The Indore Method of Composting: Foundation of Modern Organic Agriculture

One of the defining characteristics of organic farming in the 1940s was compost. Every organic farmer or gardener had a compost pile tucked away somewhere in the backyard, where bacteria, fungi, and earthworms transformed plant stalks, rotten vegetables and animal manure into that magical substance called “humus.” Properly made compost fertilized plants just as well as old-fashioned barnyard manure, but without the stink and flies. It built up soil organic matter, improved soil water-holding capacity, and provided food for myriads of soil organisms. A practical system of composting organic wastes made it possible to farm without using any chemical fertilizers at all, while maintaining or increasing soil fertility.

Almost all of these backyard compost piles (and many composting systems in use today) were based on a composting process developed by the British botanist Sir Albert Howard—the Indore Method. Because of his work on composting, Howard can justifiably be considered the father of organic agriculture, at least in English-speaking countries. But he had no idea how far-reaching his research would be when he first started experimenting with composting in India in 1924.

It all started in India…

Sir Albert Howard (1873-1947) was an English botanist who spent most of his career abroad in various parts of the British Empire. After spending some time in Barbados and Kent in England, he moved to the Agricultural Research Institute in Pusa, India, where he accepted the position of Economic Botanist in 1905. In that same year he married Gabrielle Matthaei, a highly intelligent plant scientist who soon became his inseparable partner.[1]

Sir Albert and Gabrielle made a wonderful research team. Together they worked to improve native wheat varieties and teach farmers better ways of cultivating indigo. They tackled such diverse problems as developing better methods of drying vegetables, designing better packages for fruit shipping, and teaching local farmers to feed their cattle silage during the dry season. No matter what the project, their primary goal was to improve Indian agriculture and help local farmers.[2]

Unlike many other British scientists of his time, Howard believed that it was important for him to understand traditional Indian agricultural practices before he attempted to improve them. After studying them for about five years, he found that some Indian agricultural practices were good and others were not.[3] His goal was to use modern scientific knowledge to improve Indian agriculture on its own lines, using methods that were practical for local farmers and didn’t require expensive machinery or chemicals.[4]

One observation that struck Howard as significant was that each Indian village was surrounded by a ring of lush, productive fields. Farther out from the villages, the land produced only poor crops. It didn’t take long for him to figure out what made the difference—all of the

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[1] Sir Albert Howard, *Farming and Gardening for Health or Disease* (London: Faber and Faber, 1945), 16; Philip Conford, *The Origins of the Organic Movement* (Edinburgh, UK: Floris Books, 2001), 54-55; Louise Howard, *Sir Albert Howard in India* (Emmaus, PA: Rodale Press, 1953), 20-22.

[2] Louise Howard, *Sir Albert Howard in India*, 67-68, 133-136, 138-144, 173-176, 184-186; Sir Albert Howard, *Farming and Gardening*, 19.

[3] Sir Albert Howard, *Farming and Gardening*, 17; Sir Albert Howard, *An Agricultural Testament* (London: Oxford University Press, 1940), 160-161.

[4] Louise Howard, *Sir Albert Howard in India*, 47.

night soil (human waste) from the villages was used to fertilize the closest fields. They remained highly productive, while the poor fields received little or no fertilizer. Obviously, the land was capable of producing good crops—but only if it was fertilized properly.[5]

The challenge for Howard was to come up with an inexpensive, effective fertilizer that could be produced in large quantities. The traditional British solution would have been to just spread animal manure on fields for fertilizer. In India, however, most of the cow manure was used as cooking fuel, leaving little for fertilizer. Other Englishmen had tried to get villagers to use different fuels for cooking, but Howard realized that cow dung was really the perfect fuel for slow-cooking a primarily vegetarian diet. He began looking for some way to fertilize the fields without relying solely on cow manure.[6]

In the early 1920s, Howard obtained a copy of Franklin King's *Farmers of Forty Centuries* and read it with the careful attention of an agricultural scientist. King, an American soil physicist, had traveled to China, Japan, and Korea in 1909 to see "permanent agriculture" in action—traditional agricultural practices that had maintained soil fertility for thousands of years.[7]

King recorded in meticulous detail many aspects of Chinese and Japanese agriculture. He saw cucumbers being grown on trellises, pear trees trained for easy harvesting, and rice being laboriously transplanted by hand.[8] With this intensive agriculture, Japan was able to feed three people per acre of arable land, while China supported six people per acre.[9]

Quite understandably, King was curious as to how this intensive agriculture had been maintained for nearly four thousand years. He found that the Chinese and Japanese were very scrupulous to return all organic wastes to the soil, including human excrement.[10] Nothing at all was wasted. Canal mud, bricks from old kangs, household waste, ashes, clover, and animal droppings from roads were scrupulously collected, composted, and used to fertilize the soil.[11] Because no organic material was left to rot, King noted that flies were practically nonexistent.[12] This return of all organic wastes to the soil made mineral fertilizers unnecessary.

Howard was intrigued by King's descriptions of Chinese and Japanese composting practices. Here was the answer to the Indian fertilizer problem! If all organic wastes could be composted, surely enough fertilizer could be produced to improve fields all over the country.

Research on compost, however, didn't fit into Howard's job description at Pusa. He wasn't able to start on composting research until 1924, when he was given official approval to found the brand-new Institute of Plant Industry in Indore.[13] For seven years, Sir Albert and Gabrielle labored together to develop a composting process that would eventually revolutionize global agriculture.[14] They would call it simply "The Indore Method of Composting."

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[5] Sir Albert Howard, *An Agricultural Testament*, 14.

[6] Sir Albert Howard, *Farming and Gardening*, 20; Sir Albert Howard and Yeshwant Wad, *The Waste Products of Agriculture: Their Utilization as Humus* (London, 1931; repr., Oxford City Press, 2011), 86-87; Louise Howard, *Sir Albert Howard in India*, 47.

[7] C. B. Tanner and R. W. Simonson, "Franklin Hiram King—Pioneer Scientist," *Soil Science Society of America Journal* 57 (January/February 1993): 286-292.

[8] F. H. King, *Farmers of Forty Centuries: Organic Farming in China, Korea, and Japa*. (1911; repr., Mineola, NY: Dover, 2004), 21, 203, 289-292.

[9] King, *Farmers of Forty Centuries*, 193.

[10] King, *Farmers of Forty Centuries*, 19.

[11] King, *Farmers of Forty Centuries*, 141-142, 167-174, 200, 251.

[12] King, *Farmers of Forty Centuries*, 78, 202.

[13] Louise Howard, *Sir Albert Howard in India*, 41-43; Sir Albert Howard, *Farming and Gardening*, 20-21; Conford, *Origins of the Organic Movement*, 54-55.

[14] Sir Albert Howard, *Farming and Gardening*, 21.

Waksman and Humus

Being a good scientist, Howard did a careful review of literature before he started experimenting with composting at Indore. He discovered that many advances in the knowledge of humus and decomposition had been made in the early 20th century, both in Great Britain and the United States. And he discovered that some of the best work on humus had been done by an American soil microbiologist—Selman Waksman.

Selman Abraham Waksman (1888-1973) was a professor of microbiology at Rutgers University. He spent most of his life studying actinomycetes, a little-known group of organisms that shared characteristics with both bacteria and fungi. His most famous contribution to science was the discovery of the antibiotic streptomycin, which workers in his lab isolated in 1944 from a soil actinomycete. In 1952, he was awarded the Nobel Prize for Physiology or Medicine for the discovery of streptomycin, which was the first drug ever developed that could cure tubercular meningitis.[15]

Before he discovered streptomycin, however, Waksman spent over a decade studying humus—that mysterious fertility-enhancing organic substance in soils. Unlike previous researchers, who looked at humus strictly from a chemical point of view, Waksman focused on the microbiological aspects of humus formation. He discovered that it was microorganisms—including bacteria, fungi and actinomycetes—who decomposed plant and animal residues and transformed them into humus and plant-available nutrients.[16]

Waksman was one of the first scientists to emphasize the importance of microorganisms in soil fertility and plant nutrition. Soils had to be supplied with a constant source of fresh organic matter to sustain these important microbes. Otherwise, crop yields would drop—even if chemical fertilizers were used. This was why "dead" subsoils were unproductive, despite containing plenty of mineral nutrients—they lacked humus-forming organisms and organic matter.[17] "Any system of permanent soil improvement or soil cultivation must, therefore, consider the influence of soil treatment upon the activities of the soil-inhabiting microorganisms," he wrote in his 1936 book *Humus: Origin, Chemical Composition, and Importance in Nature*.[18]

What fascinated Howard most was Waksman's experiments with forming humus "artificially," or outside the soil. Waksman discovered that any combination of organic materials could be turned into humus, provided that the organic materials contained approximately 30 parts of carbon to each part of nitrogen. Decomposing organisms use carbon for energy and require nitrogen to build up their microbial biomass. If a residue contains too much carbon, it takes a very long time to decompose. On the other hand, if there's too much nitrogen, much of it is lost

[15] Alex Sakula, "Selman Waksman (1888-1973), Discoverer of Streptomycin: A Centenary Review," *British Journal of Diseases of the Chest* 82, no. 1 (1988): 23-31; Farhat Yaqub, "Selman Abraham Waksman," *The Lancet Respiratory Medicine* 2, no. 9 (September 2014): 694-695.
[16] Selman A. Waksman, "What is Humus?" *Proceedings of the National Academy of Sciences of the United States of America* 11, no. 8 (1925): 463-468; Selman A. Waksman, *Humus: Origin, Chemical Composition, and Importance in Nature*, 2nd edition (Baltimore: Williams and Wilkins, 1938), 6, 12-15, 20, 102.
[17] Waksman, *Humus*, 412-413.
[18] Waksman, *Humus*, 413.

in the form of ammonia or nitrous oxide. With that perfect 30:1 carbon-nitrogen ratio, almost all of the nitrogen is fixed into stable, plant-available forms.[19]

It was a short step from Waksman's humus-formation experiments to composting; the same principles applied. Howard continued to look in the literature to see if anyone had tried using this information to compost organic wastes for the purpose of making fertilizer. And he found that researchers had done just that—at the Rothamsted Experiment Station.

Learning from Rothamsted

Rothamsted is a famous name in agricultural history. It is a private experiment station in England that was established in 1843 by John Bennet Lawes and Joseph Henry Gilbert. Lawes, who owned a factory that made superphosphate fertilizer from bones and sulfuric acid, was curious to see whether or not it was possible to completely replace farmyard manure with chemical fertilizers. He started a series of long-term fertilizer experiments with wheat—the first of their kind in the world. On some plots, he applied farmyard manure; on others, he used only chemical fertilizers; and as a control, he left some plots unfertilized. Some of these trials are still continuing today, making them the longest-running agricultural experiments in the world.[20]

After about twenty years, Lawes and Gilbert concluded that the wheat on the chemically fertilized plots seemed to be doing just as well as that fertilized with manure. Their experimental results encouraged many farmers to use increasing amounts of chemical fertilizers on their fields. Because of the role that Rothamsted played in the rise of chemical fertilizers, Howard would later view the experiment station as the archenemy of organic farming.[21]

By 1915, however, Rothamsted researchers found that chemically fertilized soils had greater variations in wheat yield and experienced more deterioration than plots fertilized with manure.[22] They began to realize that farmyard manure added something to the soil that chemical fertilizers didn't, but there just didn't seem to be enough manure in England to satisfy the demand for organic matter. However, increased acreage devoted to wheat during World War I resulted in a huge excess of straw. Cattle, they reasoned, could turn worthless straw into valuable manure; was there any way to do it without putting it through the digestive system of a cow?[23]

Shortly after the end of World War I, two Rothamsted researchers—H. B. Hutchinson and E. H. Richards—began working on a method to make "artificial farmyard manure" from straw. They soon discovered that the main reason straw didn't turn into manure on its own was because it had too high of a carbon-nitrogen ratio—nearly 100 parts of carbon to each part of nitrogen. The scientists at Rothamsted decided to try lowering the carbon-nitrogen ratio of straw by adding nitrogen fertilizer to it. After experimenting with several nitrogenous substances, they

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[19] Selman A. Waksman, Florence G. Tenney, and Robert A. Diehm, "Chemical and Microbiological Properties Underlying the Transformation of Organic Matter in the Preparation of Artificial Manures," *Journal of the American Society of Agronomy* 21, no. 5 (May 1929): 539-544.

[20] 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 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.

[21] Howard, *Agricultural Testament*, 14; Howard, *Farming and Gardening*, 79-84.

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

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

found that urine, urea, and ammonium carbonate all gave good results; ammonium sulfate, the most popular nitrogen fertilizer of the time, was too acidic to allow proper decomposition.[24]

While the finished "artificial manure" wasn't *quite* as good as the real thing, it was a vast improvement on plain old straw. The excited researchers, after a bit more experimentation, took out a patent on their method and called it the "Adco" process. Customers could purchase a powder containing nitrogen fertilizer, lime, and phosphate fertilizer, which they could then add to straw or other high-carbon organic wastes to create their own "artificial manure," or compost.[25]

Howard's Compost Work at Indore

Sir Albert Howard studied closely both the humus theory of Waksman and the practical composting experiments being done at Rothamsted.[26] He even experimented a bit with the Adco process himself, but was not really impressed with the finished product.[27] Besides, synthetic nitrogen fertilizers weren't readily available in India at that time, and Howard wanted to develop a method of composting that would be practical for the average Indian farmer. That was where Franklin King's *Farmers of Forty Centuries* came in. Obviously the Chinese and Japanese had been composting their organic wastes for thousands of years without buying Adco powders; it must be possible to do it with strictly natural materials.

The key, Howard discovered, was to classify organic wastes into nitrogen-rich and carbon-rich substances, then mix them together in proper proportions to reach that magic 30:1 carbon-nitrogen ratio. Fortunately, Nature had already made a distinction between carbon and nitrogen. Plant wastes (including cotton stalks, weeds, straw, and sawdust) were very high in carbon. Animal manure and urine, on the other hand, were very high in nitrogen. By combining 3 parts vegetable wastes to 1 part animal manure, Howard found that he got an initial carbon-nitrogen ratio very close to 30:1.[28]

In addition to properly balancing carbon and nitrogen, Howard found that there were a couple other ingredients essential to making high-quality compost. It was necessary to add lime, ashes, or some other base to the compost pile to keep it from becoming too acidic. In addition, he learned from *Farmers of Forty Centuries* that soil was an integral part of a good compost pile. Instead of just digging up dirt from his fields, however, Howard realized that the soil under his cattle pens was soaking up all the liquid excrements from his animals. This "urine earth" not only added soil to the pile, but was a practical way to catch and use all of the nitrogen excreted in urine.

After several years of experimentation, Howard came up with a very practical system of composting. He called it simply the "Indore Method," since he had developed it at Indore. To make compost using this "Indore Method," he first started by digging pits 30 feet long, 14 feet wide, and 3 feet deep. He then "charged" these pits by laying down a 6-inch layer of plant wastes, topped these with 2 inches of cow manure, sprinkled on some urine earth and wood ashes, and then started the layering process again until the pile reached 2-5 feet in height.

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[24] H. B. Hutchinson and E. H. Richards, "Artificial Farmyard Manure," *Journal of the Ministry of Agriculture* 28, no. 5 (August 1921): 398-411.
[25] Hutchinson and Richards, "Artificial Farmyard Manure," 398-399; Howard and Wad, *Waste Products of Agriculture*, 38-40.
[26] Howard, *Agricultural Testament*, 51; Howard and Wad, *Waste Products of Agriculture*, 41.
[27] Howard and Wad, *Waste Products of Agriculture*, 60-61.
[28] Howard and Wad, *Waste Products of Agriculture*, 58-60.

Once the compost piles were completed, Howard found that it was only necessary to turn them 2 or 3 times—once 3 weeks after "charging" and a second time 5 weeks later. The decomposition process started out aerobic, but anaerobic organisms took over after the second turn. After about three months, the compost was ready. The finished product was a brown or black powder, smelled like rich earth (not like manure), and had a carbon-nitrogen ratio of about 10:1—a perfect fertilizer for plants. Howard called his finished compost "humus," though technically it also contained microbes and other organic matter.[29]

The Indore Method was very practical. It helped solve the problem of adding fertilizer to depleted soils in India. Composting also provided a practical way to dispose of organic waste products. If cow manure wasn't available, human wastes worked just as well, and composting was much more sanitary than other methods of disposal.

Along with a chemist at Indore, Yeshwant Wad, Howard wrote up all the details of his Indore Method and published it in a thin book titled *The Waste Products of Agriculture: Their Utilization as Humus*. But his composting research came to a tragic conclusion when his beloved wife and fellow researcher, Gabrielle, died of cancer in 1930. Howard was broken-hearted and fell ill himself. As soon as possible, he wrapped up his research at Indore and retired. It was the end of his scientific career, and he left India in 1931 to return to England.[30]

But it was not the end of the Indore Method, nor of Howard's interest in composting. Ten years after leaving India, Howard wrote another book, entitled *An Agricultural Testament*. This book, which recommended a new agricultural system based on composting, soon became the manifesto of the new organic farming movement.

Other leaders of the early organic movement slightly modified the Indore Method to make it more practical for backyard gardeners. For example, J. I. Rodale gave detailed step-by-step composting instructions in his 1945 book *Pay Dirt*, where he suggested making compost piles at least 5 feet long, 5 feet wide, and 4 feet high.[31] Lady Eve Balfour provided similar information in her 1943 book *The Living Soil*.[32]

With these small modifications, Howard's Indore Method became the foundation of the early organic farming movement. Howard envisioned a day when all organic wastes would be composted and returned to the soil, making both waste management and fertilization much more sustainable. Though he would not live to see this dream become reality, Howard believed that he had found the key to keeping soils permanently fertile and productive. That key was compost.

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[29] Howard, *Agricultural Testament*, 41-47; Howard and Wad, *Waste Products of Agriculture*, 48-55, 73.
[30] Gregory A. Barton, *The Global History of Organic Farming* (Oxford: Oxford University Press, 2018), 94-100.
[31] J. I. Rodale, *Pay Dirt: Farming and Gardening with Composts* (Emmaus, PA: Rodale Press, 1945), 39-40.
[32] E. B. Balfour, *The Living Soil: Evidence of the Importance to Human Health of Soil Vitality, with Special Reference to Post-War Planning* (1943; repr. Soil Association, 2006), 56-60.