The Law of Return: Cornerstone of Organic Agriculture

When the United States Department of Agriculture first attempted to create a national organic certification program in 1997, organic growers and consumers across the country found fault with the original guidelines. Three controversial practices would have been allowed: food irradiation, genetically modified organisms, and the use of sewage sludge (biosolids) as fertilizer. After receiving over 275,000 comments in protest, the USDA reversed its decision and banned these three inputs in the final rules for organic agriculture.[1] It is currently illegal in the United States to use any form of human waste in organic farming, even if it is composted first.[2]

In the case of both GMOs and irradiated foods, the decision to exclude them from organic farming makes sense, as they are both new technologies that did not exist a century ago. And I understand, too, why organic food advocates are wary of using sewage sludge for fertilizer, as it may contain heavy metals, synthetic chemicals, and pharmaceuticals.

But, inadvertently, this ban on human waste recycling has made it illegal in this country for organic farming to be the closed cycle that its founder, Sir Albert Howard, originally envisioned. Howard hoped that someday all organic wastes—including human wastes—would be composted and returned from the cities to the farms, thus eliminating any need for mined chemical fertilizers. He dreamed of a permanent civilization that mimicked a natural ecosystem, following what he called Nature's "Law of Return."

The Law of Return was the central principle of the original organic farming movement in the 1940s. But the idea did not originate with Howard, though he may have been the first to use that exact phrase. His concept of nutrient cycling was influenced by many other agricultural scientists, including the work of Justus von Liebig in the mid-19th century.

Liebig and mineral nutrition

Justus von Liebig (1803-1873) was a pioneering German chemist who taught chemistry at the University of Giessen and in Munich for over forty years. He was one of the scientists who brought the discipline of chemistry out of the medieval darkness of alchemy and into the modern age. During his lifetime he made an astonishing number of scientific discoveries, but he is most famous for his applied chemistry work in plant nutrition.[3]

In Liebig's day, the accepted theory of plant nutrition was the "humus theory." Farmers had noted since antiquity that soils rich in humus grew better crops than those poor in humus. Thus, scientists up through the early 19th century assumed that plants "ate" humus as a carbon and energy source.[4]

Liebig pointed out the flaws of the humus theory in his groundbreaking 1840 book, *Chemistry in Its Applications to Agriculture and Physiology*. There just wasn't enough carbon in

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[1] Treadwell, "From Philosophy to Science," 1012.

[2] 7 CFR §205.203: Soil Fertility and Crop Nutrient Management Practice Standard. https://www.ecfr.gov/cgi-bin/text-idx?SID=87e509c85a82bcce02911c0bd85671df&mc=true&node=sp7.3.205.c&rgn=div6.

[3] William H. Brock, *Justus von Liebig: The Chemical Gatekeeper* (Cambridge: Cambridge University Press, 1997), 5, 10, 13, 16, 28, 33, 292, 328; W. A. Shenstone, *Justus von Liebig: His Life and Work* (New York: Macmillan, 1902), 11, 20-22, 80,

[4] Eric C. Brevik and Alfred E. Hartemink, "Early Soil Knowledge and the Birth and Development of Soil Science," *Catena* 83 (2010): 26; Raphaël J. Manlay, Christian Feller, and M. J. Swift, "Historical Evolution of Soil Organic Matter Concepts and Their Relationships with the Fertility and Sustainability of Cropping Systems," *Agriculture, Ecosystems and Environment* 119 (2007): 221.

humus to satisfy the energy requirements of plants; the only logical carbon source that could grow an enormous tree from a tiny amount of soil was the carbon dioxide in the air, which plants fixed into carbohydrates using the process of photosynthesis.[5]

Though plants didn't need the *carbon* in humus, they still needed something from the soil—mineral elements. About 5% of the total dry weight of plants (and all other organisms) is comprised of minerals—phosphorous, potassium, calcium, magnesium, sulfur, iron, and others.[6] In a natural ecosystem, these mineral elements are constantly recycled from plant to animal to soil and back to a plant again.

But when crops are removed from an agricultural field, the mineral elements contained in them are also removed. In his 1863 book *The Natural Laws of Husbandry*, Liebig explained that it was the farmer's responsibility to restore these minerals to the soil: "The hand of man alone restores to the ground the conditions of the life of plants: in farm-yard manure wherein they are contained, the farmer, following a natural law, restores the lost power of production."[7]

Since there were not many inorganic fertilizer options in his time, Liebig believed that the only practical way to ensure sufficient mineral nutrients for plants was to return all organic wastes to the soil, especially human excrements. He cited several practical examples where this was being done, including at a German military barracks and in practically every home in Japan.[8]

Liebig perceived waterborne sewage systems to be the greatest enemy of sustainable nutrient cycling. He was especially critical of England, which washed thousands of tons of mineral nutrients out to sea every year with their wastewater.[9] In a frantic attempt to keep their fields fertile, the British imported thousands of tons of bones from European tombs and battlefields every year to use for fertilizer.[10] Another popular fertilizer source in the mid-19th century was the nitrogen- and phosphorus-rich guano from Peru's Chincha Islands, but by the 1860s the supply was nearly exhausted.[11]

The solution, in Liebig's mind, was not necessarily to search the world for new sources of fertilizer, but rather to return the wastes of the cities to the land. As he wrote in *Chemistry in Its Applications to Agriculture*: "If it were practicable to collect, without the least loss, all the solid and fluid excrements of all the inhabitants of towns, and to return to each farmer the portion arising from the produce originally supplied by him to the town, the productiveness of his land might be maintained almost unimpaired for ages to come."[12]

While Liebig emphasized that better organic waste recycling was the only feasible way to replenish soil fertility in the short term, his theory of mineral nutrition did open the door to the

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[5] Justus von Liebig, *Chemistry in Its Application to Agriculture and Physiology, from the Fourth London Edition, Revised and Enlarged* (New York: John Wiley, 1872), 7-17.

[6] Ohn L. Havlin, Samuel L. Tisdale, Werner L. Nelson, and James D. Beaton, *Soil Fertility and Fertilizers: An Introduction to Nutrient Management*, eighth edition (Upper Saddle River, NJ: Pearson, 2014), 14.

[7] Justus von Liebig, *The Natural Laws of Husbandry*, edited by John Blyth (New York: D. Appleton, 1863), 183.

[8] Liebig, *Natural Laws of Husbandry*, 260-261, 363-369.

[9] Liebig, *Chemistry in Its Applications to Agriculture*, 158-159.

[10] Richard Bradfield, "Liebig and the Chemistry of the Soil," in *Liebig and after Liebig: A Century of Progress in Agricultural Chemistry*, edited by Forest Ray Moulten (Washington, DC: American Association for the Advancement of Science, 1942), 54.

[11] Vaclav Smil, *Enriching the Earth: Fritz Haber, Carl Bosch, and the Transformation of World Food Production* (Cambridge: MIT Press, 2001), 40-42; Thomas Hager, *The Alchemy of Air: A Jewish Genius, and Doomed Tycoon, and the Scientific Discovery That Fed the World but Fueled the Rise of Hitler* (New York: Harmony Books, 2008), 27-35; Lewis B. Nelson, *History of the U.S. Fertilizer Industry* (Muscle Shoals, AL: Tennessee Valley Authority, 1990), 35-36.

[12] Liebig, *Chemistry in Its Application to Agriculture*, 261.

possibility of eventually replacing organic wastes with concentrated mineral fertilizers. "It must be admitted as a principle of agriculture, that those substances which have been removed from the soil must be completely restored to it; but whether this restoration be effected by means of excrements, ashes, or bones, is in a great measure a matter of indifference," Liebig wrote in *Applications to Agriculture*. "A time will come, when plants growing upon a field will be supplied with their appropriate manures prepared in chemical manufactories—when a plant will receive only such substances as actually serve it for food."[13]

Liebig did not live to see that time—but when it came, his prediction was remembered by both proponents and opponents of chemical fertilizers. Neither group mentioned his emphasis on organic nutrient cycling.

Bones, Rocks, and Superphosphate

By the mid-nineteenth century, soil exhaustion due to poor waste recycling was causing serious problems in England, Europe, and the eastern and southern regions of the United States. Farmers began to realize that they had to return something to their soil if they wanted to maintain yields, and one of the first off-farm fertilizers used in England was imported human bones from old graves in Europe—30,000 tons of them a year.[14]

"England is robbing all other countries of the condition of their fertility," Liebig warned. "Already in her eagerness for bones, she has turned up the battlefields of Leipzig, of Waterloo and of the Crimea; already from the catacombs of Sicily she has carried away the skeletons of many successive generations. Annually she removes from the shores of other countries to her own the manurial equivalent of three millions and a half of men, whom she takes from us the means of supporting, and squanders down her sewers to the sea. Like a vampire, she hangs around the neck of Europe—nay, of the entire world!—and sucks the heart blood from nations without a thought of justice toward them and without a shadow of lasting advantage to herself."[15]

Though he didn't think that relying on bones from old battlefields was a sustainable way to feed the world, it was Liebig who first discovered that the phosphorus and calcium in bones became more available to plants when the bones were dissolved in sulfuric acid. In 1842, an English farmer named John Bennet Lawes took out a patent on the process for making what was soon known as "superphosphate" fertilizer from bones.[16] By 1853, there were 14 superphosphate factories operating in England, and the first superphosphate was manufactured from bones in the United States in 1852.[17]

Making superphosphate fertilizer was one thing; convincing farmers to use it was another. The year after John Bennett Lawes patented his superphosphate manufacturing process, he partnered with the chemist Joseph Henry Gilbert to test his new fertilizer. In 1843, Lawes and Gilbert established the Rothamsted Experiment Station and started long-term fertilizer experiments with wheat—some of which are still running today.[18]

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[13] Liebig, *Chemistry in Its Applications to Agriculture*, 179.
[14] Nelson, *History of the U.S. Fertilizer Industry*, 10-11.
[15] Richard Bradfield, "Liebig and the Chemistry of the Soil," in *Liebig and after Liebig: A Century of Progress in Agricultural Chemistry*, edited by Forest Ray Moulten (Washington, DC: American Association for the Advancement of Science, 1942), 54.
[16] Nelson, *History of the U.S. Fertilizer Industry*, 13-15.
[17] Nelson, *History of the U.S. Fertilizer Industry*, 36-39.
[18] A. E. Johnston and P. R. Poulton, "The Importance of Long-Term Experiments in Agriculture: Their Management to Ensure Continued Crop Production and Soil Fertility; the Rothamsted Experience," *European Journal of Soil Science* 69 (January 2018): 113-125; Sir E. John Russell, "Rothamsted and Its Experiment Station," *Agricultural*

After about twenty years, Lawes and Gilbert concluded that the wheat on plots given only inorganic fertilizers seemed to be doing just as well as wheat fertilized with farmyard manure. This seemed to confirm Liebig's theory that the main value of manure was in its mineral elements and that manure could be completely replaced with inorganic fertilizers of the proper chemical composition.

Encouraged by the Rothamsted experiments, farmers in Europe and parts of the United States began using increasing volumes of fertilizer from off-farm sources, and the superphosphate industry boomed. But turning bones into superphosphate did not actually create a new fertilizer source; it only made the phosphate in the bones more available to plants. The supply of bones was limited, and in the long term using them for fertilizer could not solve the problem of a broken waste recycling system.

What would happen when there were not enough bones left to make superphosphate? It was the ingenious Americans who answered that question by following Liebig's mineral nutrition theory one step further. Bones, after all, were still an organic fertilizer, so it wasn't much of a leap to use them in addition to, or instead of, manure. But if superphosphate worked just as well as bones, did it matter where the phosphate came from? What if superphosphate could be made from something in much greater supply than bones—like rocks?

In 1837, geologists discovered a rock formation in South Carolina that contained many nodules of phosphate-rich rock, ranging in size from small grains to large boulders. Thirty years later, they started mining this phosphate deposit and using it to make superphosphate fertilizer, chemically identical to the superphosphate made from bones.[19]

Since the deposits of phosphate rock were much larger than the previous supply of bones, the superphosphate industry boomed after this discovery. By 1889, as Lewis B. Nelson recorded in his 1990 book *History of the U.S. Fertilizer Industry*, 22 companies mining phosphate rock on land and 12 mining rock in rivers produced a peak of 329,000 long tons (a long ton is 2,240 pounds) of phosphate. Sixteen companies manufactured superphosphate from rock in Charleston, South Carolina during this period, for shipment around the world.[20]

After 1899, the production of phosphate rock in South Carolina declined rapidly as companies were faced with declining ore grades. After a hurricane in 1903 destroyed most of the equipment for the river rock companies, they ceased operation in 1909, and mining on land ended in 1920. The once-rich phosphate rock had been depleted in only thirty years—hardly a long-term solution to the world's fertilizer problems.[21]

The superphosphate industry didn't end when the ore ran out in South Carolina, however. In the 1880s, prospectors discovered even better and larger phosphate deposits in Florida—some with twenty to forty times more phosphate per acre than the South Carolina deposits. The Florida phosphate boom began in 1889, and from 1895 on Florida became the leading producer of phosphate rock both in the United States and the world. Phosphate rock was also discovered in Tennessee, Utah, Idaho, Wyoming, and Montana, seemingly assuring supplies for years to come.[22]

History 16 (1942), no. 4: 161-183; J. Storkey et al., "The Unique Contribution of Rothamsted to Ecological Research at Large Temporal Scales," *Advances in Ecological Research* 55 (2016): 3-42.

[19] Nelson, *History of the U.S. Fertilizer Industry*, 55-57.

[20] Nelson, *History of the U.S. Fertilizer Industry*, 61.

[21] Nelson, *History of the U.S. Fertilizer Industry*, 62.

[22] Nelson, *History of the U.S. Fertilizer Industry*, 63066, 74-83, 241.

Humus Farming

Things seemed to be going great for the chemical fertilizer industry at the turn of the twentieth century. Plants could get their three most important nutrients—nitrogen, phosphorus, and potassium—all from mined sources. Nitrogen came from guano mined off the coast of Peru, potassium salts (potash) from Germany, and superphosphate from Florida. Hauling stinky manure and town wastes back to farm fields was unnecessary and could transmit disease; concentrated chemical fertilizers were lighter, easier to measure and apply, and more sanitary.

Yet back at Rothamsted, the ongoing long-term fertilizer experiments began to show some disturbing results. Researchers found that, after half a century of long-term trials, chemically fertilized plots had greater variations in wheat yield and experienced more soil deterioration than plots fertilized with manure.[23] "The day is past when a chemist alone could supply all the science an agricultural experiment station could be supposed to need," a Rothamsted researcher wrote in 1915.[24]

Slowly but surely, even the chemical fertilizer industry began to realize that perhaps they had been a bit too hasty in throwing out organic fertilizers altogether. During World War I, the Rothamsted researchers encouraged farmers to compost straw with nitrogen and phosphate fertilizers to make "artificial manure" and replenish soil organic matter.[25] Back in the United States, the soil microbiologist Selman Waksman spent a decade studying humus and discovered that soil microorganisms were far more important to nutrient cycling and soil fertility than Liebig had ever imagined.[26] Another American soil scientist, F. H. King, traveled to China, Japan, and Korea to document the efficient systems of waste recycling that those cultures had practiced for centuries.[27]

It was in this context that Sir Albert Howard developed his Indore Method of composting as an alternative to chemical fertilizers, a way to close the nutrient cycle and return both inorganic and organic wastes to the soil.[28] Thirteen months after his beloved first wife, Gabrielle, died in 193, Howard married her sister—Louise Matthaei. Louise was a good writer who had worked for a publishing company as well as the International Labor Organization, a part of the post-World War I League of Nations. She was excited about the practical improvements that Sir Albert's Indore Method of composting could make in global agriculture, and she tutored Howard on how to present his ideas in a way that would be accessible to the general reader.[29]

In 1940, Sir Albert Howard published a seminal book entitled *An Agricultural Testament*. In it he brought together the philosophies and experiences of a lifetime into a coherent system of agriculture, which he called "humus farming." Though Howard did not initially use the phrase "organic agriculture" (it is believed to have been first used by the biodynamic farmer Lord Northbourne in his book *Look to the Land*, also published in 1940), his system was the cornerstone of the organic farming movement.

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[23] Sir John Russell, "Rothamsted and Agricultural Science." *Nature* 111 (April 7, 1923), no. 2788: 466-470.

[24] D. J. Jefferey, "Agricultural Research at the Rothamsted Experiment Station," *Nature* 95 (June 10, 1915), no. 2380: 405-406.

[25] H. B. Hutchinson and E. H. Richards, "Artificial Farmyard Manure," *Journal of the Ministry of Agriculture* 28, no. 5 (August 1921): 398-411.

[26] Selman A. Waksman, *Humus: Origin, Chemical Composition, and Importance in Nature*, 2nd edition (Baltimore: Williams and Wilkins, 1938).

[27] F. H. King, *Farmers of Forty Centuries: Organic Farming in China, Korea, and Japa*. (1911; repr., Mineola, NY: Dover, 2004).

[28] See "The Indore Method of Composting" for details about the Indore Method.

[29] Gregory Barton, *The Global History of Organic Farming* (Oxford: Oxford University Press, 2018), 94-117.

The central principle of Howard's organic farming was the Law of Return. Howard used the phrase "Wheel of Life" to describe the natural cycle of growth and decay.[30] Around the world, the ruins of once-great ancient civilizations served as a grim reminder of what happened when farmers failed to return their organic wastes to the soil and the Wheel of Life became unbalanced. If Western societies failed to honor this fundamental law of nature, they, too, would suffer the same fate.[31]

Howard thought that Liebig, by trying so hard to discredit the flawed humus theory of plant nutrition, had erred in assuming that humus was unimportant.[32] Maybe humus wasn't the carbon source for plants, but it had many important functions in maintaining soil health and tilth. Humus served as the perfect slow-release fertilizer, allowing mycorrhiza and other soil organisms to gradually make nutrients available to plants right when they needed them. Thus, it was important to return all organic wastes to the soil, not just their mineral constituents.

The biggest difference between Liebig and Howard's concepts of returning organic wastes to the soil was that Howard insisted that they be composted first, using the Indore Method that he had developed in India in the 1930s. Composting wastes before returning them to the soil made nutrients immediately available for plant uptake, rather than tying up soil nitrogen during the process of decomposition. This made compost an even more valuable fertilizer than the wastes themselves.

If the Law of Return was followed properly, and the Wheel of Life set in motion again, Howard believed that many of the problems plaguing contemporary agriculture would disappear. Soils fertilized with humus would be healthy and full of life. Plants grown on healthy soils would be strong and healthy, and pests and diseases would practically disappear.[33] Animals raised on healthy, humus-grown plants would also be healthy and free of disease, and humans who ate humus-grown produce would also be free of many of the nutritionally-caused diseases plaguing England at the time.[34]

Closing the Cycle

Howard realized that, in order to fully satisfy the Law of Return, *all* wastes needed to be composted and returned to the soil, including human excrements. Like Liebig, he decried the waterborne sewage systems that had been installed in practically all British cities by 1940. Sewage treatment plants were still largely nonexistent, and sewage was dumped directly into rivers and the ocean, turning potentially valuable fertilizer into a serious pollutant and health hazard.[35]

The Indore Method of composting seemed to provide the perfect solution to the sewage pollution problem. If human wastes could be collected and composted with high-carbon organic wastes, along with plenty of soil, they could become a safe and valuable fertilizer. To facilitate the collection of wastes for composting, Howard was a firm advocate for using "earth closets" rather than water closets in rural areas and new developments.[36]

But Howard realized that it would be nearly impossible to do away with water closets and a sewage system in the cities. With a waterborne sewage system, returning wastes to the soil was

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[30] Sir Albert Howard, *An Agricultural Testament* (London: Oxford University Press, 1940), 25.
[31] Howard, *Agricultural Testament*, 78-79.
[32] Howard, *Agricultural Testament*, 182.
[33] Howard, *Agricultural Testament*, 156-169.
[34] Howard, *Agricultural Testament*, 169-180.
[35] Howard, *Agricultural Testament*, 115.
[36] Howard, *Agricultural Testament*, 113-115.

much more difficult, but Howard thought that it would still be possible in municipalities that had installed sewage treatment plants. Sewage sludge, the solid residue from sewage treatment, was a valuable source of humus and phosphorus and could be used for composting.[37]

Howard also suggested using water hyacinth as a trap plant to recover potash and nitrogen from sewage effluent, which would purify the water before it was returned to a river. The hyacinths could then be harvested and composted with sewage sludge, thus creating a safe product that could return all the nutrients and much of the humus from the sewage back to the land.[38]

Of course, for the Indore Method to work properly, there needed to be some high-carbon vegetable wastes to compost with human wastes. These, Howard believed, could be reclaimed fairly easily—urban refuse was already being collected and dumped into 6-foot deep “controlled tips,” which were covered with a permeable layer of earth and ashes and resembled one of Howard’s compost heaps.[39] After a few years, these tips could actually become “humus mines”; all that was necessary was to pick out the tin cans and bottles (which were the only non-organic items), and the humus was pretty much ready to apply to the land.[40]

The ideal system would compost organic refuse and human wastes together, thus solving two waste disposal problems and creating valuable fertilizer in the process. The finished compost could then be distributed to the farmers who supplied food to the cities, creating a completely closed nutrient cycle.[41]

It would take major infrastructure changes to convert British agriculture to the organic method, but Howard and many others believed that it was worth it. They envisioned a national system of waste recycling that kept Britain’s fields permanently productive without being dependent on imported food or fertilizers. With German naval blockades and very real food shortages during World War II, this seemed like a highly desirable outcome. And thus it is not really surprising that the organic movement grew extremely rapidly in Britain—and came to the United States—during the war years.

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[37] Sir Albert Howard, *Farming and Gardening for Health or Disease* (London: Faber and Faber, 1945), 197.
[38] Sir Albert Howard, “Activated and Digested Sewage Sludge in Agriculture and Horticulture,” *Soil and Health* 2, no. 1 (Spring 1947): 13-25.
[39] Howard, *Agricultural Testament*, 110.
[40] Howard, *Agricultural Testament*, 105.
[41] J. C. Wylie, *Fertility from Town Wastes* (London: Faber and Faber, 1955).