. We can no more separate our hu-

2 Especially popular among China's most affluent classes is Toto's top of the line model, the Neorest 550H Dual Flush Toilet, which retails at about 35,000 yuan and, according to ads, offers "ecology-minded luxury, with our technologically advanced Washlet, Tornado siphon jet flushing system, remote control, heated seat and CeFiONtect glaze, an extraordinarily smooth, ion-barrier surface to help keep the bowl cleaner longer." http://www.totousa.com/neorest-550h-dual-flush-toilet-10-and-08-gpf-1.

man history from earth history or from the laws of matter and energy than we can ignore where our body wastes go when they are flushed into our sewers and disappear from sight and smell.

A muck-conscious history should begin with the human belly and its significance as an environmental force. Through our stomachs we have been directly connected to the natural world and have made an impact on it. Even in the most advanced industrial nations of today, filling our stomachs remains vital to survival and, surprisingly, it is still the main way we generate environmental change and crisis. Through gathering food we intervene in natural flows of matter and energy and try to make them serve our self-interest. We change nature, often radically, by interfering with flows and processes that have evolved over many epochs and are vital to the maintenance of millions of other species and their habitats.

But let us not stop with giving the human belly its due. The belly is directly connected to other parts of our anatomy, including nearly 30 feet of large and small intestines and the human bladder. We should therefore speak of an interconnected "belly-to-bladder" history. Our sense of the past should include the entire cycle of eating and eliminating as it has changed over time—changing us as it has changed nature. We need a new history that joins in one narrative both ends of our digestive tract—a history that is unabashedly material, metabolic, and excremental.

The stuff that goes into our bellies is the most vital of natural resources, for like water or air it keeps us alive. What comes out the other end are "waste products," primarily our feces and urine, which in earlier days were not considered a resource at all. In a hunting-gathering state of development, the world our ancient ancestors knew for so many millennia, bodily effluvia were considered not enriching but defiling. Excreta had no place in the human economy. People looked on feces as simply a toxic substance they wanted to void, and then to avoid as much as possible.

Food was the most basic of resources, while human excrement was not a resource at all. On the contrary, it was the first environmental pollutant that humans created. A pollutant is anything foul or toxic that corrupts and poisons its surroundings when it surpasses some critical threshold in the air, water, or soil. All cultures and civilizations have recognized that excrement is a pollutant, one of the worst of all. Poop and pee are dangerous.

Made up of teeming populations of bacteria, viruses, pathogens, and parasites, including such helminths as hookworm, the Chinese liver fluke, pinworms, and the parasitic flatworms called schistosomes, excrement can be deadly. Those parasites can cause, for example, bilharzia, a debilitating disease from which today three hundred million people suffer worldwide, a disease that can damage the liver, kidneys, and bladder or cause cancer. People contract bilharzia simply by standing in irrigated rice paddies that have been polluted by human wastes. Additionally, exposure to excrement can cause diarrhea or dysentery, spread typhus or cholera, or start an *E. coli* epidemic.[3]

Our foraging ancestors feared with good reason their body wastes, which is why they trudged off into woods and bushes to do their business at a safe distance from cave dwellings and encampments. They understood that they were capable of despoiling their habitat. And when the woods and bushes became full of their wastes, they moved on. They resettled to find new food resources, but they also moved to escape those nasty waste products.

Figure 1: Albrecht Dürer, *Job on the Dunghill, with His Wife*, 1505 CE, Städel Museum, Frankfurt am Main. The Israelite is sitting dejectedly on a dunghill, pondering the injustice of the world, while his wife (dressed in contemporary German fashion) pours cold water over his feverish body covered with boils.

The invention of sedentary agriculture, beginning some 10 millennia ago, made avoiding that deadly pollution a much more complicated and difficult problem. Sedentarized communities were forced not only to put up with the intensified stench, but also to live in close proximity to their excreta and to drink from streams into which they had voided their wastes. This is a major reason why agriculture should be seen, not as a great leap forward, but as our species blundering into disaster. As the Bible tells us, farming was a divine curse on humanity; it brought a loss of leisure and an intensification of hard work. We should add to the story of the fall from Eden that the curse of farming, compared to the more "innocent" gathering of natural fruits or hunting wild game, brought an intensification of pollution and dis-

3 A gram of feces can contain 10 million viruses, 1 million bacteria, 1,000 parasite cysts, and 100 worm eggs," writes Rose George in *The Big Necessity,* 1. For the most part those organisms are harmless to people, even sometimes necessary for the body to function, but Rose adds, "plenty are malign." Sanitary practices that separate people from those microorganisms are responsible for adding decades to the average human life.

ease. Dung heaps began to appear in the villages and towns that agriculture created—and they festered, steamed, and stank. Dung heaps were the habitat of the doom-ridden Job and of all those who were forced to dwell near mounds of excrement, relegated to the bottom ranks of society.

At what point did agricultural communities begin to overcome their disgust and try to recycle body wastes as fertilizer for their fields? When did they begin to find in excrement an economic value? Who was the first entrepreneur who realized that there was food or money to be made by turning this pollutant into a resource, making a virtue out of necessity? We are familiar with the modern equivalents of this trick, for today we are trying to get the lead or carbon out of the air or paper out of landfills and turn those wastes into profit instead of into brain damage or climate change or reeking dumps. The challenge to transmute pollutants into wealth is not new but as old as human settlements.

The first discovery of how to transform wastes into nutrients and resources remains shrouded in historical mists. We can only surmise that at some point someone began to realize that she or he could collect and reuse their own wastes safely—that is, if they could manage to store them until, through the heat of fermentation, they became harmless enough to use as a soil supplement. Likely it took centuries to work out how one could do that, and even then the treatment was never perfect. As late as the twenty-first century, people have died from eating vegetables that have been fertilized with inadequately processed human or other kinds of excrement. But a breakthrough came when farmers began to understand that, after careful processing, excrement could be applied in the raising of food. The discovery was miraculous. It meant they could create an almost timeless loop of productivity: food in, waste out, more food derived from that waste, more waste out. And so was born the dream of creating an endless abundance. Other animal wastes, vegetable matter, and household rubbish were added, encouraging some to embrace composting as the way to infinite richness.[4]

Unfortunately for the dreamers, nature sets limits on human resourcefulness. Most basically, the laws of thermodynamics make endless abundance a fantasy, like the related

4 According to the ancient agricultural book by Sixie Jia, 齐民要术 *Qiminyaoshu* (reprint, Beijing: Science Publisher, 1958), a wide diversity of animal wastes, including silkworm droppings, were used by farmers, though it is hard to say how large the quantities were. They made manure by first collecting straw and other residues after harvesting, spreading the material on a flat surface, and making oxen walk over it (p.17). Other methods included boiling horse, ox, sheep, pig, and deer bones with snow melt and the juice of monkshoot (p. 48). This classic text was first published during the Northern Wei dynasty, circa 386–534 CE.

idea of a perpetual motion machine that never runs down. Each point in the food cycle, whether in agricultural or industrial economies, cannot avoid losing energy into space, where it becomes unavailable as food or the ability to do work. Economies never become isolated systems; they leak energy constantly. That is why no one has ever figured out how to invent a system of food production that could go on forever—banishing all shortages, sustaining itself indefinitely, and requiring little or no work from any of us.[5] Always and inescapably, we face the limits of what is naturally possible.

I want to address several questions in this paper. First, when did modern citizens, especially Westerners, begin to get interested in ancient practices of using human excrement as fertilizer, and why were they so interested? What did they ignore or misunderstand about those practices? Second, what can historians tell us about the actual use of human excrement in China's past, and do they acknowledge any flaws or problems in that remarkable achievement? Should we celebrate the Chinese use of human excrement in agriculture as a "green" innovation made by farmers who lived in harmony with nature, or should we see it more darkly as a forced and degrading response to overpopulation and declining soil fertility? Third, how in general should we look on ancient folk traditions and practices like excrement recycling when they are offered today as solutions to modern ecological problems? Should we be seeking a return to traditional ways, or should we embrace modernity more enthusiastically as offering the best hope for the planet?

5 For the bizarre story of nineteenth-century European economists who wanted to replace labor and capital with the abundant fertility of excrement, see Dana Simmons, "Waste Not, Want Not: Excrement and Economy in Nineteenth-Century France," *Representations* 96 (Fall 2006): 73–98.

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Figure 2: Franklin H. King. Published on the frontispiece of Farmers of Forty Centuries. Via Wikimedia Commons.

Before coming to China nearly two decades ago, the first book I read about its environment was the American soil scientist Franklin L. King's *Farmers of Forty Centuries*.[6] Still in print a century after its first publication, and recently translated into Chinese, the book's nearly four hundred pages describe a journey King made along China's eastern coast to learn about traditional, or what he called "permanent," agriculture. Sailing from Seattle, he reached Yokohama, Japan, on 9 February 1909 and Shanghai, China, on 2 March. From there he voyaged south to Hong Kong and Canton, then retraced his steps to Shanghai, where he spent many frustratingly idle days in the Astor House Hotel trying to figure out what to do next and where to go. Not far from that seaport city lay the fertile and prosperous Yangtze River delta, also known as Jiangnan, the most successful agricultural region in the country. After much delay he managed to travel through that region extensively, threading through its dense intertwined landscape of canals, rice paddies, and mulberry groves on a houseboat. Here at last he was able to study more closely China's methods of handling soil and improving fertility.

The Jiangnan region had long been one of the world's greatest rice producers, raising two or three crops every year through a substantial investment in an irrigation system and through heavy dressings of fertilizers, including human excrement, animal wastes, and everything else they could throw in to enrich the soil. But Jiangnan was not all of China. It was the most advanced region of the country in agricultural productivity and in living standards, one that most closely approximated European and American standards of prosperity, while most of China remained, by international norms, extremely poor and backward even into the late twentieth century.[7]

6 Franklin H. King, *Farmers of Forty Centuries: Or Permanent Agriculture in China, Korea and Japan*, ed. J. P. Bruce (Emmaus, PA: Organic Gardening Press, 1927), available online at http://library.umac.mo/ebooks/b30796635.pdf. A Chinese edition has recently been published as 四千年农夫: 中国, 朝鲜和日本的永续农业, trans. Cheng Cunwang and Shi Yan (Beijing: Oriental Press, 2011).

7 For a comparative history of Western Europe and the more advanced regions of China, see Kenneth Pomeranz, *The Great Divergence: China, Europe, and the Making of the Modern World Economy* (Princeton, NJ: Princeton University Press, 2000), especially pp. 31–68.

In mid-May 1909 Dr. King arrived at the German treaty port of Qingdao (or, in the old spelling, Tsingtao), where the Boxer rebellion had erupted just a decade earlier. After briefly exploring that settlement and its hinterland, he crossed Shandong province to Tianjin, another treaty port and major harbor, but he never got so far inland as Beijing. From Tianjin he passed out of China into Korea before ending his investigations in Japan.

In all, King's research trip lasted nearly six months. In that time his eyes took in a thousand striking scenes and his notebooks gathered a rich fund of statistical data. Again and again his nostrils caught the tang of manure. While previous foreign travelers had noted the use of human wastes in agriculture, King was the first to examine that practice in detail and to come away convinced that it offered a viable solution to the soil nutrition problems he saw in modern farming as practiced in the United States.

In 1911, before completing the final chapter of his book, King died in his Wisconsin home. That was the year of the Xinhai revolution, which overthrew two thousand years of imperial rule in China and brought the Western-educated and republican-minded Sun Yat-Sen into power. King was apparently unaware of that dramatic political transformation. He had come and gone unaware of the extent of the social discontent that had been gathering in China's cities and countryside, of internal stresses going back at least to the Opium Wars, and that would abruptly break out after his return home and lead to a radically new China for the twentieth century. King came to focus solely on older farming practices, and nothing he saw during his travels seems to have stirred any awareness of the region's political or economic vulnerability or the shakiness of its fragile, long-troubled relationship with the land.

King believed that he had found a country that was completely stable and peaceful, well fed and efficient. He extolled its people for producing "the highest industrial art of the world." In letters sent home to his wife Carrie, he described in greater detail the careful techniques and ingenious tools that those people had invented so long ago and were still using with skill and precision. Like Joseph Needham, the British scientist who came decades later—"the man who loved China" and who created one of the most impressive publishing projects the West has ever seen, the multi-volume series *Science and Civilisation in China*—King was delighted with everything scientific, tech-

nological, and agricultural. “China is a strange land in almost every imaginable way,” he wrote.

> The more I see of the Chinese the more my admiration for them grows, and the more one realizes that they have really solved their problems along the line of least resistance and of highest economy. Every man and woman seems to be busy and each has put down the bucket where he is and is sustaining life and apparently living in contentment. [8]

Although the peasants he saw had to labor hard for a bare pittance—farm workers in Zhejiang province were making a mere $50 annually—to him they seemed happy with their lot. Each person knew their job and did it well. That impression was one that he formed early on and reinforced each time he ventured from his lodgings.

King did not, however, speak or read Chinese—although he was able to hire capable interpreters through whom he spoke to many Chinese people along the way, relatively few were farmers or laborers. Most of his conversations seem to have been with fellow travelers from the West rather than with peasants living on the land or even with Chinese officials. Did his admiration for the rural Chinese obscure his judgment of their condition? Was he blind to hardship and suffering? And did his limited penetration of the country’s geographical vastness leave him with impressions that were atypical of China as a whole? Why did he miss the long-festering tensions pitting the country’s peasants against their landlords, the common people against their Qing emperors (who were of foreign Manchu origin), or the nation as a whole against the disruptive imperialistic powers like Britain and Germany that had carved out commercial enclaves along the coast, imposed their power on the country, and even invaded the interior with armies, technology, and capital?

Perhaps King was no blinder than most foreign travelers of the time. Even today, looking back on the causes of revolution in the world, we often are not inclined to ask how declining ecological or economic conditions can suddenly erupt in violence or revolu-

8 King to Carrie King, 10 March 1909, Franklin King Papers, Wisconsin State Historical Society, box 2, folder 2, page 142. The correspondence from this trip amounts to about 500 pages of scrawled handwriting, covering back and front and all the margins of his pages. Mostly the letters focus on the ad hoc travel arrangements he had to make, the costs of his travel (he was apparently paying his own way), and reports on his health (he suffered from rheumatism).

tion and turn institutions upside down. Few of King's time pondered critically enough the agricultural dead end that China had reached, making further progress seem uncertain and even hopeless. The countryside was running out of options. It would be twenty years later when the American novelist Pearl Buck, a child of missionaries and a fluent speaker of Mandarin, author of such poignant books as *The Good Earth*, published in 1931, introduced the outside world to the harsher realities faced by China's peasant farmers.[9]

At the time of his travels King had just retired as chief of the soil management division in the US Department of Agriculture. He was inspired to go by American colleagues who had preceded him, starting in the 1890s. Those fellow experts generally tended to stay in Western-style hotels and communicate with each other by means of transoceanic telegraph services. They received considerable help from a string of consular officers, and they enjoyed the modern comforts of steamships and railroads. Typically, they arrived in a mood of certainty that they had all the answers when it came to raising food. Charles Denby, for example, who served as US ambassador to China from 1885 to 1898, declared that despite "the great antiquity of agriculture among them, the Chinese have failed to make any great progress in it. . . . They have made no improvements in this line for a thousand years, just as they have stood still in every other art of civilization." Where King saw a tale of mastery, Denby found one of backwardness. His dismissive appraisal was echoed by David Fairchild, Seaman Knapp, Frank Meyer, and Pearl Buck's husband, the agricultural economist John Lossing Buck, for all of whom China was a stagnating country.

Fairchild, the son of the president of Kansas Agricultural College, arrived in 1898 and, though intrigued by the strange, exotic things he found growing in Chinese gardens, could not regard them as real food but more as contemptible weeds. He was repelled by the stench of city streets, which came from the muck carried by "coolies" in earthenware pots suspended on bamboo poles. He could not understand why the Chinese had not turned to Western-style chemistry to find better fertilizers than human ma-

9 Pearl Buck, whose famous title inspired the more sardonic one of this essay, is worthy of more attention by American and Chinese historians. Born Pearl Sydenstricker in 1892, she was the daughter of Southern Presbyterian missionaries who took her to Anhui and Jiangsu provinces, including the grand old city of Nanjing, where she spent more than three decades. Eventually she married the agricultural economist John Lossing Buck, but in 1934, in the midst of religious and political turmoil, left her husband and China for the United States. In 1938 she was awarded the Nobel Prize in Literature.

nure, whose collection, transportation, and application to crops condemned "many people to lives of disgusting drudgery."[10]

Unlike them, Frank King was less confident that the West provided a better model. Before setting out, he had become a critic of US farming and was looking for alternatives in the East. American farming practices were to his mind wasteful, destructive, and careless. It is hard to say what made him so critical. Having grown up on a farm near Whitewater, Wisconsin, he had graduated from the local teacher's college and earned a PhD in agriculture at Cornell University, studying with the famed horticulturalist Liberty Hyde Bailey. Perhaps it was Bailey's influence that turned him against modern agriculture and made him an admirer of the old ways. After graduation, he was hired as professor of agricultural physics at the University of Wisconsin–Madison, where he wrote one of the first textbooks on soil science. Then he left his home state for a career in Washington as a federal scientist. Along the way he seems to have taken up the cause of Progressive-era conservationists, who taught him to worry about America's declining supplies of natural resources. Like other conservationists, but unlike most of his fellow agriculturalists, he feared that the United States was heading toward a Malthusian crisis of too many people crowding onto a vulnerable, deteriorating soil base.

"If the United States is to endure," he wrote, "if we are to project our history even through four or five thousand years as the Mongolian nations have done, and if that history is to be written in continuous peace, free from periods of widespread famine or pestilence, this nation must re-orient itself." The United States, he was adamant, must stop wasting its once-abundant natural resources. Compared to China (*Zhongguo* in Pinyin, meaning the central or middle-of-the-earth country), the United States (*Meiguo*, the beautiful land, a country of fortunate abundance) seemed to the Chinese as well as Americans to offer the best hope for humanity. King, however, did not approve of that comparison and came to find out what China, Korea, and Japan could offer American farming. During his travels he concluded that those countries were and always had been a model of sustainability from which much could be learned.[11]

10 Randall E. Stross, *The Stubborn Earth: American Agriculturalists on Chinese Soil, 1898–1937* (Berkeley: University of California Press, 1986), 8, 22.

11 King, *Farmers of Forty Centuries,* 239, 240. Unfortunately, King did not have the benefit of Mark Elvin's paradoxical essay, "Three Thousand Years of Unsustainable Growth: China's Environment from Archaic Times to the Present," *East Asian History* 6 (December 1993): 7–46.

In 1910 the US population stood at one hundred million, while China's was five times larger. For a very long time something like one-quarter of all humanity had lived under Chinese rule, more than 90 percent of them living directly on the land, raising a subsistence food supply with just enough surplus to export as tribute or commodity to the cities. Both the US and China occupied about the same amount of physical space on the world map, but China had reached the point of sustaining itself on far less land per person than America. King calculated that his country possessed more than 20 acres to support each man, woman, or child, while the Chinese had only two acres, more than half of which was mountain terrain, difficult or even impossible to farm.[12]

But if in 1909 the Americans had an enormous advantage in arable land, their future had begun to look a little uncertain. King assumed that his country's population might one day rise to as much as 1.2 billion, making the US about as crowded as China. That prediction would not come to pass; even after another century the US population would stand at a mere 320 million, while China's would rise to 1.4 billion. But King's prediction suggests what some conservationists and agriculturalists at the time tended to assume: a huge growth in American population numbers was coming, an increase that no one could or should try to prevent, one that many even welcomed in a spirit of nationalistic pride. But how would that future behemoth feed itself, King wondered, and what could China teach the farmers of Wisconsin or Iowa so they could be ready for a more crowded future?

Everywhere he journeyed King recorded an astonishing diversity of crops growing on the miniscule Chinese farms, far more diversity than in the United States. He saw grass carp swimming in rice paddies, pigs fattening in muddy yards, silkworms feeding on mulberry leaves along the paddy dikes, tea growing on nearby hillsides, cereal crops like rice, millet, and wheat sprouting in rich green carpets. He found exotic plants like corn and potatoes, introduced from the New World, and then there were all those indigenous but unfamiliar food plants flourishing in their midst. The typical farm in China included far fewer domesticated animals than in America. One typical Shandong farmer, for example, kept only a single donkey and a single cow for labor

12 Since King's day, the ratio of arable land to people in both countries has declined precipitously, while at the same time agricultural land has been lost to housing and industrial development. According to the World Bank (www.worldbank.org), China's arable land has fallen from 0.16 hectares per person in 1961 to 0.08 in 2013, while the US has experienced a similar decline from 0.98 hectares per capita to 0.48. See also Vaclav Smil, "Who Will Feed China?" *China Quarterly* 143 (September 1995): 801–13.

and two pigs for meat and manure to support 12 humans in the household—altogether 16 creatures crowding onto a tiny plot of 2.5 acres, or about one hectare. Such farms, in contrast to those of Wisconsin, were more like densely cultivated gardens than American-style "farms," but their per-acre yields were often higher than back home.[13]

That astonishing productivity would not have been possible if the peasants had not grown used to brutal work schedules maintained all through the year—work for both humans and their farm animals. King did not altogether fail to notice that intensification of labor, but rather than seeing it as cruel, he lauded its moral effects. China's work burdens, he declared, were the foundation of its national strength and virtue. "This marvelous heritage of economy, industry and thrift, bred of the stress of centuries," he solemnized, "must not be permitted to lose virility through contact with western wasteful practices, now exalted to seeming virtues through the dazzling brilliancy of mechanical achievements. More and more must labour be dignified in all homes alike, and economy, industry and thrift become inherited impulses, compelling and satisfying."[14] The West encouraged too much laziness and its companion, mechanization, while in the East farmers still followed a rigorous work ethic and practiced stingy and patient thrift. King, though a scientist, was a moral traditionalist who was repelled by sloth and conspicuous consumption.

King's enthusiasm for the whip hand of hard work and agricultural efficiency seems to have left him insensitive to the full costs of China's productivity—tired muscles, long work hours for humans and beasts, and not least the distasteful but inescapable chore of handling human and animal excreta, with all the health risks it entailed. To collect that vile stuff required the efforts of everyone in the household, so that even small children had to pick up their daily quota. After collection, the wastes had to be stored on-site until it was time to spread them on fields or paddies.

13 According to King (*Farmers of Forty Centuries,* 214), maize, or corn, yields in Shangdong province averaged 420–480 catties per mu. Converting the catty to the kilogram and the mu to the hectare, those farmers were getting 6,750 kilograms per hectare. American farmers, in contrast, from 1860 to 1940, harvested on average 1,630 kilograms per hectare. See A. E. Tiefenthaler, I. L. Goldman, and W. F. Tracy, "Vegetable and Corn Yields in the U.S., 1900–Present," *HortScience* 38 (October 2003): 1080.

14 King, *Farmers of Forty Centuries,* 147.

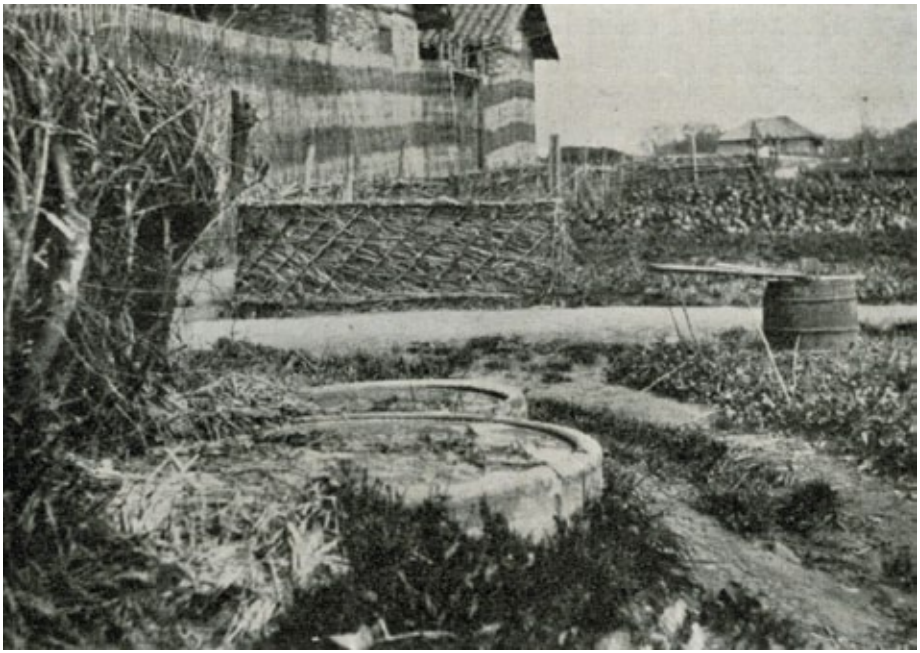

Figure 3: Receptacles for human waste. Franklin King, *Farmers of Forty Centuries.*

Undoubtedly there was beauty and grace in that old peasant farming, along with health and happiness, but there was also a high degree of hardship and degradation. David Fairchild may have been too condescending toward Chinese agriculture, but he was surely right that peasant life included a great deal of "disgusting drudgery," which had been forced on people by growing demands to extract more and more return from the same piece of land. King, in contrast, celebrated in the peasant way of life an "almost religious fidelity . . . which may well cause western nations to pause and reflect."[15]

Data gathered by King from Japan and Europe indicated that a single ton of human excrement contained more than 12 pounds (5.4 kilograms) of nitrogen (chemical symbol N), almost 2 pounds (0.9 kilograms) of phosphorous (P), and 4 pounds (1.8 kilograms) of potassium (K), the elements identified by the nineteenth-century German chemist

15 King, *Farmers of Forty Centuries*, 241.

Justus Liebig as the three essentials of soil fertility.[16] So the amount of nutrients lurking in the combined excreta of China's five hundred million people, each producing 40 ounces per day, was considerable. There were riches of NPK literally lying at their feet.

But note that it took a lot of human waste to get a little fertilizer. To produce 12 pounds (5.4 kilograms) of nitrogen a day, it would take 800 people voiding their bowels and bladders. Using King's figures, we can calculate that the body wastes of all of China in 1910 roughly totaled around 7,500 tons (6,800 metric tonnes) daily. Scanty though it was for such an immense country, nothing like it could be found in the United States. America's much smaller population would have produced only about 1,500 tons (1,360 metric tonnes) of nitrogen per day. Worse, almost all of that nitrogen was washing into rivers and seas. A large part of it, of course, was replenishing soils wherever it fell, but it was not being used for restoring fertility on crop fields. The usually placid King became furious at the thought of so much muck not being put to productive use: "Man is the most extravagant accelerator of waste the world has ever endured."[17]

Meanwhile, ignored by King was another kind of natural wealth washing down from China's Loess Plateau and mountains, as it had done for centuries, clogging rivers and canals with precious soil and eventually drifting out to sea. Conservationists pointed out that it came from clearing away native vegetation and plowing up highly erodible ground. The centrally located plateaus and mountains were losing their substance to the Yellow River (a.k.a. Huang He, often described as the "cradle of Chinese civilization") and had been doing so for many centuries. Over and over its clogged currents and rising riverbed had caused severe flooding downstream. In 1855, because of heavy erosion and silt deposits, the river unexpectedly cut a whole new course across Shandong province and began pouring its silt-laden waters into the Bohai instead of the Yellow Sea.[18]

16 Justus von Liebig (1803–1873) was a German chemist who made significant contributions to organic chemistry. In 1840 he published *Chemistry in Its Applications to Agriculture and Physiology*, which argued that atmospheric ammonia and soil nitrates were more important sources of plant nitrogen than manures, a controversial claim that led him to develop and promote the use of "chemical manures" to enhance crop production. For more on his life and ideas see Margaret W. Rossiter, *The Emergence of Agricultural Science: Justus Liebig and the Americans, 1840–1880*. (New Haven, CT: Yale University Press, 1975).

17 King, *Farmers of Forty Centuries*, 171–73.

18 Important monographs in English include: Ling Zhang, *The River, the Plain, and the State: An Environmental Drama in Northern Song China, 1048–1128* (New York: Cambridge University Press, 2016); and David A. Pietz, *The Yellow River: The Problem of Water in Modern China* (Cambridge, MA: Harvard University Press, 2015).

King, as he traveled along the coast, had to pass the newly created outfall of the Yellow River and to witness its soil-laden waters staining the ocean. He was familiar, as were other American conservationists in the days of President Theodore Roosevelt (who left office in the very year of King's journey), with the long history of Chinese soil erosion and heavy flooding. But that part of the conservationist lament King resisted. To his wife he wrote that the explanation for the heavy silt load carried by rivers "cannot be that man has ruthlessly cut away the forests and thus brought ruin upon the land as foresters are all the time talking."[19] The silt must be due to natural causes, he insisted—namely, to the scantiness of inland vegetation caused by a warm semi-tropical climate. China's ingenious farmers were not at fault—not guilty of destroying the soil-holding vegetation. In fact they were to be praised for discovering the compensatory powers of muck.

Make no mistake: Franklin King was, despite his limited understanding, onto something important. Good soil stewardship is required of all societies and requires a farming community that understands fully the threats to soil health and appreciates soil's foundational role in human welfare. While Justus Liebig had managed impressively to isolate the three major elements of soil fertility, his success tended to encourage overconfidence in reductive thinking. Scientists were ignoring what traditional farmers of Asia knew from bitter experience, that good soil is more than a three-chemical problem. Farming must approach soil management as holistically as it would approach the life and health of any living organism. On the other hand, King should have realized, as a trained scientist, that agriculture needed more than traditional methods and remedies, distorted as they often were by superstition, engrained bad habits, and unreliable data. Maintaining good soil conditions required the analytical rigor of modern science—provided that science could become more organismic in concept and more respectful toward nature's ways. Furthermore, saving the soil required a conservation-minded society that questioned not only wasteful behavior but also the growth in human numbers and its environmental consequences.

For a science more organismic in approach we can turn to one of the most remarkable men of the twentieth century, Sir Albert Howard. Born in 1873, a quarter century after King, he grew up on a farm in Shropshire, England, near the birthplace of Charles Darwin, the great theorist of natural evolution. Both men absorbed rural English cul-

19 King to Carrie, 4 March 1909, Franklin King Papers, box 2, folder 2, page 125.

ture while becoming scientific pioneers. What Darwin poetically called "the web of life," the intricately evolved fabric of nature, Howard preferred to call "the wheel of life," emphasizing the cycles through which nature flows. Plants, he understood, are interdependent parts of that ever-turning wheel and so is the soil. We can label both men early ecologists, spanning an old and new consciousness in science. Ecology would not fully emerge until the mid-twentieth century, but decades earlier Howard, like Darwin, was already thinking about how age-old relationships that evolved among soil, plants, and animals might determine a farmer's success or failure. Darwin's interest in the role of earthworms in soil formation, for example, would produce a modern classic in agricultural ecology. Both he and Howard approached farming as a problem in applied evolution and ecology. Agriculture, they believed, should be regarded not merely as the single-minded task of growing straight rows of beans or mulberry trees in a field of dirt, but as the nurturing of a dynamic community of many kinds of beings all interacting for mutual survival.[20]

In 1905 Howard was hired by India's Imperial Department of Agriculture and assigned to work in the town of Pusa in order to discover how to raise more food for a famine-plagued country. Pusa was an out-of-the-way place; fortunately for his personal life, Howard's wife (née Gabrielle Matthaei, also a trained scientist) joined him in this work. And it was Gabrielle who had pushed him, even while they were still back in England, to realize that a mechanistic and over-reductive science could never fully grasp the complex problem of crafting a sustainable food system.[21] Together, the Howards launched a powerful project for rural development to improve Indian economic wellbeing.

In 1924 the husband-wife team moved to the city of Indore, located in the heavily populated Narmada River Valley of Madhya Pradesh. There they took over a small government-owned farm of 75 acres and made it their outdoor laboratory for crafting a new agriculture. Then Gabrielle died in 1931, whereupon Albert married her younger sister Louise. In 1940, undoubtedly with Louise's behind-the-scenes help, he published his most important book, *An Agricultural Testament*, which set forth in clear, compelling prose an

20 Charles Darwin's last published work (1881) was *The Formation of Vegetable Mould, Through the Action of Worms*, which took him back to an earlier interest in agricultural landscapes, as he had known them around his estate in Down, Great Britain.

21 "The plant knows no division of science," wrote Gabrielle in a 1905 letter to Albert; "in growing and carrying out its functions it uses all." Quoted by Louise E. Howard (Gabrielle's sister and Albert's second wife), in *Albert Howard in India* (London: Faber and Faber, 1953), 15.

ecology-based model for agriculture. It emphasized the importance of humus, the living, organic component of soil, and its enhancement by careful application of muck. Along with Franklin King's book of three decades earlier, *An Agricultural Testament* became a holy scripture for what we now call "organic farming."[22]

These are the opening words of *An Agricultural Testament*: "The maintenance of the fertility of the soil is the first condition of any permanent system of agriculture." Echoing King, Howard called for a better kind of farming, attentive to conserving soil quality, even before farmers chose their seeds and stuck them in the ground. Nature enhances life by building soils, Howard declared, and nature is "the supreme farmer." The human tiller of soil must begin by taking special care of the soil. Other nature-inspired principles and practices must follow.

> Mother earth never attempts to farm without livestock; she always raises mixed crops; great pains are taken to preserve the soil and to prevent erosion; the mixed vegetable and animal wastes are converted into humus; there is no waste; the processes of growth and the processes of decay balance one another; ample provision is made to maintain large reserves of fertility; the greatest care is taken to store the rainfall; both plants and animals are left to protect themselves against disease.[23]

Could farmers replicate the success of Mother Earth? They must do so, Howard believed, if countries like India were to achieve an abundant and enduring supply of food and fiber.

But where and how to observe "Nature's farm" in operation? For Howard the answer was to find an old-growth forest where a diversity of trees and other plants grew, along with the animals and microorganisms that lived as one community, and observe carefully how together they achieved a self-renewing harmony through time. Walking observantly through a healthy forest was the best education. There one learned foremost that sustainability depends on the careful recycling of all nutrients. "The forest," Howard

22 Albert Howard's *An Agricultural Testament*, like *Farmers of Forty Centuries*, is still in print, but it is most easily accessible online at this site: http://journeytoforever.org/farm_library/howardAT/ATtoc.html. See also Howard's *Soil and Health*, with an introduction by Wendell Berry (Lexington: University Press of Kentucky 2011), and Philip Conford, *The Origins of the Organic Movement* (Edinburgh: Floris Books, 2001).

23 Howard, *Agricultural Testament*.

wrote, "manures itself." Get down on your knees and examine the forest floor, he urged, where animal and vegetable residues mix together, where fungi and bacteria decompose those residues and turn them into humus. All is sanitary, clean, and pleasant to the nose. "There is no nuisance of any kind—no smell, no flies, no dustbins, no incinerators, no artificial sewage system, no water-borne diseases, no town councils, and no rates. On the contrary, the forest affords a place for the ideal summer holiday: sufficient shade and an abundance of pure fresh air." Why cannot the same be said for agriculture as practiced by humans? Because farmers have not paid enough attention to how the natural world works.

Howard's laudatory view of Nature (a word he always capitalized) owed something to traditional farming cultures, and to their common belief that a divine power had made the world and pronounced it good. Call that power "God" or "Mother Nature," it amounted to the same thing. But the past century or two had been hard on that older view of the world. It was no longer possible to portray nature simply as the nurturing goddess of life, nor to maintain that she has organized the earth for the good of all.

Was it reasonable to call a wild forest that had evolved over millions of years, through competition among so many species and individuals, a "farm"? Was there no distinction to be made between trees struggling to grow and take possession of the land, prior to human intervention, and a selectively bred crop of rice or maize? These were not questions that the researcher pursued.

Albert Howard made heavy use of ancient metaphors and images, but they had begun to lose their power. The notion of nature as a "supreme farmer," the true Darwinian must admit, could lead to outmoded anthropomorphism and nature deification. In trying to straddle two worlds, Howard overlooked or de-emphasized the aimless trial and error of nature, the lack of design in its workings, the competitive struggle going on in the soil that had been revealed by modern biology. A real forest, Darwin had explained, might be incredibly complex, but its complexity contained the bad as well as the good by human standards. Nature included a profusion of flies, odors, and diseases, along with dangerous creatures like tigers and wild elephants who could take a peasant's life. Agriculturists had always fought to gain control over that evolutionary wildness. How then could one adopt "Nature" as one's teacher and at the same time overlook the darker side of lower-case nature as described by evolutionary science?

It was a conundrum that Albert Howard did not try to resolve. But we might give him credit for seeking a traditionalism that could merge seamlessly into modernity. At the same time we may emphasize more than he that the natural processes of evolution, as revealed through science, could provide better models for the farmer than older, pre-Darwinian worldviews. An understanding of nature as the sum of material things, nature as the world that humans did not create, nature as an evolving set of patterns based on trial-and-error adaptation was Darwin's main idea, and it could offer some guidelines toward sustainability. To mimic those natural processes, without turning them into holy writ, might help humans farm more successfully. Farmers might well be advised to acquire a more humble mentality, but they did not necessarily need to approach nature in a spirit of uncritical, worshipful obedience.

With the advent of factories and the market economy, Howard argued, had come an increasing hubris and overconfidence that ignored the unspoken wisdom of evolution as well as the wisdom of tradition. "Since the Industrial Revolution," he declared, "the processes of growth have been speeded up to produce the food and raw materials needed by the population and the factory. Nothing effective has been done to replace the loss of fertility involved in this vast increase in crop and animal production. The consequences have been disastrous. Agriculture has become unbalanced: the land is in revolt: diseases of all kinds are on the increase: in many parts of the world Nature is removing the worn-out soil by means of erosion."[24]

Cotton was one of the first big modern agricultural commodities to be raised and traded internationally. Manufacturing nations like Great Britain could not grow it at home, so they began to import cotton in great quantities and spun and wove it into cloth in their textile mills. Along with other mass-produced crops like sugar, jute, oil seeds, dyes, opium, tobacco, tea, and coffee, cotton was widely viewed as a "money crop," raised to sell on world markets to make a profit. To grow such a crop, capitalists had come to India and other countries, turning them into colonies, and taking over vast acreages that had traditionally been devoted to raising food for local consumption. Cotton growing came to be based on an economic philosophy that aimed at quick extraction of resources and infinite economic growth. While the older subsistence farming had shown no little ruthlessness in raising food, the capitalist farmer was more contemptuous than ever toward nature and, worse yet, tended to leave the next generation to look out for itself.

24 Howard, *Agricultural Testament.*

Albert Howard and his wives were sharp critics of industrial-capitalist farming—its over-reliance on chemical fertilizers, its sterile mono-cropping, and its shortsighted devotion to mechanization driven by profit. By the 1930s and 40s it was apparent to them that much of Asia had already been conquered by the new-fangled agriculture. India's food system was, consequently, no longer a sustainable enterprise. Only China, in their minds, offered a significant alternative to Western modernity. At this point Howard fell back on King's *Farmers of Forty Centuries* as he wrote: "The peasants of China, who pay great attention to the return of all wastes to the land, come nearest to the ideal set by Nature. They have maintained a large population on the land without any falling off in fertility."[25] China, it was hoped, could help countries like India throw off the influence of industrial capitalism and its ruthlessly oversimplifying, mass-producing approach to raising food.

But could Chinese agriculture of the time really support such hopes and dreams? What hidden problems lay in its methods of using land and recycling wastes? Had the strategy of human manure proved as good for people as for the land? The answers were more complicated, and less reassuring, than either King or Howard supposed.

II

Excremental history should not gloss over deficiencies or failures in traditional ways. On the other hand, it should not ignore the high social and ecological costs that modernity so far has brought. It must try to discover the full and honest truth lying in our wastes and in their handling. Above all, we should never deny that muck is really vile, polluting stuff, no matter how "natural" it may be. That nastiness is not a mere construct of fastidious, over-civilized minds but a biological awareness wired into our senses and brains. Acknowledging the nastiness should lead us to ask how it could ever have become a common soil additive in the first place, what its use in agriculture required of people, and how and why it abruptly declined in use.

Unquestionably China was among the earliest places in the world to use human body wastes to renew soil and improve food production. Here, in contrast to the feces-avoiding hunters and gatherers, the peasants began collecting that resource deliberately, treating it with care and intelligence, and even developing markets for it. What had been considered "unclean" came to have a utilitarian function and a money value. Excrement became the peasant's savings account.

25 Howard, *Agricultural Testament*, 15.

Before there was a need for fertilizer there had to be agriculture, defined as the cultivation of domesticated plants and animals for human nutrition. China boasts one of the oldest continuously functioning agricultural societies on earth. Only the Levant (Turkey, Syria, and Palestine) can claim a longer pedigree, basing its path-breaking agriculture on emmer and einkorn wheat, barley, peas, lentils, bitter vetch, chickpeas, and flax. Levantine farming, however, proved weak in terms of sustainability. The Han people—descendants of tribes on the Loess Plateau and originally called the Huaxia, who became the dominant ethnic group in China—were more successful, far surpassing the Fertile Crescent in longevity and productivity. Their plant domesticates would one day become some of the world's most important cereal crops, especially rice, which was first developed in the lower and middle Yangtze River Valley seven to eight thousand years ago. Then there was millet, which even earlier, about ten thousand years before the present, became the basis of farming where China's Loess Plateau meets the North China Plain.[26]

Following that agricultural breakthrough there emerged, in the words of Francesca Bray, "the agrarian state *par excellence*," one of the most important political systems in human history. Over time it became a powerful institution—a centralized government presiding over a vast, sprawling landscape densely inhabited by small farmers.[27] Large imperial retinues and a substantial number of rich landowners, along with a supporting cast of village craftspeople and a scattering of urban trade centers, grew up on Chinese soil. Considered *trophically* (that is, as a system of food and energy distribution, a word derived from the Greek *trophikos*, meaning nourishment), the agrarian state resembled a steeply pointed pyramid.

The top-level consumers in the Chinese system were the warlords and emperors. A succession of dynastic governments ruled the pyramid. Their role was to protect the producers at the bottom of the pyramid, primarily farmers, against their enemies; during times of drought northern nomads regularly showed up to pillage and plunder the defenseless farmers. In exchange for protection, governments extracted taxes from the vulnerable and claimed a "mandate from heaven." From the Qin to the Qing dynasties,

26 Zhang Chi and Hsiao-chun Hung, "The Emergence of Agriculture in Southern China," *Antiquity* 84, no. 323 (March 2010): 11–25; Houyuan Lu, et al., "Earliest Domestication of Common Millet (*Panicum miliaceum*) in East Asia Extended to 10,000 years ago," *Proceedings of the National Academy of Sciences* 106, no. 18 (5 May 2009), 7367–72. See also Robert B. Marks, *China: Its Environment and History* (Lanham, MD: Rowman & Littlefield, 2012), 23–32.

27 Joseph Needham, *Science and Civilisation in China*, vol. 6, *Biology and Biological Technology, bk. 2, Agriculture* by Francesca Bray (Cambridge: Cambridge University Press, 2000), 1.

indeed right through to Franklin King's time, the agrarian state persisted, rising and falling but never altogether disappearing, reflecting the farmers' changing fortunes of plenty alternating with famine.

Historian Ping-ti Ho has argued that the Loess Plateau, constituting much of the Yellow River's watershed, was the foundation of Chinese civilization and its state apparatus. Later scholars have challenged that theory as too narrow, but for an environmentally aware scholar it seems obvious that those ancient wind-blown deposits must have been of considerable significance historically. They covered much of the north, forming a blanket of nutrients that had been blown in by strong post-Pleistocene winds from Mongolia and Xinjiang. Over a span of ten thousand years, the fine yellow-brown particles washed down the hillsides to fill the lower valleys and plains. Everywhere they were a godsend of fertility.

In the dry years that followed the retreat of ice sheets, various species of hardy grasses and shrubs arrived and covered the Loess Plateau, anchoring the soil and keeping it in place. Likewise, humans arrived, but not to live on the grass as nomads. On the contrary, they destroyed it. Bunch grass was so much easier to remove than the forests that once covered much of China, and that difference explains why it was here that the early cultivation of crops occurred. Destroying native grass, however, accelerated soil erosion, as the soil was left open once more to wind and rain, and to the cultivator's tools. On the plus side the loess's innate fertility allowed farmers to intensify food production, far exceeding their predecessors who had been limited to burning off patches of forest and, in the resulting ashes, raising crops. Those patches, incredibly fertile though they were, could be worked for only a few years before nutrient depletion set in and forced farmers to move on and start over. Compared to forest soils, the loess allowed agriculturalists to reap rich harvests year after year without moving so incessantly; they could conserve much of the energy that was usually required to clear new virgin lands. Now and then, to be sure, they had to restore lost nitrogen to their fields, but this they could do by fallowing or by planting a nitrogen-fixing crop like soybeans. For a while they needed little fertilizer.

Whether those loess soils were the single basis of Chinese civilization or not, their natural fertility did help sustain China's agrarian state over many centuries. Farmers spread relentlessly across the Loess Plateau, then down over the northern plains, and then down the river valleys, adding wheat, barley, and draft animals to their tools of conquest.

Eventually, however, China's farmers reached the limits of loess cultivation. Nomadic invaders or their own reproductive success forced many to leave the loess behind and to migrate southward. Going south, they encountered rival, indigenous peoples who had built up a radically different kind of agriculture based on the rice plant. The northern farmers overran that obstacle, pushing into the Yangtze River valley and then pushing farther south into what today are Jiangxi, Guangdong, Sichuan, and Yunnan provinces. In that southward expansion, they were forced to leave their traditional crops and techniques behind and to learn from the people they invaded. They learned to make rice paddies, watered with elaborate ditches, separated by mud walls, and arranged on cascading terraces. The yield of rice per acre was astonishingly high, justifying all that heavy labor, but rice paddies, in contrast to the loess country to the north, needed a lot of fertilizer all the time. So began a hunt for anything that would restore fertility quickly.

To grow rice abundantly year after year, peasants were forced to work harder and fertilize more. In the beginning, simple paddy irrigation made possible a new and prosperous foundation for the agrarian state. The south was awash in natural waterways, coursing everywhere through the hills and deltas, flooding repeatedly. When harnessed for irrigation, the streams brought to the farmer's crops loads and loads of sediment, or river mud. Sediment was rich enough in nutrients to allow more than one crop per year, but multiple cropping could not be sustained forever merely on river sediment. They must find a wealth of supplements. Where could these be found? Animal manure was in short supply in rice country because farmers there kept comparatively few farm animals. Thus, by necessity, they were forced more and more to utilize their own urine and feces.

The soil scientist King had set himself the goal of learning "how it is possible, after twenty and perhaps thirty or even forty centuries, for [China's] soils to be made to produce sufficiently for the maintenance of such dense populations." Later in his book he omitted the indecisive phrase "twenty and perhaps thirty" centuries and rounded his chronology up to a full and certain forty centuries, or four thousand years. It must have sounded more impressive that way. The alliterative roll of "farmers of forty centuries" would stick in Western thought and be repeated endlessly by agricultural reformers around the world.

Perhaps to a soil scientist like King the difference between two, three, or four thousand years was insignificant, but for a historian the sonorous sweep of millennia must be scrutinized more closely. Historians want to know a little more precisely when and

where muck was first used extensively on Chinese farms. Did this practice really go back four thousand years? Instead of merely four thousand years, why not go back to eight thousand years ago, when rice was first domesticated? Or why not stop at two thousand years ago, or one thousand years, or even less?

Some historians have argued that human excrement may have been in use as a natural resource as long ago as the Shang (or Yin) dynasty, about 3,000–3,600 years before the present. That falls somewhat short of King's estimate. The evidence for even that point of origin, however, is shaky and imprecise. It comes mainly from a few inscriptions on "oracle bones," which were China's first written records. The Shang dynasty was a time when diviners or soothsayers began inscribing, with knife or brush, tiny pictographs on the shoulder blades of oxen or on the belly shells of tortoises, covering the bones with questions posed to the supernatural powers about the future. One of those pictographs seems to have been the precursor for the modern Chinese character **分粪** (*fen*). As noted earlier, *fen* refers these days to excrement, human and other, but in Shang times what did it mean? Perhaps it meant not excreta but rather household sweepings, or dirt or trash in general. Or it may have referred to the ashes that accumulated from burning forests or grasslands for agricultural use and be associated with land reclamation. Still another reading argues that *fen* referred to organic soil dressings, but not necessarily to human wastes.

After careful examination of these conflicting interpretations of ancient writing, Wang Lihua of Nankai University has concluded that "Chinese farmers began using human excrement, along with the stool of livestock and poultry, a variety of weeds, burned animal bones, and ashes for fertilization more than 2,000 years ago."[28] What remains unclear is which farmers we mean, how many of them there were, and what quantities of excrement and other supplements they used.

The problem is that the appearance of a single pictograph or character cannot tell us what was *typical practice* among rank-and-file peasants. That could only be determined by finding a lot more material evidence, which is probably impossible. There

28 Wang Lihua, "'Turning Waste into Treasure': An Overview to Waste Utilization in Chinese Agricultural History," unpublished essay generously furnished to the author. See also Hu Houxuan 胡厚宣, 再论殷代农作施肥问题 [Reexamination of Fertilizer in Yin Dynasty Farming], *Social Science Front Monthly* (1981): 102–9, and Yu Xingwu 于省吾, 从甲骨文看商代的农田垦殖，考古 [Farmland Reclamation of the Shang Dynasty, In the Perspective of Shang Calligraphy of Inscriptions on Bones], *Archaeology* (1972): 40–45.

is, to be sure, an important clue from the Zhou and Han dynasties (1045 BCE to 220 CE, i.e., the age of Confucius). It consists of small clay models of pigsties that have been unearthed by archaeologists, generally from the rice-growing part of China. The models are for a type of building that may have housed pigs but also produced fertilizer from human waste. These are elegant-looking structures, with solid masonry walls enclosing a yard for keeping pigs on the ground level and a stairway that curves upward to a second-story toilet where people could sit and drop their excrement on the animals below. Perhaps they did so in a spirit of revenge! Folklorists say that the Chinese once identified pigs with an evil, powerful "toilet spirit." Although they were the most common four-footed animals on farms, and the major source of meat, pigs could be seen as fierce, dirty, dangerous, and even contemptible.

Figure 4: Han-era model of combined pigsty and human privy, from Joseph Needham, *Science and Civilisation in China*, vol. 6, *Biology and Biological Technology*, bk. 2, *Agriculture* by Francesca Bray (Cambridge: Cambridge University Press, 2000), 291.

No wonder the unearthed models have found their way into museums, for their architectural form could grace a palace, and probably did so. But were such integrated toilet-barnyards widely constructed and widely used by typical peasants? Such buildings must have required considerable capital and labor to put up and maintain. Would a farmer struggling to raise food on a few *mu* of land be able to invest in them? Or were they found only on the grandest estates of the time, among the richer classes or the more "progressive" breeders of pigs who were also growers of rice? Until we can say with certainty how common they were in the landscape, we remain in the dark when we try to pinpoint the origins and extent of using human waste as a standard fertilizer.[29]

Other forms of soil additives came into use much later, during medieval times, and were found across Asia and Europe. They included all kinds of biodegradable trash, ashes from stoves and fireplaces, a wide array of animal droppings, urine-soaked straw bedding from stables and barns, and so-called "green manure," crops that were grown not for food but

29 For an amusing, informative overview of pigs in Chinese history, see C. W. Hayford's blog article, "Pigs, Shit, and Chinese History, or Happy Year of the Pig," 28 January 2007, http://www.froginawell.net/china/2007/01.

for fertilizer, to be turned under by the plow, including winter cover crops like rye or the stubble from harvested rice. Much later, around 1400 CE, farmers in China began pressing vitamin-rich oil out of soybeans and using the dry residues to make "fertilizer cake."[30] Agricultural experts extolled all of these and urged that they be used to improve output. Was anyone listening? The experts' lists of fertilizers are so long that we must assume a growing need. But it was not until five hundred to a thousand years ago that demand for more food reached such a peak of urgency that a revolution in excrement use began.

Professor Li Bozhong has argued that the widespread and systematic use of human fertilizer was coterminous with the invention of what he calls "ecological agriculture," an integrated system of farming that included a more carefully organized diversity of crops and heavier doses of human manure to maintain soil fertility. That system first emerged in the Song dynasty, which lasted from the tenth to the thirteenth centuries CE. Then during the succeeding Ming and Qing periods, the use of human muck became a much more common and systematic practice. That is, it did so primarily in what became the most agriculturally productive region of the country, the rich Yangtze delta (a.k.a. Jiangnan), the very region that Dr. King toured in 1909.[31]

Li has examined in detail farming practices near the city of Suzhou in Changshu County, typified by a pair of brothers named Tan. Their farm consisted of a remarkably interrelated and complementary series of contrived agro-ecosystems, including dry land crop fields, irrigated paddies, and fish ponds, from which they harvested cereals, fruit, vegetables, chicken, fish, and other commodities. Their farm featured intensified recycling and tight nutrient loops, which gave them a lot more food and fiber, including highly profitable silk. The result was a much larger income than most farmers had enjoyed before. A key ingredient in that process of innovation was the common use of human manure. Every ounce of the stuff came to be utilized because every ounce was now worth a lot in cash.

30 William Shurtleff and Akiko Aoyagi, "History of Soybean Crushing: Soy Oil and Soybean Meal," from unpublished manuscript, *History of Soybeans and Soyfoods, 1100 B.C. to the 1980s* (Lafayette, CA: Soyinfo Center, 2007), http://www.soyinfocenter.com.

31 See Li Bozhong, "A Quantitative Analysis of the Demand for Fertilizer in the Jiangnan Region during the Ming and Qing Period: The First Discussion of the Fertilizer Problem of Ming and Qing Dynasties," *Qing History Journal* (1999): 30–38, 108. But Mark Elvin has argued that an earlier agricultural revolution occurred between the eighth and twelfth centuries, based on "the mastery of wet-field rice cultivation, which allowed a great southward migration." One aspect of that medieval revolution was the improvement of soil preparation for rice transplants, including the use of human manure. See Elvin, *The Pattern of the Chinese Past* (Stanford: Stanford University Press, 1973), 113, 118–20.

During the Ming and Qing dynasties, which lasted from 1368 to 1911 CE, Li's so-called "ecological agriculture" spread across the broad flatlands of Jiangnan, becoming more and more popular and essential to that region's economy. With the intensive application of human wastes came not only more abundant food but also a more sanitized landscape. Farmers were assiduously combing the countryside for human wastes, while at the same time they were buying the wastes of towns and cities. The result was a tidier-looking country and city, though the air was redolent with toilet stench.

Across the whole delta and beyond, a rationalized trade in human wastes developed over this period. It was part of a broader tide of intensified "commercialization" that characterized the region. Markets came into existence for almost every product grown on those intensely managed farms and for the muck needed to restore them. More tightly than ever, markets tied city and countryside together into a single web of productivity, prosperity, and economic rationality. Now the odor of excrement came to smell like money.[32]

This new agriculture seems to have developed mainly in southern China near the coast. It was far less prominent in the north. An imperial treatise published in 1737, during the early Qing dynasty, complained that while the southerners seemed to "treasure nightsoil as if it were gold," the northerners remained ignorant of its value. "Therefore, the streets in the north are not clean. The land is filthy. . . . The northerners should follow Jiangnan's example. Every household should collect night soil."[33] Why didn't the northerners, this government official wanted to know, see the potential wealth in human excrement? Because they were, in his opinion, less intelligent and enterprising. Or was it because they were not eager to take on the task of making city life more salubrious by collecting the urbanites' wastes? Or because they were reluctant to change their practices due to the fact that they did not feel the same pressure to change as their southern counterparts? Perhaps their soils had not been so thoroughly depleted, or their numbers did not press on the land so heavily.

32 For an overview of what the author calls "agrarian urbanization," see Xue Yong, "'Treasure Nightsoil as if It Were Gold': Economic and Ecological Links between Urban and Rural Areas in Late Imperial Jiangnan," *Late Imperial China 26* (June 2005): 41–71.

33 Xue Yong, "Treasure Nightsoil as if It Were Gold," 60–61. The imperial official report he cites can be found in *Qinding shoushi tongkao* (1737), vol. 35, 7–8.

Urbanization in the south was a key driving force behind the emergence of a feces-based rural economy. In the early modern period it was the southern cities on or near the coast that became the largest, fastest-growing, and richest in all of China. Hangzhou (formerly known as Hangchow), sitting at the head of Hangzhou Bay, began exploding in numbers and importance after it was made the southern terminus of the Grand Canal, an artificial river which reached all the way to Beijing by 609 CE. Over subsequent centuries the city served as a major seaport, until by the mid-nineteenth century it became one of the largest cities on earth. Hangzhou was also a prefecture, or political division, in the province of Zhejiang, and as such its total population exceeded three million by 1820. Another city-prefecture, Suzhou (Soochow), located within the Yangtze delta, counted 6.5 million inhabitants by 1851, while in the same year its sister city, Nanjing, located in the very heartland of that delta, counted 6.2 million residents.[34]

Cities swelled so hugely because surplus people from rural districts migrated to them, looking for work. Upon arrival, the newcomers often had no public or private toilets to serve them; therefore, they were forced to void their wastes along the streets or wherever they could. Noticing how the feces piled up, shrewd minds saw an opportunity for making a profit and began collecting those wastes and selling them to farmers back in the countryside. Many of the new migrants were among the leaders in the business, collecting manure by scraping it from the streets and emptying household buckets and night stools. This odiferous waste was called "night soil" because it was collected in the early morning, after nighttime use of household privies or chamber pots. The night soil collectors figured out how and where to find the best manure and which routes out of town would lead straight to farmers. The farmers paid them well for more fertilizer, in order to produce more food for the city. This back-and-forth exchange became the basis of a new economy, unprecedented for scale and profit in the world.

Scholars today have created a fancy phrase for this changing geography of muck: "metabolic rift." It means that body wastes came to be generated mainly in urban places, far from the fields that fed most of the people. Metabolism refers to the chem-

34 These statistics are from Liang Fangzhong, *The Statistics of the Household and Population, Farmland and Land Tax in Ancient China* (Beijing: Zhonghua Book Campany, 2008), 430–37, 446–47, 450–51; Cao Shuji, *The History of China's Population*, vol. 4, *Ming Dynasty* (Shanghai: Fudan University Press, 2000), 137–38; and Cao Shuji, *The History of China's Population*, vol. 5, *Qing Dynasty* (Shanghai: Fudan University Press, 2001), 72–77, 85–86, 105–7.

istry of staying alive—the process of matter and energy exchange that goes on within a living organism to keep it from dying. The social organizations created by humans must follow the same metabolic laws as all organisms. For thousands of years farmers had derived whatever nutrients they needed close to home. Given a small, dispersed, and fairly steady population, they could grow crops for a long time in the same place without going far afield. But with larger numbers of people came migration, resettlement, urbanization, trade, and commercialization—and then a rift began to appear and widen between city and country, leaving both places impoverished, depleted, and polluted. Such became the fate of some parts of China by the Ming period, and even more so, by the Qing. Food left farms and journeyed to cities, whereas body wastes piled up in the same cities, becoming a deadly pollutant and an offense to urban noses.

The phrase "metabolic rift" comes from American sociologist John Bellamy Foster, who was inspired by the radical social criticism of Karl Marx. Both teacher and follower have blamed Western capitalism for this serious breakdown in human metabolism. Capitalist investment in agriculture, Marx noted, pushed people from the land—remember those infamous eighteenth-century enclosure acts in Britain that forced so many tenant farmers off their fields and into towns and cities. Capitalist relations, Marx declared, disturbs "the metabolic interaction between man and the earth, i.e., it prevents the return to the soil of its constituent elements consumed by man in the form of food and clothing; hence it hinders the operation of the eternal natural condition for the lasting fertility of the soil." He summed up his critique in a pithy and much quoted phrase: "All progress in capitalist agriculture is a progress in the art, not only of robbing the worker, but of robbing the soil."[35]

But this Marxist explanation runs the danger of an oversimplification of history, exaggerating the role of the West and perpetuating a myth of ancient pre-capitalist, non-Western harmony on the land. China in fact began to experience a "metabolic rift" centuries before capitalism emerged in Western Europe and began forcing people into cities. Not until the late twentieth century did China become truly "capitalistic" in its mainstream thinking, in government policies, or in social hierarchy. Before that, businesspeople and business principles did not rule the country. Capitalism, which makes

35 Karl Marx, *Capital: A Critique of Political Economy* (reprint, New York: Modern Library, 1906), 554–55. See also John Bellamy Foster, "Marx's Theory of Metabolic Rift: Classical Foundations for Environmental Sociology," *American Journal of Sociology* 105 (September 1999): 366–405.

economic self-interest the highest ethos and most compelling logic in a society, was not part of the traditional Chinese past. A merchant class, to be sure, existed in China for many centuries, but it was not highly esteemed or honored, ranking below farmers, laborers, and government officials, and the merchants did not rule over the agrarian state. Certainly, state leaders had often tried to promote "development," encouraging technological innovation for the sake of expanding social wealth. Unmistakably they had sought the conquest of nature, but no businesspeople had led that conquest. It was the farmers who had spearheaded China's traditional conquest of nature. In Jiangnan, the farmers and state together had developed a system of intensive agriculture and spawned the biggest cities. There, well before capitalist England or Europe, a stark metabolic rift emerged.

Humans may have tried to rejoin what had been sundered in nature, but doing so would have required both rural and urban innovation. Li Bozhong offers a telling example of how a few Chinese people tried to overcome metabolic rift by adopting new ideas and methods. It comes from a village located far from urban centers and lacking sufficient fertilizer to meet its needs. In desperation the adults and children learned to go along the roads collecting the feces of travelers who happened to answer the call of nature. Then someone came up with a better idea: build a clean, comfortable public toilet—a three-room palace painted in glistening white—and offer the facility along with free toilet paper to those passing through. The point was to entice the traveler to leave a deposit of his or her manure. Thus the town could collect excrement from well beyond its limits.[36]

Where farmers lived nearer a town or city, a heap of treasure lay just over the horizon and within much easier reach. There was so much muck in the city going to waste. All that was needed was a group of middlemen, called *fenfu*, to take over its collection and redistribution to the farmers. By the early modern period the feces being spread on farms along China's coast were largely coming from such urban centers as Shanghai, Hangzhou, Ningbo, Suzhou, and Nanjing. An army of men driving wheeled carts became a familiar presence on city streets, combing the main avenues and byways, looking for human wastes everywhere. Their carts could carry six to 10 covered wooden

36 Li Bozhong (in "A Quantitative Analysis of the Demand for Fertilizer in the Jiangnan Region during the Ming and Qing Period"), illustrates the "toilet economy" through the story *Digging New Holes: The Miser Became a Rich Man* (掘新坑铿鬼成财), written by the Master of the Zhuoran Pavilion.

containers, each holding as much as 60 pounds (27 kilograms) of excrement. Or where draft animals and carts were in short supply, unemployed men could be hired at low wages to carry the heavy loads of feces on poles resting on their aching shoulders.

A picturesque feature of the muck trade was the gondolas, or long narrow boats, devoted exclusively to distribution. Franklin King saw them in operation in the early twentieth century, collecting urban wastes in Suzhou and floating them far into the countryside. Men and animals brought pails of muck to large empty lots located outside the city, selling it at the rate of a cent per pail. Here the muck was spread, dried, and sanitized. Nearby were segregated docks designated for gondolas to tie up and load the fertilizer on board. "The boats," King wrote in a letter, "are carefully washed outside and covered before leaving the city and the offensiveness of the practice is not nearly so great as you might think."[37] Each year the city of Suzhou, from its foreign quarters alone, shipped out 276,000 tons (250,382 metric tonnes) of excrement.

Figure 5: A flotilla of manure boats on Soochow Creek, collecting human wastes in the city of Shanghai, for removal to cultivated fields. Franklin King, *Farmers of Forty Centuries.*

King was as impressed by the gondolier's cheery work attitudes as he was with the farmers'. In his pages we can almost hear the boatmen poling their craft through rural districts and shouting enthusiastically, "Here comes your muck!" Along the way they may have sung many romantic tunes about willow trees swaying over the water or a

37 Franklin King Papers, Box 2, folder 2, page 40.

maiden's dark eyes inviting a lover, warbling like the gondoliers of Venice who floated on Italian canals also redolent with excrement. Did the farmers who received all the muck from the cities also sing lovely songs as they ladled the purchased poop onto growing plants, so carefully feeding each new sprig of rice?

To treat human body wastes as a valuable commodity, bought and sold in markets, returning them to the soil after they had been separated from it by urban migration, was a revolutionary step in China's transformation of the natural environment. It required farmers who were prepared mentally and economically to get the most out of feces. In the cities it required a class of laborers who formed a human drainpipe to the fields. And then it depended on an elaborate scale of value differentiating the different types of human excrement. The body wastes of Hangzhou's elite, because of their better health, which came from eating more diversified diets, ranked as the most valuable. The feces of the poorer classes brought a lower price. Even in excrement markets there was an elaborate hierarchy. Pig manure was ranked too, but not so highly as human, and usually it was confined to a particular set of crops, while sheep manure was esteemed best for others. Urine had its own special market, river mud another price and use, while old bones and slaughterhouse blood and offal had still another.

By the time of King's visit, the Jiangnan region had become adept in extracting fertility out of a nauseating chaos. They had created an advanced system of waste recycling, which paid large profits to a group of merchants but also yielded large dividends to the agrarian state in the form of tribute or taxation. Not everyone shared fully in the labor or in the wealth that made this system function so well. In the city as on the farm some people gathered all the crap while others gathered most of the money.

Historian Cao Mu has probed the archives of the coastal city of Tianjin and uncovered fascinating insights into the early-twentieth-century muck trade.[38] Tianjin was a northern treaty port that had been carved up by the imperial powers of Britain, France, Italy, Japan, Germany, and other nations into nine concessions, creating an unusually international commingling of peoples in comparison to the rest of China. Here as elsewhere, people once had defecated anywhere they could, on the streets or in backyards. But that helter-skelter way of disposal became intolerable with denser settle-

38 Cao Mu, "The Public Lavatory of Tianjin: A Change of Urban Faeces Disposal in the Process of Modernization," *Global Environment* 9 (2016): 196–218.

ment. Overcoming the unsanitary conditions became one of the city government's main projects, especially after Westerners began demanding greater cleanliness.

Inhabitants of the different foreign quarters urged the construction of elaborate sewers that would wash all wastes into the sea, as cities in Europe and the United States were doing. But before that expensive investment in infrastructure could be taken seriously, Tianjin began licensing and constructing public lavatories. By the late 1940s almost five hundred such facilities existed. They were not all equal in size, comfort, or accessibility. But generally they were located within reach of every citizen—making street pollution unnecessary, concentrating waste deposits in designated spaces, not too far away from people in case of urgent need and requiring only a short walk on a cold morning. Some residents seldom used those public lavatories, either because they were too rich to need a communal facility or too weak and infirm to walk to one. But most people learned to go there, paying a small fee for access, and they were better off because no longer were they forced to dwell amongst their own or others' muck accumulating along the narrow *hutongs*, or alleyways, lined with courtyard residences.

The quality of those public lavatories improved steadily. At first they were often no more than straw shelters, with grass-matted walls and tattered roofs, open to the wind and prying eyes. New or old, however, those facilities required one to lower oneself over a dark and redolent cesspool—squatting down on one's haunches while swatting away the buzzing flies. And in the public lavatories one had no choice but to move one's bowels while visiting with the neighbors or hearing their fights. Privacy was impossible.

So bad were the earliest structures that in 1937, according to Cao, Tianjin's Public Health Bureau had to pass regulations specifying that "each lavatory have a red brick wall, a lead roof, a screen door and windows, concrete floor and squat pits, and a seeping pit to discharge urine. The inside and outside of the wall must be coated with cement one meter thick, and the building regulations of concrete grooves and clay tanks below the ground were to be decided according to the government's judgment."[39] But construction regulations alone could not achieve high standards of maintenance or teach people better habits of use, nor did they end all controversy or struggle over who had the right to collect and who to sell the public's excreta.

39 Cao's source for these new regulations is "Renovating the City's Public Lavatory, 1937," The Archive of Tianjin, J0001-3-000624.

One especially fierce battle occurred between a publicly licensed lavatory owner named Ma, and an unlicensed competitor, a Mr. Wu, who had "squatted" in another sense: he had boldly seized space on the street and put up an outdoor privy for his restaurant, competing for the local trade without government approval. Each rival accused the other of endangering public health through poor sanitation. The battle went on until mediators intervened and backed Ma, but only on the condition that he must clean up his squalid facility. Pure laissez-faire economics was not tolerable in this business. Yet there were always would-be monopolists who tried to grab control of all the public lavatories across the city and corner the fertilizer market. They wanted to grasp for themselves the substantial gain that came from selling muck to farmers.

None of those muck chains that appeared in Suzhou or Tianjin, Beijing or Shanghai, would endure. Already by the mid-twentieth century, forces were at work breaking them apart, reopening the metabolic rift, allowing human feces once more to be wasted, poisoning the air and polluting the land.

III

Before we follow the collapse of the excremental economy in our time, we need to ask more pointedly why it came into existence at all: *why,* and not merely *when*. Why did China's peasants come to rely so heavily on human excrement to produce food? Farmers elsewhere commonly scorned the practice as too "dirty," and they still do so in parts of Yunnan among the non-Han minority peoples. The explanation for China's exceptionalism on this matter can be linked to another, larger question: Why over many centuries did China's peasant farmers devour so much of what was natural around them—forests, grasslands, wetlands, mountain slopes—destroying so many ecosystems needed by other species? Why did peasants send into extinction the country's elephants, tigers, and rhinos, along with birds, fishes, and insects of so many dazzling colors and shapes?[40] The answer to that question, like the answer as to why excrement was needed so badly, is the same: because there were so many human bellies to fill—too many in fact for the soil to support without more and more excreta. That is the simple and, indeed, obvious answer, but explaining why there were so many people crowding China's lands is a bit more complicated.

40 Mark Elvin, *The Retreat of the Elephants: An Environmental History of China* (New Haven: Yale University Press, 2004), 9–85.

Peasants fought against and killed nature not because they *hated* it or because they were motivated by modern capitalist greed. On the contrary, their folk religion told them that nature was the home of many spirits that must be revered, or at least feared. But after kowtowing to the spirits within nature, they did not ask themselves the question Albert Howard thought all farmers should ask: What practical lessons can we learn from nature in order to live sustainably in this place? Learning such lessons would have required deliberately keeping some of the forest intact and entering it respectfully in order to observe how nature works. Instead, wholesale destruction outpaced humble observation.

The peasants left almost nothing that could serve as a teaching resource. In place of the wild they constructed an increasingly human-made and human-centered landscape, though more so in some places than others. If one could call Jiangnan's farms "ecological," as Li Bozhong does, they were never ecological in the sense of carefully preserving the natural landscape and using it as a model for humans. "Ecological" when used as a label for traditional societies means only that they recycled their wastes, used fish carcasses or mud to feed their crops, and so forth. Peasants were not ecological in a modern scientific sense. They were, instead, *economical*—thrifty and careful with nutrients, but all the same intent on extermination and appropriation.

Following the invention of agriculture, peasants all over the planet began to destroy the wild nature that had evolved over millions of years. They did so in order to support their own reproduction, to feed their growing number of mouths. Long before the rise of consumer societies, where needs and wants have become virtually infinite, peasant societies felt many gnawing needs and wants of their own, especially the urge to eat and have sexual intercourse. Why should we view those needs as more pure or good than the "needs" stoked and nurtured in shopping malls? From the perspective of nonhuman species, one human need was not better than another. In the face of aggressive human needs, they must retreat and find safer, less populated frontiers where people were scarce, until finally there might be no place left to go.

China has, to be sure, a long history of reproductive self-control that must be acknowledged, but it was practiced for economic survival, not ecological harmony. None of the methods the peasants used to prevent pregnancy or to manage family size—including, most horribly, female infanticide—ever brought them into a lasting state of natural

harmony or equilibrium. Nor did those halting, poorly understood, and sometimes violent population-control methods prevent the ongoing, relentless assault on the land.

While facing squarely this central truth in history, we do not necessarily have to endorse the old-fashioned Malthusian doctrine about the inevitability of poverty. Thomas Malthus, author of *Essay on the Principle of Population*, first published in 1798, after witnessing a huge increase in the number of poor people in England, concluded that producing more food would fail to alleviate hunger. More production might even lead to more misery, for it was the nature of people, he believed, to breed and overshoot the land's capacity to produce. That oversimplified formula, one he later softened somewhat, blamed the human condition on inner drives established by the Divine Creator. But today we must insist that there was never any divine decree that made people want to reproduce. There was only innate self-interest, even if that self-interest might be amenable to cultural change.

By giving birth to lots of children, China's peasants hoped to have offspring (male children especially) to depend on in old age. Who but one's offspring would be there to help at the end of life? For thousands of years neither the village nor the state offered any old-age assistance. More children were the only form of pension available. So little children came along like cabbages in the field: planted with calculation, watered and fed with nutrients, stocked up for the rough days ahead. A surplus of children assured that there would always be someone around to provide for the parents' comfort and security.

The Danish economist Ester Boserup, who is favored today far more than Malthus, provided an optimistic alternative theory. She too granted that population always presses on natural resources, but she contended that more children led not to impoverishment but to agricultural innovation. Or as she put it, population is "the independent variable which in its turn is a major factor determining agricultural developments."[41] As children become more numerous, a food crisis ensues. All might seem hopeless, hunger foreordained. But then farmers learn how to shorten their fallow patterns, from 20 or 30 years to five years or fewer, until eventually they do away with fallowing altogether. They fig-

41 Ester Boserup, *The Conditions of Agricultural Growth: The Economics of Agrarian Change under Population Pressures* (London: George Allen & Unwin, 1965), 4. For an application of her theory to China, see Kang Chao, *Man and Land in Chinese History* (Stanford, CA: Stanford University Press, 1986). Also, William Lavely and R. Bin Wong, "Revising the Malthusian Narrative: The Comparative Study of Population Dynamics in Late Imperial China," *Journal of Asian Studies* 57 (August 1998): 714–48.

ure out how to plow the same fields year after year. To do that, however, requires finding fertilizers that can increase productivity, or practicing irrigation, or creating new breeds of plants and animals that can use resources more efficiently.

Boserup spent several years in Asia observing its struggle for economic development and concluded cheerfully that demographic increase has always been a blessing, never a curse. Population pressure pushes societies upward toward a higher civilization and material abundance for all. Hunters and gatherers managed the earth hardly at all, so over time they had to give way to peasant farmers, who in turn must give way to those armed with modern technology. Every new baby means another brain ready to contribute to that progressive narrative, another hope for innovation, and another brick in the road toward abundance.

The flaw in Boserupian economics is that humans cannot expect to go on improving their land forever, overcoming any and all limits in nature, never encountering any setbacks. The first lands to be conquered are the easiest, but then it gets harder and harder, and more and more expensive, to keep the process moving forward. In opposition to Malthusian pessimism, Boserup offered an equally simple optimism. She pinned her hopes on the human mind's infinite resourcefulness, glossing over the contrary evidence and ignoring the dark chapters of recurrent land abuse, ecological decline, and social collapse. Never fully acknowledged in Boserup's writings is that more people are dying from malnutrition today than ever before. To avoid such disasters people have been forced to work like demons. The quest for survival has pushed societies toward "enhanced labor productivity"—a dignified way of saying "enslavement to work." And to gain that productivity, those in positions of power again and again have intensified the burdens on the poor while seizing the fruits for themselves.

Trying to meet the most fundamental of imperatives, the survival of self and offspring, the peasant farmers of China, as elsewhere, kept trying to expand output. They monopolized the process of photosynthesis. Always they tried to get more food out of the same old fields. According to Dwight Perkins, in the period from 1368 to 1968 China increased its agricultural output by no less than 400 percent. The conquest of new land, he calculates, explains one half of that increase, while "the other half was the result of a doubling in the average output per unit area, which was again a development powered by the population growth." In other words, Chinese farmers figured out how to produce

twice as much foodstuff on the same acres. One of the most effective ways of doing that was to work longer and longer hours; another was to increase the number of workers, and still another was to lard the land with fertilizer.[42]

Today China, which once supported only a few thousand humans, supports a billion and a half, the most people of any nation by far. One can celebrate that accumulation of humanity as a glorious achievement, a defiant rebuke to all the Malthusian pessimists. Or one can see it as a tragedy for the earth, a leading cause of the modern environmental crisis, and a vandalizing of our natural legacy. In any case, it now seems clear that such increases in food or population will be nearly impossible to quadruple again over the next six centuries.

Perhaps the best summary of China's demography comes from Judith Banister, a specialist in population history and China's in particular. She sums up the country's record in these terse numbers:

> The population apparently fluctuated between 37 and 60 million for a thousand years, showing no consistent trend. The first recorded instance of sustained population growth (averaging an estimated 1.2 percent a year) took place in the last half of the eleventh century under the Song (Sung) Dynasty, but this trend was reversed by subsequent centuries of dynastic struggle, civil war, Mongol invasion, and bubonic plague. Then, starting from the early years of the Ming Dynasty in the late fourteenth century, China experienced six centuries of population growth. Only twice was this growth checked, once because of the fall of the Ming Dynasty in the early seventeenth century, and once during the Taiping Rebellion that hastened the decline of the Qing (Ch'ing) Dynasty in the late nineteenth century. . . . The period of most rapid population growth (1749–1851) saw more than a doubling of China's population in a century.

42 Dwight H. Perkins, *Agricultural Development in China, 1368–1968* (Chicago: Aldine, 1969). See also Philip C. C. Huang, *The Peasant Economy and Social Change in North China* (Stanford, CA: Stanford University Press, 1985), quote on page 10.

Her synopsis ends at the mid-nineteenth century—when 432 million inhabitants were fighting for food where once there had been only 60 million. The pressure would not end there.[43] After 1851 the population went on increasing exponentially, until demographic curves were bending almost vertically upward, like a rocket heading straight into outer space.

Figure 6: Applying liquid manure from carrying pails, using the long-handled dipper. Franklin King, *Farmers of Forty Centuries.*

Surely that extraordinary increase in human beings has been China's most distinctive feature and most powerful determinant of social and environmental change. But far back in pre-civilized, unrecorded times, even comparatively low levels of population could press hard on local environments. Add to the equation the recurrent changes in the world's and China's climate, shifting from dry years to wet to dry again, and the past begins to look, in John Brooke's phrase, like "a rough journey."[44] Population change—and mostly it has been population *increase*, whether slow and gradual or fast and furious—has been one of the greatest drivers of history, and too often we simply ignore it. Or we may try to justify it, as both Malthus and Boserup did, as a kind of providential force, pressing us onward to "higher levels of civilization," even when those increased human numbers may have brought not an advance but a severe decline in the quality and variety of life.

The peasants of China drove themselves hard straight into a feces-based economy. They did so to escape a fate they were making for themselves, and that others ruling over them had helped them make. They solved resource shortages by becoming ever more resourceful, displaying knowledge and skill in that process, forcing themselves to work from sunrise to sunset, forcing every other being in their household to do the

43 Judith Banister, "A Brief History of China's Population," in *The Population of Modern China*, ed. Dudley L. Poston Jr. and David Yaukey (New York: Plenum, 1992), 51.

44 John L. Brooke, *Climate Change and the Course of Global History: A Rough Journey* (New York: Cambridge University Press, 2014).

same, and not least by overcoming an innate distaste for handling their own muck and that of countless strangers.

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Change never stops in this story of population growth and recurrent crises. In very recent times, change has taken a turn toward the invention and use of chemical fertilizers coming out of a scientific laboratory. During the early part of the twentieth century, scientists in Europe figured out how to create fertilizer out of the very air around us and from fossil gas pumped from the ground, a breakthrough that seemed to promise an altogether superior remedy, with no apparent drawbacks, for restoring degraded, depleted soils.

Here is Albert Howard speaking in 1940, complaining that chemistry would make it harder for his farming model under development in Indore to succeed and be put into common practice:

> Artificial manures are widely used. The feature of the manuring of the West is the use of artificial manures. The factories engaged during the Great War in the fixation of atmospheric nitrogen for the manufacture of explosives had to find other markets, the use of nitrogenous fertilizers in agriculture increased, until to-day the majority of farmers and market gardeners base their manurial programme on the cheapest forms of nitrogen (N), phosphorus (P), and potassium (K) on the market. What may be conveniently described as the NPK mentality dominates farming alike in the experimental stations and the countryside. Vested interests, entrenched in time of national emergency, have gained a stranglehold.
>
> Artificial manures involve less labour and less trouble than farm-yard manure. . . . For the moment farming has been made to pay. But there is another side to this picture. These chemicals and these machines can do nothing to keep the soil in good heart. By their use the processes of growth can never be balanced by the processes of decay. All that they can accomplish is the transfer of the soil's capital to current account.[45]

45 Howard, *Agricultural Testament*, 14.

Earlier, Franklin King had known little of chemical fertilizers—they were mostly a futuristic dream during his lifetime. But by the 1930s and 40s, chemical (artificial or commercial) fertilizers were becoming ubiquitous. They promised to fulfill Boserupian promises, to increase agricultural production without limits. As Howard feared, however, they might "do nothing to keep the soil in good heart."

During World War I, the German chemist Fritz Haber discovered how to convert a gas, atmospheric nitrogen, into liquid ammonia by bonding that gas to hydrogen derived from natural gas, a fossil fuel. Nitrogen was abundant in the air, and Germany and other nations first learned how to extract it for use in armaments manufacturing. To aid Germany's defense, the chemical company BASF assigned one of its top scientists Carl Bosch the job of using nitrogen to make explosives. Then after the war, what came to be called the Haber-Bosch process of nitrogen extraction was turned from making explosives to making chemical fertilizers.

Liquid ammonia, rich in nitrogen, was the base for that fertilizer. It could be combined with phosphorous and potash—the latter chemicals were easily mined in various parts of the world—and, presto, a new generation of "multi-nutrient" fertilizers came on the market. They dramatically altered farming, making fertilizer seem cheaper than it had ever been and a lot more pleasant to handle.[46]

All over the world, farmers began buying the magical N in the form of liquid ammonia or dry-powder urea, along with P and K, to apply to their crops. New seed varieties designed to absorb those elements more efficiently appeared on the market, and the result was astonishingly higher yields in the countryside. This was true for all the basic foodstuffs and fibers—vegetables, cereals, cotton, and feed for livestock.

But that enhanced production came at a high cost, not in terms of money as much as in environmental quality. Muck quickly dropped out of the farmer's list of "resources" and became once more "waste," dismissed for its low economic value. Now without a productive role to play, muck became once again a pollutant, although now it was

46 The best account is Vaclav Smil, *Enriching the Earth: Fritz Haber, Carl Bosch, and the Transformation of World Food Production* (Cambridge, MA: MIT Press, 2004). See also his papers, "Nitrogen Cycle and World Food Production," *World Agriculture* 2 (2011): 9–13; and "Detonator of the Population Explosion," *Nature* 400 (1999): 415. The Haber-Bosch process is one of the leading reasons why the world population has increased from 1.6 billion in 1900 to 7.4 billion today.

being generated in prodigious quantities by the billions of people crowding the planet. Muck that was no longer part of agriculture became once again dangerous stuff, fouling streams and lakes, creating algal blooms, killing a wide spectrum of other species.

After several decades of importing chemical fertilizers from other countries, China began building its own nitrogen factories. The biggest in Republican China, and for a short while the biggest in East Asia, was named Yongli; founded in Nanjing in 1933, it was ruined soon after the outbreak of the Sino-Japanese War. Then in 1975, just one year before Mao Zedong died, a large national facility came into production, marking a great leap forward into the chemical age. Just as communism broke down the old unequal land ownership patterns, it also turned farmers into consumers of chemical fertilizers. Eventually China was producing and consuming more of the miracle additives than any other nation on earth.[47] Today, its factories turn out some 50 million tons (45 million metric tonnes) a year, about half of a world total of more than one hundred million metric tonnes. Those two figures may be among the most important statistics in modern economics.

Cheap mass production of synthetic fertilizers has begun to revolutionize the practices of even the smallest Chinese farmers, allowing them to keep working the land for a few more years until they are worn out and expendable. *National Geographic* writer Dan Charles tells the story of an elderly man near Nanjing, Song Linyuan, who has farmed the same 1.3-acre parcel his whole life. In pre-chemical days he annually spread on his rice crops some 130 pounds (60 kilograms) of nitrogen—all of which came from muck. The old manure-based farming was hard work for an old man—including so much painful stooping to insert rice plants into the paddies, then the meticulous spooning out of liquid and biosolid manures, and finally the harvesting and threshing of the rice crops. Weary of work, the old man decided to try spreading urea instead of excrement. It proved so easy and inexpensive, and so effective in results, that he soon escalated his usage to 500 pounds (227 kilograms) of nitrogen a year. Remarkably, his yields more than doubled to 7,200 pounds (3,266 kilograms) per acre. Never mind that most of the fertilizer he spread was wasted; it was never taken up by the plants because

47 Kai Zhang, "The Evolution and Development of Chinese Agricultural Fertilization in the Last Hundred Years," *Agricultural History of China* 3 (2000): 107–13.

it leached into groundwater or ran off into ditches and streams. But what this small farmer saw and cared about was not the money he wasted on unused fertilizer, but the bounteous crop he harvested and the painful labor he avoided.[48]

Today, how many Chinese producers and consumers have become dependent on rice and other foods raised with chemical fertilizers? The answer is almost everybody. Whether consumers reside in a city or rural area, purchase food in supermarkets or raise it for direct consumption, they are eating chemical fertilizer. Astonishingly, some 80 percent of the nitrogen in Chinese bodies now comes from food produced with the aid of chemical fertilizers. So change is going on deep within the modernized human body. When does such change become damaging? As fear spreads about the unknown health consequences, China's supermarkets have begun to promote "organically raised" fruits and vegetables, which claim to use no or little commercial fertilizers or pesticides. However, it remains to be seen whether a nation the size of China can be fed organically, or whether new safety concerns may arise as the next round of agricultural innovation unfolds.

Night soil has not completely disappeared from the farm. It is still part of Chinese food production. Around Tai Lake, for example, a few farmers continue to collect and store their family wastes and use them on crops. Large ceramic tanks or concrete pits are in plain view around their houses or outbuildings. A sluice may connect a farmer's pig stall with a night-soil storage tank, mixing animal with human manure and urine. But these days the supply of that older organic fertilizer is so small that it cannot be depended on for growing the major cereals like rice or wheat. Excreta are now used almost exclusively on small vegetable patches. Perhaps we should not waste our pity on the old-fashioned vegetable farmer who is still ladling that old smelly stuff out of a bucket and spreading it over lettuce and broccoli. She or he may be making a better income than ever before. Among supermarket consumers it is a common belief that bok choy (Chinese cabbage) grown with human excrement has better flavor than other kinds. Certainly, it costs more.[49]

48 Dan Charles, "Our Fertilized World," *National Geographic* 223 (May 2013): 94–110. For global trends see Food and Agriculture Organization of the United Nations, "Current World Fertilizer Trends and Outlook to 2016" (Rome, 2016), ftp://ftp.fao.org/ag/agp/docs/cwfto16.pdf.

49 E. C. Ellis and S. M. Wang, "Sustainable Traditional Agriculture in the Tai Lake Region of China," *Agriculture Ecosystems & Environment* 61 (1997): 177–93.

Within a span of four decades, China's agriculture has shifted away (though not completely) from muck to manufactured chemicals. There are strong economic and humanitarian reasons for that shift. It has brought food abundance and a more balanced diet. Working the land has become easier than it was in the old days. Modern methods have allowed millions of laborers to abandon their home villages and relocate to cities, withdrawing their energies from agricultural production and putting them to use in washing the windows of silver-gray skyscrapers or raking through overflowing garbage bins outside restaurants and dining halls.

Besides the loss of rural population, with its hidden toll in personal feelings, and besides the acceleration of social inequality, has come a host of environmental calamities. Chief among them is the growing eutrophication of China's waterways. Eventually, the superabundant chemical fertilizers leach into lakes and rivers, causing algae blooms that deplete suspended oxygen and kill once-vibrant ecosystems. Along the seacoast the fertilizer industry is responsible for a series of "dead zones" at the mouth of every river—watery expanses where almost nothing can live under the newly prevalent anaerobic conditions, which are fatal not only to marine species but also to the fishermen who depend on them to live.

Many decades ago the Western scientists King and Howard came to Asia seeking to learn from a very old model of farming, one they hoped would be more natural and sustainable. But since then a powerful tsunami of population pressures, recurrent famines, the economic imperatives of industrialization, urbanization, and capitalism, along with many new technologies, have washed over and wiped out the permanency they sought. Not completely so, for awareness of the threat that unutilized body wastes or excessive chemical fertilizers can bring has spread across the land and, by the twenty-first century, that awareness has begun to find its voice in protest. But at the time Howard died in 1947, the writing was already on the wall. Even China, which for a long time stood fast as a holdout for traditional methods of building fertility, would join the modern flood tide and even ride the waves.

As those Western scientists did, we value tradition and for good reason. Whatever is traditional can represent hard-won wisdom. From the rich fund of traditional experience, field-testing has gone on over long expanses of time that cannot be duplicated in any academic laboratory. Tradition can offer guidance to what works over the long

term and what can minimize risk. In agriculture as elsewhere, we do well to take seriously the old ways that have stood the test of time.

Yet any tradition, no matter how wise or rational, can suddenly become a dead-end from which there is no escape. Instead of evolving, agriculture can become involuted, turning in on itself, failing to innovate sufficiently to keep up with demand, and proving unable to adapt. This has been frequently identified as China's great problem before the days of Chairman Mao—the curse of involution. Fixed on maintaining tradition, farmers failed to create new ideas and their communities found themselves in a downward spiral until they began to vanish into the soils they once exploited. Traditions can carry the seeds of their own destruction, as when China's preferences for large families and high fertility became so dysfunctional that it drove the country relentlessly into the violent whirlpool of upheaval and revolution.

For many Westerners, the most innovative contribution of Chinese agriculture was that of spreading human muck on fields from which people ate. For a long time, that practice proved effective in solving two problems: turning a dangerous pollutant of both city and countryside into a natural resource, and using that resource to feed an ever-growing population. Mark one up for peasants! But then that old practice ran out of efficacy and it collapsed for more than one reason. China could not continue down that road forever. It could not sustain itself on its own excrement. In holding fast to that tradition, people were forced into a state of degradation that should not have been allowed to continue. In the context of a shrinking planet on which too many people are burdening the soils and yet demanding a cleaner, healthier, and easier lifestyle, China's recent trajectory means its excremental past has lost out in the struggle for existence. Farmers have been forced to ditch their traditions and embrace modernity.

When tradition fails, science and technology may come to the rescue, or at least that is our hope. With the aid of sciences like ecology we may discover how to put human wastes where they can do little or no damage, how to restore soil fertility in a manner that is safe and labor friendly, and how to recycle all the muck we produce day after day and make it once more a national treasure. At the same time modern science is never without drawbacks. Every innovation, including the latest sewage treatment plant designed to the highest engineering standards, may bring complications and unwanted consequences. We can only press forward in hope, tempered by the realism that comes from heeding tradition and experience.

Fellow historians, don't turn away from this tangled story of bodies, nutrients, and resources. Don't turn up your noses at the stench that once permeated fields and dwellings, soiling clothing and hands and making stomachs heave. Don't run away from the foul odors that still gather around our cities and farms. Don't ignore the centrality of agriculture to our history of living within the natural world. Don't over-idealize, as some have done, the traditional agriculture of China or romanticize its poor overworked people, who were forced by their own fecundity to collect and make use of their body wastes simply to survive year after year. Don't assume that every scientific advance is in fact a step forward for nature and humanity.

The lesson of this story is that every utopia, whether of the past or future, tradition or modernity, eludes us when we stare down at our own excrement.

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