The Man Who Discovered the "Divine Materials" in Compost

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Compost life continues bright, vigorous and upstream for Harry Hoitink, as he "not really retires" from The Ohio State University research center.

Gene Logsdon

AS UNLIKELY as it may seem, Harry Hoitink — one of the most respected compost scientists in the world — has something in common with Walt Whitman, one of the most respected poets in the world. In one of his poems, Whitman exclaims with his usual ebullience: "Behold the compost! Behold it well! It grows such sweet things out of corruptions...it gives such divine materials to men and accepts such leavings from them at last."

Divine materials? As a plant pathologist, Hoitink would hardly allow himself such poetic license. But then again when he starts talking about the secrets that he and his team of scientists have unlocked in compost, one is tempted to think that Whitman was one very scientifically-perceptive poet or that Hoitink is one very poetically-perceptive scientist.

In Hoitink's long career, he first rocked the world of plant pathology and microbiology in the 1970s by proving that properly composted organic matter was not just a great soil amendment, but could actually suppress harmful pathogens in the soil and control fungal diseases more effectively and at less cost than toxic fumigants. This discovery eventually helped to end the common use of methyl bromide as a plant protectant and has made steam lines in greenhouses obsolete. The disease-suppressive materials in compost also controlled harmful soil nematodes that previously were kept in check with chemicals that can leach into ground water and drinking water and thus cause health hazards, not the least of which is sterility in humans.

Putting the disease suppressive ability of compost into practical use took many years; some of it was an uphill battle. Not only did disease suppressive effects in compost need to be proven unequivocally to doubting scientists, but the whole ancient process of composting had to be brought into the industrial world. Over a period of about 20 years, Hoitink participated in, and to great extent guided, the whole step by step, trial and error process that eventually resulted in today's varied approaches to industrial-scale compost manufacturing.

EFFECTS OF "TAILOR MADE" COMPOSTS

That was the first line of accomplishment. Starting about 1990, the second got underway. Compost scientists discovered effects from compost that if not divine might surprise even a divinity student. "We began to see that the effects of properly cured and aged composts could be more far-reaching than just sanitizing the soil safely," says Hoitink. "As we identified one beneficial strain of soil microbe after another, it was apparent that some of them could induce systemic resistance to diseases in the plants themselves. The resistance actually travels up from the roots to the tops of the plants to stop infections before they get serious. Just as interestingly, this ability to cause induced systemic resistance (ISR) varies from one species of microbe to another, sometimes from one strain to another. A particular strain of Trichoderma controls one disease; another a different disease. We began to perceive a possibility of preparing 'tailor-made' composts for specific problems, not only in greenhouses but perhaps out in farm fields as well."

Hoitink's team discovered that the transfer of ISR could also take place from root to root without inoculating all the soil involved, which of course meant a great savings in the amount of compost needed. "It may explain why a bushel of compost dumped under a tree in one heap would have beneficial effects on the entire tree area, not just where the compost was placed," he says. "This was electrifying. Biocontrol agents and possibly the signals that they induce in plants, were being passed along through the root system and on up the plant. Subsequent research revealed that certain strains of microbes in compost were activating genes in the plant. Several laboratories across the world are now studying just how this natural defense pathway induces this effect in plants. It seems that numerous genes are involved."

RESEARCH FRONTIER AND COMMERCIAL APPLICATION

These discoveries not only opened a vast new frontier for research but suggested a commercial application: Could specific compost products be marketed to growers for specific problems? To make a very long story short, Hoitink went through the long and thorny procedure of getting a patent for one such compost process, and then in time, a second patent. Trying to market a product that was technically considered a biofungicide, even if a nontoxic one, required EPA clearance also. "Getting EPA approval for a pesticide is a very trying process," says Hoitink, "but one I think is necessary even for composts."

His ventures into patenting have been something of an ordeal too. One company which agreed to market the first product, patented in 1987, decided the compost would cut into its fungicide sales too much, and dropped the idea. That product is now being considered for marketing by Sellew and Associates of Carlisle, Massachusetts. Trichoderma hamatum T382 is being test-marketed by Sylvan Biosystems of Cabot, Pennsylvania which in another location also grows the cultures for commercial mushroom houses and by Scientia Terrae, a division of DCM in Belgium which has rights to the process for all parts of the world outside the U.S.

GROWING UP IN HOLLAND

Hoitink’s career as an international guru of compost all started with sick rhododendrons. He grew up in Holland, where as a farm boy he remembers working with horses and wondering even then why plants got sick sometimes and sometimes didn’t. He went to MacDonald College in Canada as a Gold Scholar for his B.Sc degree in 1963 and to McGill University the next year for his M.Sc, earning his PhD at the University of Wisconsin in 1967. He then went to work at The Ohio State University in Wooster where he is now Professor Emeritus in the Department of Plant Pathology.

Rhododendrons came into his life a few years after he started to work at Ohio State. He was asked to look into the fungal disease that was plaguing commercial growers and which standard toxic fumigants were no longer controlling very well. "I learned to think like a microbiologist rather than a plant pathologist," he says, a twinkle in his eye. "That led to trying controls other than chemicals or disease resistance because standard practices available then were not effective. There wasn’t much in the scientific literature on natural controls but of course in Asia, composts had been used for many years to control plant diseases. There was a study done at Corvallis, Oregon in 1954, indicating that Phytophthora disease on strawberries could be controlled with ammoniated Douglas fir bark. So I started experimenting, and sure enough, composted bark and peat in potting mediums showed some promise. Sometimes it worked, sometimes not."

As he perfected his compost mixes in potting soils, he became known for his knowledge about composting and when cities started realizing in the 1970s that they had to find better ways of dealing with sewage sludge and yard wastes, he was called on to lend a hand. After that, as they say, the rest is history.

EARLY WALK THROUGH EXPERIMENTS

I was fortunate enough to have met Harry Hoitink when he was just beginning his work with disease suppressive composts in greenhouse potting mixes. I think it was 1973. I was still working at Farm Journal magazine where the idea of replacing pesticides with compost sounded suspiciously like a "commie plot." I didn’t have an appointment, didn’t know him at all, hadn’t even planned to visit him. But he literally took me by the hand and walked me through his experiments. I couldn’t tell a Trichoderma from a Pachyderma but at least I had enough brains to know when I was looking at something amazing. By the time I left, I was spouting words like Pythium and Rhizoctonia like I knew what I was talking about.

I’ve often asked Harry what it was like to champion a new idea that went against the grain of established thinking. "Your data must be rock solid," he says. "Your proofs have to go beyond what is normally required. The problem is critical with young scientists because it is difficult to get grants in controversial areas. I experienced a loss of competitive funding when my group first announced biological control of disease and pesticide replacement by compost."

But that didn’t stop him. He went out and got grants from industry. "I tend to disregard individuals stuck with old ideas. Fortunately, most people in academia are forward-looking, naturally inquisitive about new ideas. I guess I have always been a little on the contrary side. I recently looked at my motto in the yearbook when I got my B.Sc at Macdonald: ‘Living fish swim up the current; only the dead ones float along.’"

More than any scientists that I have interviewed over the years, Hoitink goes out of his way to credit accomplishments to what he almost always refers to as "my group." "A university-based individual's success is measured by what is produced, like everyone else," says Hoitink. "In the case of a professor like me, that means contributions to science and, being in agriculture, the impact we have on ag industries. Most important of all, it is the number of good students I can attract, train and help find positions for. Their success is my success."

Among his many graduate students who have made names for themselves in compost science and related fields are (in no particular order): Eric Nelson, now at Cornell; Alexandra G. Stone at Oregon State; Geoffrey Kuter, of Agresource, Inc., a Massachusetts-based commercial composting venture; Mathew E. Krause at DCM in Belgium; David Y. Han at Auburn, Alabama; Mike J. Boehm at Ohio State University; Tom J.J. De Ceuster, vice president with DCM in Belgium; Weizheng Zhang, crop consultant, Windsor, Ontario; Weidong Chen with USDA-ARS at Washington State University; Young Chung, Provost at the University of Seoul, Korea; Mirabelle Trillas, professor of plant biology at the University of Barcelona, Spain; Pervaiz A. Abbasi, Agriculture and Agri-Food Canada, London, Ontario; and Jaber al-Dahmani, Univ. of United Arab Emirates, Bahrain, UAE.

"You try to pick for your team the best and the brightest students and visiting professors available, of course — then see that they learn to publish and help them get good positions. Young faculty members in a controversial field need to have senior faculty members who know the facts surrounding new, controversial directions assisting them in career development. All this builds the successful group concept in academia and makes going to work a pleasure. Esprit de corps is critical to success. It happens automatically when you have bright enthusiastic students in the lab. I was lucky. The kind of work I do attracted lots of them."

Along the way, Hoitink has garnered his share of recognition including in 1998 the coveted Ruth Allen award given annually by the American Phytopathological Society. The award is given for work that radically changes the view of plant pathologists.

A NEW LOOK AT THE WORLD

One of the keys to understanding his enthusiasm, which in turn infects his associates (and even laypersons like myself), is learning to see the world as he does — a roiling, toiling, coiling, moiling mass of microscopic life swarming in the crust of the earth, invisible to the human eye, but utterly essential to the well-being of all life. A gram of soil contains millions of different types of microscopic plants and animals, at least millions of them in any given fistful of dirt. This makes the microbiologist or bacteriologist or plant pathologist, a sort of husbandman on the most demanding and utterly fascinating "farm" in the world: the whole universe. Only about one in 750 microbes have so far been shown to have a potential influence on plant health and by extension the health of animals and humans who eat the plants. It is a frontier beyond all frontiers except perhaps astrophysics where one is faced with the limitless reaches of space.

Manipulating this extremely complex world of living things requires as much art as it does science. A microbiologist must have an attitude towards microbes not unlike that of a shepherd toward sheep. Some microorganisms in soil are more aggressive than others, some more picky about what they eat, some seemingly more irritable than others, sulking when things aren’t quite right. "Scientific composting really is partly art which is why people who understand the way animals digest feeds can better catch on to what is required in composting than the beginning microbiologist." says Hoitink.

"Farmers who are familiar with soil, manuring, and seed bed preparation already have experienced some of the fundamentals of composting. As a teacher, I try to relate composting, which is essentially feeding microbes, to their experience. Farmers feed and take care of animals. They know that good composted manure smells like good soil. They understand that puddles in a compost windrow mean odor, and that adding sawdust to high protein wastes can avoid putrifaction."

Carl Kipp, the man who according to Hoitink, "deserves as much credit as anyone for the progress of sludge composting in Ohio," is an engineer, but with a background in animal nutrition. Kipp developed the Paygro system that makes excellent compost on a large scale with mixtures of cow manure and hardwood bark. Working with him, Hoitink developed a way to compost hardwood bark that would suppress certain plant pathogens for up to two years. "This was a great advantage. Peat alone was fairly easy to sterilize with steam, as was the general practice, but it was likely to be recontaminated by pathogens in a short time."

CARING FOR SOIL MICROBES

Once composters understand the basic "husbandry" of caring for soil microbes, it becomes easier for them to grasp how microbial life can with the right conditions, work the magic of disease suppression, explains Hoitink. In fresh organic matter, free nutrients are plentiful and both pathogens and biocontrol agents proliferate. The biocontrol agents, having plenty to eat, do not have to resort to their survival tactic of producing antibiotics that would kill off their pathogen competitors. Without natural antibiotics in the soil, the plants are more apt to get diseases. But in properly aged compost, nutrients are scarce, and the biocontrol microbes go on the offensive, produce antibiotics, and kill off competitors for available food. The plants stay healthy. Finally, as the food base declines further, the biocontrol agents decline also. Other microorganisms that can thrive in rundown soils take over and then the only way to control plant problems is with pesticides. The idea is to keep the organic matter stable at the stage where biocontrol agents keep attacking the pathogens with antibiotics.

"We are learning that during this process, microorganisms communicate with their environment and to some extent with each other," says Hoitink. "We call it ‘quorum sensing.’ Pathogens interact with biocontrol agents by signaling each other through molecules. The more stable the organic matter, as long as it has not been stabilized to the humic acid form, the greater the interaction, or perhaps, the better the communication."

The future obviously promises advances in the uses of compost that seem astonishing. In fact, Hoitink won’t yet discuss some of the intriguing developments in the works. But recent proven applications of compost science to field agriculture are already astonishing. For example, a new Pythium disease is attacking carrots, causing a rotten area right at the soil line. For the very large carrot farms of today, the disease poses an enormous problem, especially since the new disease seems immune to any chemical that can be used on a food crop like carrots. But an application of eight tons of composted cow manure per acre is bringing control whereas all chemical approaches failed. Several recent reports also show that foliar diseases of plants can be reduced by compost amendments in field agriculture.

How significant are results like these? What if new diseases increase as a result of soil practices which were once believed to bring higher yields but which are in fact destructive of soil quality and of microbial life? If that is the case, as past experience indicates, the only line of defense might be disease suppressive composts, green manuring or improved tillage practices. If that were to occur, we will raise a monument to scientists like Harry Hoitink who would rather swim upstream than float with the dead.