

Chapter Twelve

Compost Toilets and Dry Toilets

The World Health Organization in 2018 defined a toilet as a “user interface with the sanitation system, where excreta is captured, and can incorporate any type of toilet seat or latrine slab, pedestal, pan, or urinal. There are several types of toilets, for example pour- and cistern-flush toilets, dry toilets and urine-diverting toilets. The superstructure of the toilet may be a stand- alone structure, or the toilet may be located within a building. . . .” They add that “billions of people live without access to even the most basic sanitation services. Billions more are exposed to harmful pathogens through the inadequate management of sanitation systems, causing people to be exposed to excreta in their communities, in their drinking water, fresh produce, and through their recreational water activities.”¹

It never ceases to amaze me that many, if not most, of the citizens of the US, approximately 4 percent of the world’s population, don’t have much of a clue about how the other 96 percent of humanity lives. People who grow up with water toilets and never knew any other type of sanitation system can’t conceive of what it’s like to live without a toilet. But hundreds of millions of humans still practice “open defecation,” which means they crap outside in a field, behind a tree, or in their backyard, every day. Still many more only have a hole in the ground for a toilet, which is considered an improvement over open

defecation. The holes are usually located away from the living area because they're full of poop, they stink like hell, and they breed flies by the millions. So the toilet is a hundred feet away, outside, in the rain, at night, and maybe they have little kids to deal with. Or maybe they're bed-ridden, elderly, incapable of walking, or amputees, or have diarrhea, or are even just temporarily ill. We're talking numbers in the billions here, people who have never had a water toilet, nor have their ancestors, nor will their descendants. What some take for granted is not possible for others, and never will be.

Providing comfortable, secure, convenient, odorless, indoor, sanitary toilets for these people is a dilemma that has vexed developers and sanitation workers for generations. Billionaire philanthropists try to reinvent the toilet by creating yet another hi-tech disposal device, priced way out of reach of those who need it the most. Billions of people live on \$2 US a day or less; they're not going to buy a Nano-Toilet. They're going to continue defecating in a hole in the ground until someone can show them a realistic alternative they can afford.

Much of the problem is psychological. Notice that human excrement is commonly referred to as "human waste" in US culture. When you say human waste, people automatically assume you're referring to human excrement. But what about the mountains of human waste that are dumped into landfills across the country every day? What about the pollution in our waters from sewage systems and factory effluents; the particulates in our air from smoke stacks, tail pipes and other pollution sources; what about the body burden of synthetic chemicals we all carry in us all the time; that cigarette butt you flung out the window of your car? *That's* human waste! Why is only our poop thought of as human waste?

Ironically, human excrement is actually a recyclable resource. It has value as food for microbes. The microbes eat it, along with just about any other organic materials we can throw at them, and they convert it to compost. When composting is used as a sanitation system, sewage can be eliminated, as can diseases associated with fecal contamination of the environment; toilets can be located comfortable indoors

where they're safe and convenient; and they can be odor-free. There is no waste as nothing is being wasted, and the result is compost suitable for growing food.

One of the seminal works on composting “*night soil*” (which is combined human fecal material and urine) was published by Harold B. Goetaas, professor of sanitary engineering at the University of California, Berkeley, in 1956 (World Health Organization Monograph Series Number 31). In the 205-page publication, the word “waste” is used 254 times! Anyone can write an entire book on composting and never use the word “waste” once, because composting is the recycling of organic materials, not the disposal of waste. Yet “composting waste” is an unfortunate oxymoron still in widespread use today, especially among compost professionals and academics. It's simply not *waste* if it's being recycled, no matter what it is. When I'm composting organic material and someone states that waste is being used, I say “show me the waste — point to it.” When the process is done, there is only compost; there is no waste and nothing is wasted. I know it seems like I'm belaboring this point in this book, but it needs to be done. If we can understand what waste truly is, maybe we will also eventually understand that our excretions are valuable and can be constructively reused. The billionaires who are concerned about the global sanitation issue should be thinking about *recycling*, not disposal. Think outside the box!

In 2018 the World Health Organization (WHO) declared that people have a right to water and sanitation: “After decades of neglect, the importance of access to safe sanitation for everyone, everywhere, is now rightly recognized as an essential component of universal health coverage. But a toilet on its own is not sufficient to achieve [these goals]; safe, sustainable and well-managed systems are required.” They add, “The human right to sanitation entitles everyone to sanitation services that provide privacy and ensure dignity, and that are physically accessible and affordable, safe, hygienic, secure, socially and culturally acceptable.”²

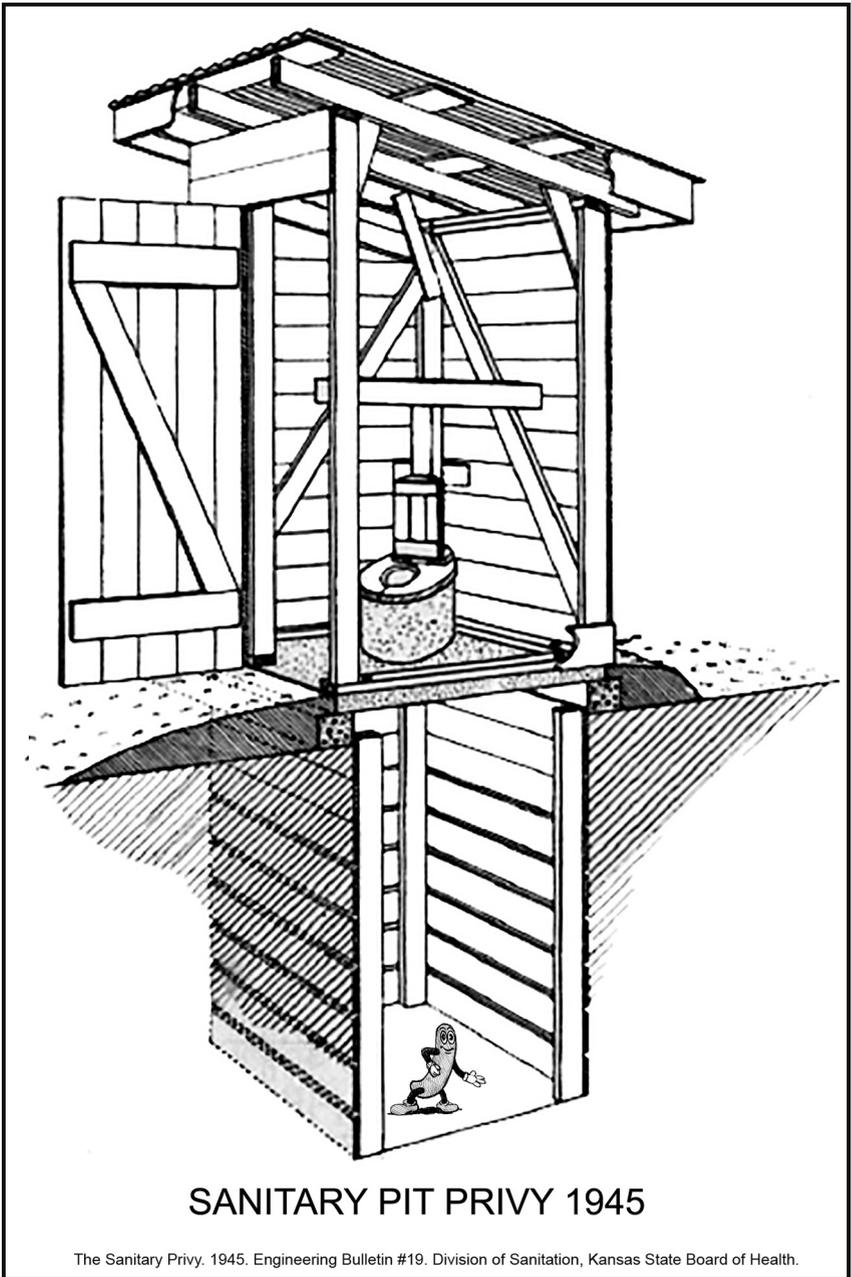
The United Nations is on the same page: “Water and sanitation facilities and services must be available and affordable for everyone, even

the poorest. The costs for water and sanitation services should not exceed 5% of a household's income, meaning services must not affect people's capacity to acquire other essential goods and services, including food, housing, health services, and education. Almost two in three people lacking access to clean water survive on less than \$2 a day, with one in three living on less than \$1 a day.”³

In 2013 WHO described “improved” sanitation to include “a pit latrine whereby the pit is fully covered by a slab or platform that is fitted either with a squatting hole or seat. The platform should be solid and can be made of any type of material (concrete, logs with earth or mud, cement, etc.) as long as it adequately covers the pit without exposing the pit contents other than through the squatting hole or seat.”⁴ This is an improvement over a basic hole in the ground with a couple of boards spanning the pit where one can squat and relieve oneself. Small children are known to fall into these “unimproved” pit latrines, and some die there.

And since we're talking about squatting, I can't tell you how many people have expressed to me the opinion that squatting is the natural way to “go.” They say that people around the world prefer to squat, that it's the only way to thoroughly evacuate your bowels, and so on. I was able to test this theory during a trip to Africa in 2018 where only squat toilets were available. What I found was that people squat because they don't have a choice — what else are they going to do if they're crapping in a hole or open defecating, stand up? Kneel? Try defecating standing up. When there's no place to sit down, you *have* to squat. Given a choice, they will choose a sit-down toilet, especially if they're elderly, have a cell phone in their pocket, want to read while on the pot, and so forth.

WHO adds that a “composting toilet [they mean a dry toilet] is a toilet into which carbon-rich material such as vegetable wastes [they mean scraps], straw, grass, sawdust, and ash are added to the excreta and special conditions are maintained to produce inoffensive compost [probably septage, not compost]. A [dry toilet] may or may not have a urine separation device.” However, ash has no carbon and doesn't be-



long in compost. Furthermore, the literature is rife with references to “composting” toilets that are actually dry toilets that do not make compost. The amount of misunderstanding and misinformation being circulated on this topic is incredible.

For example, the US EPA published a document in 1999 about “composting” toilets. It stated, “A composting (or biological) toilet system contains and processes excrement, toilet paper, carbon additive, and sometimes, food [scraps]. Unlike a septic system, a composting toilet system relies on unsaturated conditions where aerobic bacteria break down [organic material]. This process is similar to a yard [debris] composter. If sized and maintained properly, a [biological] toilet breaks down [organic material] 10 to 30% of its original volume. The resulting soil-like material called ‘humus,’ legally must be either buried or removed by a licensed septage hauler in accordance with state and local regulations.”⁵ Clearly they’re referring to dry toilets or biological toilets, but not compost toilets. The material produced by dry toilets is not necessarily sanitary, which is why it’s considered *septage* and is supposed to be removed and processed by a septage hauler. Of course, that material could instead be actually composted as a secondary procedure, rendering it hygienically safe and usable as an agricultural resource, rather than disposed of as a waste.

The EPA goes on to state, “The [toilet] unit must be constructed to separate the solid fraction from the liquid fraction and produce a stable, humus material. . . . Once the leachate has been drained or evaporated out of the unit, the moist, unsaturated solids are decomposed by aerobic organisms.” Yep, that would be a urine-separating dry toilet, not a compost toilet. They add that the toilet chamber may be heated by solar or electrical means, which is common in urine-diverting dry toilets. Compost toilets, on the other hand, rely on actual composting and on internal microbiological heat — no urine separation is needed.

Remember that composting, by definition, requires (1) human management, (2) aerobic conditions, and (3) the generation of mesophilic and thermophilic heat by microorganisms. “Composting toilets” is a misnomer. Composting is unlikely to take place inside any

toilet receptacle because sufficient biological heat will not be generated, for several reasons. For one, the mass of the collected toilet material may be too small; for another, the collected material may be too dry due to urine separation or intentional dehydration; for another, the toilet material may be anaerobic. Most devices that people call “composting toilets” would be correctly referred to as “dry toilets” or “biological toilets,” but they should not be referred to as “composting” devices. They do not make compost; instead, the result is decayed organic material, or what’s known as “septage,” which has not been subjected to the biological temperatures of true compost and is therefore not sanitary. A 2017 research study pointed out that *“conditions required for pathogen or parasites die-off. . . . are seldom or never achieved in UDDTs [urine diverting dry toilets] feces chambers in real situations.”*⁶

One of the reasons dry toilets don’t reach and maintain thermophilic conditions is that the volume of the material inside the toilet chamber is too small. One interesting research study published in 2007 compared temperatures achieved in three different “backyard” compost containers: a plastic bin, a wooden bin, and a small open pile. The volumes were small by composting standards at 74 gallons each for the plastic bin and the open pile, and 209 gallons for the wooden bin. The organic mix was made from plant material; no food scraps or manures were used. A hundred cubic meters of the mix were generated using shredding machines; 30 cubic meters were used in the numerous bins being tested, while the remaining 70 cubic meters were left in a pile. To make a long story short, none of the bins achieved thermophilic temperatures. The maximum temperature reached was about 77°F (25°C), whereas the temperatures in the big left-over pile ranged from 104°F (40°C) to 158°F (70°C). The researchers concluded that “the small volume of material is thought to be the most likely cause of the lack of temperature increase.” They also suggested that bins of at least a cubic meter in size “have greater potential to maximize heat generation,” and that “composters should attempt to better insulate compost vessels,” as well as keep some type of cover on top to protect from excessive rainfall and to insulate the pile.⁷ My own experience bears this

out. Dry toilet chambers tend to be much smaller than a cubic meter, and even when they are large, there is no way to insulate around the collected organic material inside the chamber, where the toilet contents may be right up against a plastic or metal wall.

I first became aware of the importance of the semantics surrounding composting when a dry toilet vendor from New Zealand was visiting me in my home in Pennsylvania. We were sitting at my kitchen table one evening when the conversation went something like this:

“Composting doesn’t eliminate pathogens,” he said.

“Yes, it does,” I replied. “It’s well-established science.”

“No, it doesn’t, and I can prove it. Scientists have done research on this and have published papers showing that composting doesn’t eliminate pathogens. I have one such research paper here with me now.”

“Let me see it.”

My friend rooted around in his briefcase and pulled out a printed document, a published research paper. I took it and reviewed it. It was a paper about so-called “composting toilets” and their inability to eliminate pathogens in the toilet material.

“This isn’t compost,” I said. “They’re not composting. They’re just calling it a ‘composting toilet’ because they don’t know what composting is. What they have is a *dry toilet*, and yes, pathogen removal is not very successful in these types of toilets precisely because they do not compost. If they take the collected toilet material and run it through a true composting process, then test it, they will find that the pathogens have been eliminated.”

A 1986 research project, again by the EPA, studied a variety of commercial and home-made dry toilets in California. To their credit, they referred to them throughout the paper as “biological toilets.” Their conclusions were far from flattering: “Evidence suggested that performance of the biological toilets varied from mere storage of human excrement to partially successful decomposition of organics and/or reduction of microbiological hazards. The physical presence of solids at the final chamber of a toilet system had no bearing on whether or not

treatment had occurred. The rate at which excrement moved through a system depended solely on system capacity and rate of usage. In addition, the physical appearance and odor characteristics were not reliable indicators of the biological degradation process.” To top it off, they added, “Most of the system users were advocates of alternative technology, yet they were generally unable to make their systems work satisfactorily. Few of these systems displayed any significant evidence of biological composting during 17 months of observation. The systems repeatedly showed evidence of conditions unfavorable for the occurrence of biological composting — for example, inadequate use of bulking agent, too much moisture, anaerobic conditions, insect vectors, and ambient temperatures. The users were generally not well informed about the particular sensitivities of their systems to improper operating procedures. Since a majority of the users were unwilling and/or unable to perform recommended operation and maintenance procedures, it is unclear whether any of the toilet systems studied were capable of acceptable performance.”⁸ Maybe they should have just collected their toilet material and composted it in an outdoor bin instead. That works.

So dry toilets are unfairly giving composting a bad name. As stated before in this book, this is a widespread problem, including among scientists, researchers, post-docs, grad students, and academics in general, as well as the general public. I confess, I also have been guilty of this misunderstanding in that I have incorrectly referred to dry toilets as “composting toilets” in the previous three editions of this book. Just like turning my compost piles at one time because everyone else was doing it, I had adopted the common vernacular and repeated it. My intention with the fourth edition of this book is to correct the terminology and try to set the record straight.

A *dry toilet* is any toilet that doesn’t use water to flush away “waste,” which is what a water toilet does. It disposes of waste. A dry toilet can be a urine-diverting toilet, a chemical toilet, an incinerating toilet, a biological toilet, an eco-toilet, or any of a multitude of devices designed to collect and process toilet material without water. Many dry toilets are disposal units, too, but some are recycling devices.

Most of the processing in dry toilets is done by dehydrating the toilet contents. This is achieved by “urine diversion,” which means either diverting the urine away from the solids at the source by utilizing a toilet seat designed for this purpose, or by allowing the urine to drain away from the toilet contents. These toilets are often referred to as “urine diverting dry toilets” or UDDTs.

Another type of dry toilet is a “compost toilet.” Notice that it isn’t called a “composting” toilet, because that implies that composting is taking place in the toilet. If you want to dwell on the semantics (and yes, readers will contact me to argue this point), the word “composting” is a present participle derived from the verb “to compost” which refers to an action. A composting toilet would then be a toilet that composts. A singing toilet would be a toilet that sings. A laughing toilet would be a toilet that laughs. You get the point. Since the toilets don’t compost, there’s no point in calling them composting toilets.

A *compost* toilet is any toilet that collects toilet material so that it can be composted. And composting, as you already know, requires human management, aerobic conditions, and the generation of biological heat. Since compost toilets collect toilet material for composting rather than for dehydration, urine separation is neither necessary, nor recommended. Urine is quite a good additive in compost piles.

There are scores of dry toilets available on the market today, worldwide. If the contents of the toilets are collected and then composted (most aren’t), they could correctly be referred to as compost toilets. When the researchers test the finished products of true composting, they will find that the human disease organisms have been completely eradicated, greatly reduced, or substantially weakened. Which is exactly why we want to compost humanure.

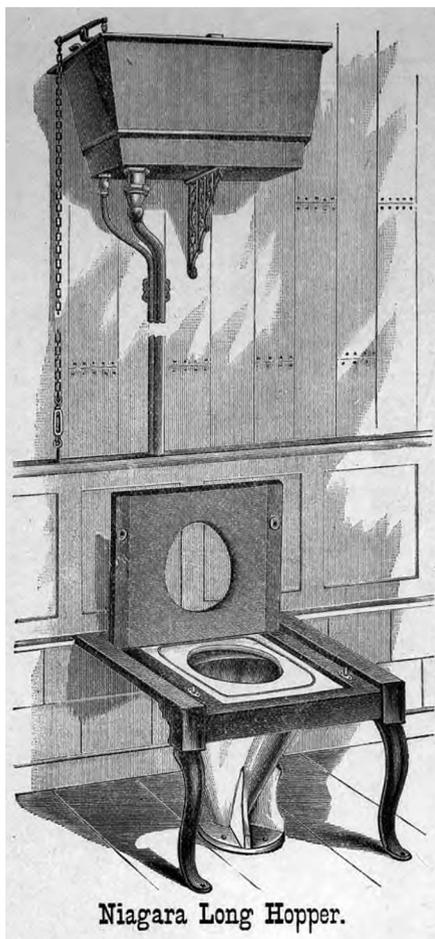
THE EARTH CLOSET

Let’s take a journey back in time to when population centers were all dealing with sanitation issues. We’ve already discussed cholera and epidemics caused by water pollution in England in the late 1800s. The

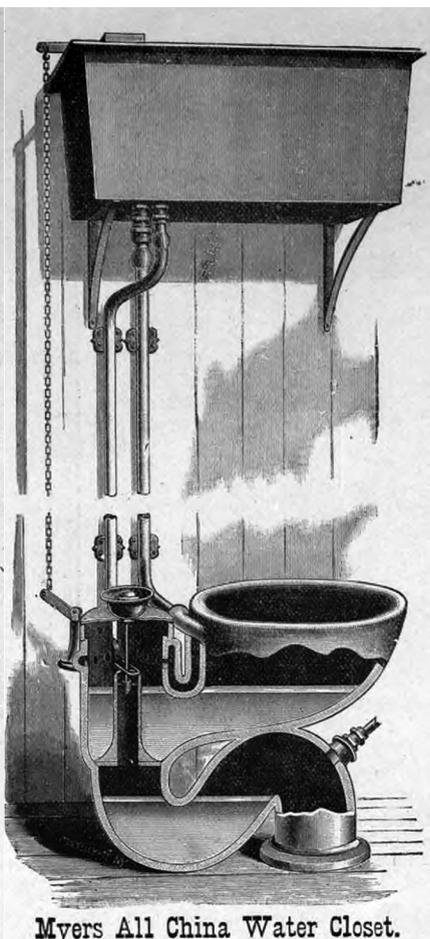
solution was water toilets and sewers designed to carry the excrement out to the river, dump it, and forget about it. Water toilets today are often credited as being the single most important device for improving human health on this planet. Yet, when they first came into use, they were blamed for *causing* cholera.

The Sanitary Fertilizer Company in 1888, clearly trying to convince the government about the agricultural value of human manure, soundly condemned water toilets. “The shortcomings of modern sanitary methods are due to the fact that in dealing with organic refuse, a scientific error is being committed by mixing excremental matter with water by means of the water-closet and the sewer,” they stated. Adding, “Not only does the putrefaction of human refuse tend to fill our rivers with foulness, but this mixture of organic matter with water is attended with other bad consequences. It fills the air of our homes and cities with disease. Since the introduction of the present water-closet, and as a direct consequence of it, we have severe epidemics of cholera, a disease not previously known; and enteric or typhoid fever, previously almost or quite unrecognized, has risen to the place of first importance among fevers of this country.”⁹

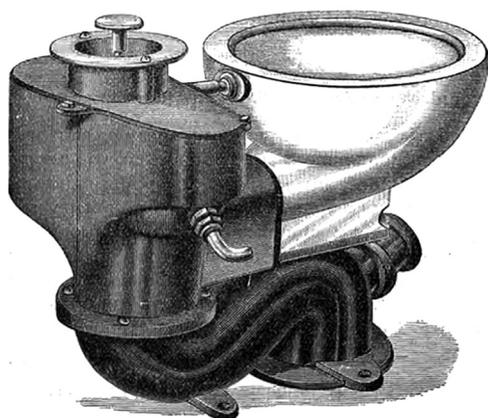
Could it be that the water closet (flush toilet) actually *increased* the incidence of waterborne disease, and therefore sanitation professionals had to scramble to build sewers that would flush the polluted water away in a more rapid and thorough manner so that the epidemics could be quelled? A report by the British Royal Commission on Town Sewage regarding local rivers seemed to bear this out: “The increasing offensiveness of the Medlock and Irwell at Manchester, of the Mersey at Stockport, of the Tame at Birmingham, and of many other rivers, proves that a national evil is fast growing up which demands immediate and serious attention. The last named river. . . . a small stream in itself, may be said without exaggeration, during dry seasons to contain at Birmingham as much sewage as water. The increasing pollution of the rivers and streams of the country is an evil of national importance, which urgently demands the application of remedial measures.” Some of these rivers were drinking water sources for entire towns.¹⁰



Niagara Long Hopper.



Myers All China Water Closet.



Egg-oval Water Closet.

1884 Water Closets

A Dr. Farr at that time reported that water closets were invented about 1813 and came into broader use among the upper class around 1828 to 1833. The effluent from these toilets was collected in cesspools with overflow drains. “It will be noticed,” says Dr. Farr, “that the deaths from cholera and diarrhea increased in London in 1842, increased still more in 1846, when the potato crop was blighted, and in 1849 culminated in the epidemic of cholera.” The first appearance of epidemic cholera and a striking increase of diarrhea in England coincided with the adoption into general use of the water-closet system, “which had the advantage of carrying night-soil out of the houses, but the incidental and not necessary disadvantage of discharging it into the rivers from which the water supply was drawn.”¹¹

In 1886, a Mr. Hedges, a laborer, and his wife, both forty-six, died of “Cholera Asiatica,” the husband after fifteen hours and the wife after twelve hours of illness. The discharges were traced from a water-closet at 12 Priory Street, draining into the Lea River, which resulted in an outbreak of cholera and diarrhea that ultimately caused the death of over 4,000 persons. “If the excreta of the Hedges family had been buried, the waters of the Lea would not have been infected, and possibly 4,000 lives would have been saved.”¹² Burial of the excrement would have helped, especially if it had been buried in a compost pile.

The new water closet trend in the late 1800s had competition in the form of Earth Closets. These would have been the predecessors of today’s dry toilets, and they bear an uncanny resemblance to compost toilets, except at that time, they didn’t know what compost was or how to make it. They didn’t know about microorganisms consuming organic material back then, but if they had, things may have been very different around the world today.

Water closets, despite the creation of water pollution, were rapidly gaining popularity in the late 1800s. An 1870 account made this clear, “The water-closet has won its way to universal favor on the grounds of convenience, comfort, and decency alone. These it secures; and there is no luxury connected with modern living that is so highly prized by those who have once known its benefits. The water-closet is the chief

thing of which women living in the country envy their city cousins the possession.”¹³ Of course, this is perfectly understandable. If you have always had to use an outhouse or pit latrine and now you have an odorless indoor toilet, this would constitute a revolution in sanitation.

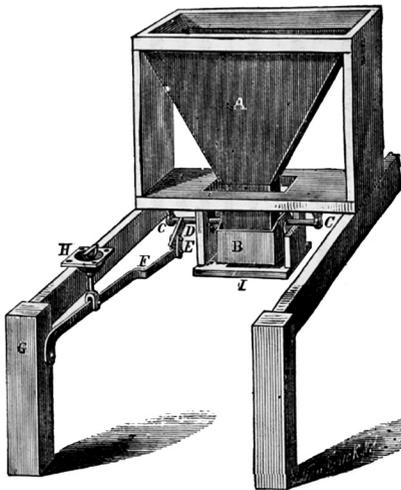
The downside of the new flush toilets included not only the expense, but also plumbing, pumps, piping systems, tanks, and vents that could malfunction, clog, or freeze in the winter, not to mention plumber’s fees, and, “worse than all, a receptacle in the garden known as a cesspool” which usually had a subterranean connection to the drinking water supply. “The manure is, of course, lost; it is worse than lost. Too far below the surface to be of use to vegetation, it lies, a festering mass, sending its foul and poisonous gases back through the soil pipe and kitchen sink drain into the house, and developing in its putrid fermentation the germs of typhoid fever and dysentery that any film of gravel in the lower soil may carry to the well or the spring.”¹⁴

Obviously, water toilets had their detractors. One of the most well known was the Reverend Henry Moule, who in 1868 published *Earth Sewage Versus Water Sewage, Or, National Health and Wealth Instead of Disease and Waste*, in which Moule presented the case for earth closets vs. water closets. “This invention [earth closets] effectually remedies evils arising from common cesspool privies and water-closets; and equally prevents the offensive smell consequent on the use of the ordinary commode in bedrooms, hospital wards, prison cells, etc. It is founded upon the well-known power of earth as a deodorizing agent: a given quantity of dry earth destroying all smell, and entirely preventing noxious vapors and other discomforts. Apart from its superiority over the water system in destroying all smell, the earth system is more economical. . . . there being no expensive cistern or pipes; no danger from frost; and the product being a manure of value to farmers and gardeners. The supply of the earth, and its removal, are attended with no more inconvenience than the supply of coal and the removal of ashes, whilst the value of the manure amply pays the cost.”¹⁵

The principles of the “dry earth system” were simple enough. First, deposits in toilets, whether solid or liquid, were covered with a dry soil.

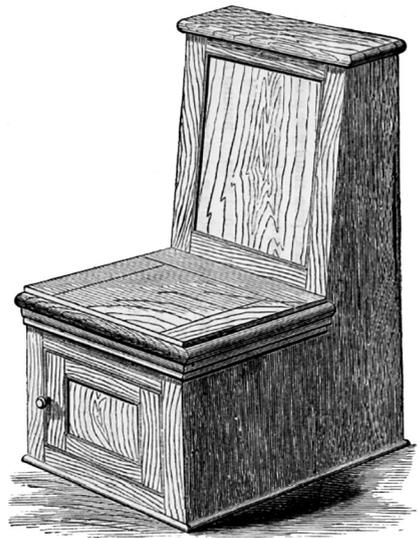
THE EARTH SYSTEM.

IT is barely two years since the first complete description of the Earth-Closet was published in America—in Judd's Agricultural Annual for 1868—and not a year and a half since the first Commode was imported; yet it may already be said that the Earth-Closet has gained such a foot-hold that its universal adoption (except in houses in which there are water-closets supplied from public water-works) is certain. It has now reached the "important if true" stage. The whole community is ready to concede that, if the Dry Earth system will accomplish what is claimed for it, nothing can prevent its general adoption. It remains necessary only to prove that it will do this, which, with the facts at command, is an easy task.



THE MECHANICAL PARTS OF THE COMMODE.

The same Fixtures are used in Closets.



THE COMMODE.

Waring, George E. Jr. (1870). Earth-Closets and Earth Sewage

When the soil/feces/urine combination accumulated in the toilet, it was removed from the toilet chamber, spread on the ground and allowed to dry out. This dry combo was then used again to cover the toilet contents, then again, or in the words of Moule, the first earth toilet principle is “the marvelous capability of dry and sifted earth, or of clayed subsoil, for deodorization. This is such, that two pounds weight of such earth, or three half-pints, is amply sufficient for one use of [the toilet]. And if with this quantity the excreta covered by it be intimately mixed, it may in a very short time be dried without offence by artificial heat. And the mass, when dried thus, or by natural heat, may be used again and again for the same purpose. I have tried it with success ten times.”¹⁶

The second principle is that the toilet material is captured and deodorized at the source and never allowed to enter any waterways. The third is that the feces/soil mix can be used for agricultural purposes. One system allows the toilet contents to fall into a vault “so that within six weeks from the deposits falling, the excreta and any vegetable matter disappear; and the mass looks and smells like fresh earth. And in that vault, without the omission of any offensive smell, it may continue three, four, or six months.” The vaults can be constructed so they can be accessed from outdoors, much like the common coal chutes of that era, and the soil periodically hauled away. Moule mentions a school of seventy boys using earth closets where a farmer paid *them* monthly to haul away their toilet by-product.¹⁷

Moule pointed out that the City of London was throwing away no less than £2,500,000 annually into the Thames from agricultural nutrients flushed down toilets, and was spending £3,500,000 on increasing sewer capacity, a combined expense of £6,000,000 that could be eliminated by the widespread use of earth closets.

Moule calculated that about two pounds of earth (1.5 pints) would be needed per “flush,” and that one person produces an average of four pounds a day of excretions. For a family of five persons, this would produce one ton of toilet by-product in sixteen weeks, or thirty-four tons a year. He adds that “it has been found that the annual evacuations of a well-fed man suffice to manure half an acre of ground.”¹⁸ Moule in-

sists that this type of sanitation is not new, but “was early known to the Hindus, and further that it has been practiced amongst the Chinese in the south of China, from time immemorial. It would seem indeed that the observance of a similar practice was enjoined by Moses upon the Israelites in the wilderness.”¹⁹

The gardens benefited from the earth closet’s by-products. In describing one gardener’s experience, Moule stated, “His barren garden was changed into a fruitful field. His peas grew seven feet high and were covered with pods; the white head of his cabbages weighed four pounds and upwards, and the passers-by stopped with wonder to ask what made his crops so much better than their own.”

Of course, we all know now that the water closets beat out the earth closets, and while water toilets are found everywhere in the US and many other countries, earth closets are nowhere to be found. Were there faults inherent in the design of the earth closet that may have led to its demise? Well, yes, in fact, there is a hygienic issue with the use of earth in a toilet of this nature. Jenkins’s three rules of human sanitation were not known back then (and still aren’t): (1) never allow human excrement to come in contact with water; (2) never allow human excrement to come into contact with soil; and (3) wash your hands after defecating (OK, the third rule is well known). Obviously, Moule was well aware of the first rule, but the second rule of sanitation was violated when soil was used as a “cover material.”

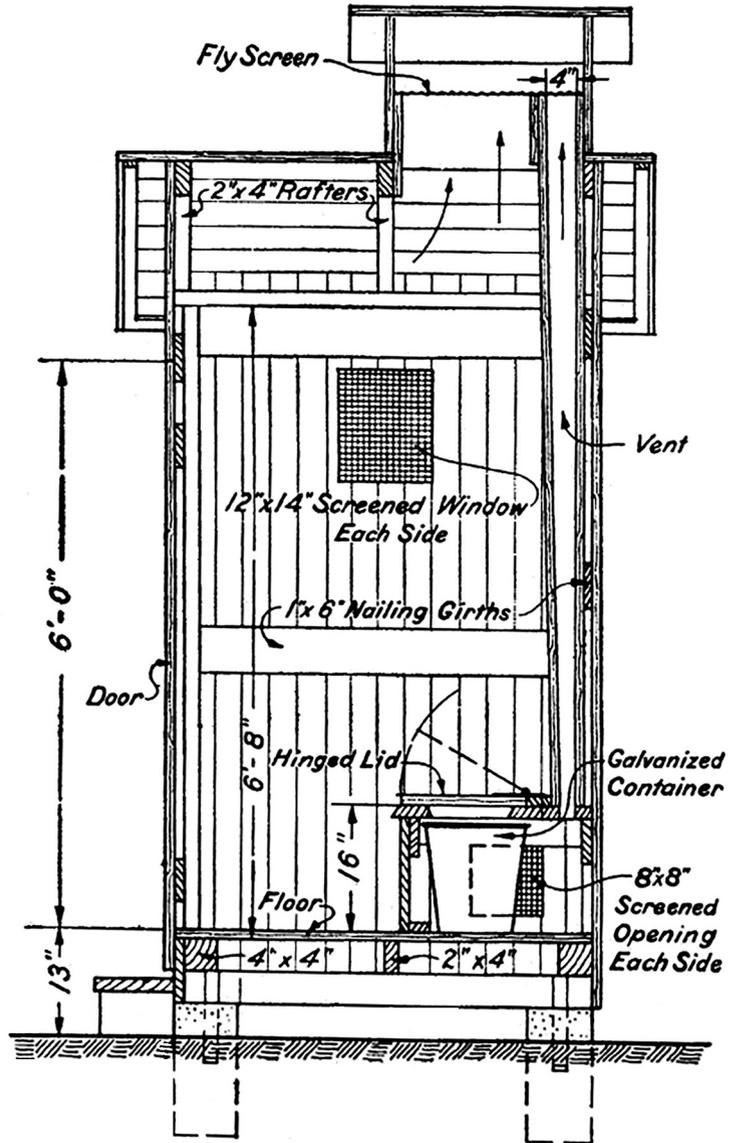
What’s wrong with soil? It’s everywhere, it’s cheap or free, an inexhaustible resource, and an excellent biofilter. The answer, in a word, is parasites. Some intestinal parasites coevolved with humans over millennia simply because we have the habit of defecating on soil. Several human intestinal parasites therefore evolved requiring a period in soil during their life cycle. When we’re allowing human excrement to come in contact with soil, we’re enabling these parasites to multiply. For example, roundworms (*Ascaris lumbricoides*) do not multiply in the human host; instead, eggs are excreted in feces, allowing the larval stage to develop *in soil*. However, knowledge about the life cycle of roundworms was unknown until 1916, long after the demise of Moule’s earth closet.

Humans acquire roundworm infections (ascariasis) by ingesting food, water, or soil contaminated with embryonated eggs. Parasitized people contaminate soil with roundworm eggs by defecating on the soil, which, after embryonation, offers a source of new infection or re-infection. People ingest infective eggs by putting their dirty fingers in their mouths (see Jenkins's rule of sanitation #3). In hot and humid areas of rural Africa, Asia, and Latin America up to 93 percent of all inhabitants in some villages may be infected with roundworms. In highly endemic areas several hundred roundworms per person are not uncommon and cases of more than two thousand worms in individual children have been reported. Roundworm infections are common in China, India, Southeast Asia, the Philippines, Japan, Russia, Afghanistan, Iran, throughout Africa and Egypt, and in Central and South America. Even in the US in the Gulf Coast states and rural parts of southern Appalachia, up to 30 percent of the population may be infected in some areas.²⁰ And the roundworm is only one example of a parasite that requires humans to crap on soil.

So now you know what Jenkins's second rule of sanitation is all about, and why there was a fatal flaw in Moule's earth closet design. By using soil as a cover material, anyone infected with intestinal parasites could have been passing those parasites on to those handling the soil coming out of the toilet, whether they were simply drying the soil, or using the soil in their gardens. They had no way of knowing anything about this at that time, but we know now.

Moule's toilet design needed to be tweaked. Instead of soil, a carbon-based cover material, such as sawdust, should have been used. Then the collected material could have been composted, and any parasites would have been killed during the composting process. Granted, carbon-based materials are not as available as soil, but such *compost* toilets could be used to a limited degree where water toilets were not available, and they could be used in a widespread sense in societies, countries, or cultures where water toilets do not exist.

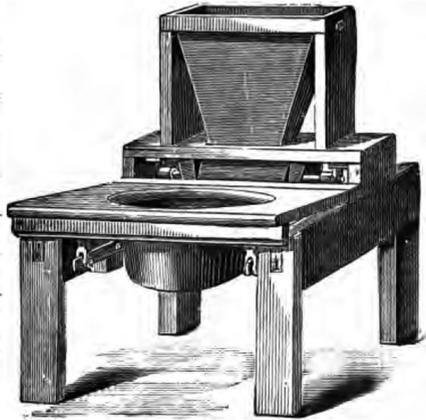
DRY EARTH PAIL PRIVY 1922



Source: Warren, George M. (1922 - revised 1928). Sewage and Sewerage of Farm Homes. US Department of Agriculture, Farmer's Bulletin No. 1227.



"PULL OUT" EARTH CLOSET



"SELF ACTING" EARTH CLOSET

Cannon, Henry Lemmoin. (1912). Sewage Disposal in the United Kingdom.

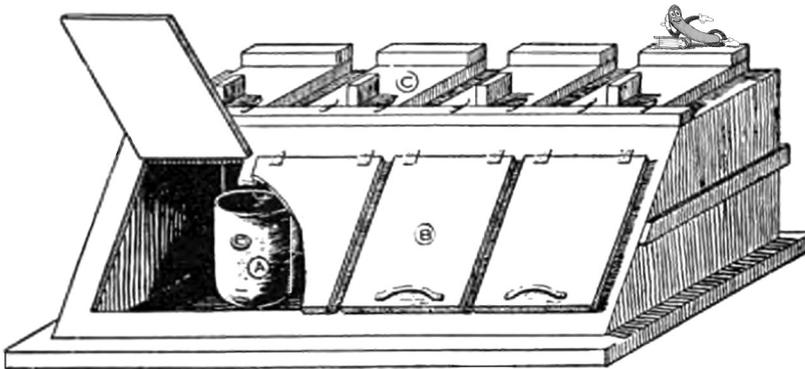
Nature's Own Disinfectant.

Dry Earth is the only efficient and safe deodorizer and disinfectant. Ashes are nearly as good.

Sick People
Well People
Old People

Should use a
DRY EARTH CLOSET
It aids recovery, prevents infection, does away with all odor, and is the only way to be healthy and clean.

Heap's Pat. Earth Closet Co., Muskegon, Mich.



BUCKET TOILETS OR PAIL LATRINES, U.S. MILITARY, 1940

BUCKET AND PAIL TOILETS

There are two words that should never be used in association with compost toilets. One is “waste,” as I have repeatedly mentioned, and the other is “bucket.” Some compost toilets utilize five-gallon buckets as toilet receptacles. Others use drums, urns, barrels, bins, or any receptacle that is water-tight and manageable, depending on the situation. Five gallons or approximately twenty liters is a good capacity for easy handling by one person, and a five-gallon container will hold approximately one week’s excretions of one typical adult, assuming an appropriate cover material is used. Five-gallon plastic buckets are easy to come by in some countries, such as the US, where they can be acquired cheaply or for free when recycled. In other countries, believe it or not, they can be nearly impossible to find.

Some people who grow up in water toilet cultures can become perturbed at the idea of using a compost toilet. One person posted on a blog during Cape Town, South Africa’s severe drought in 2018, “I’m not going to shit in a bucket. That’s disgusting!” I responded that they would be shitting in a compost toilet, as opposed to shitting in a pot of drinking water. Funny that defecating in drinkable water is not considered disgusting at all, even when the potable water supply had dwindled to dangerous levels and was looking like it might dry up completely.

Humans are the only land animal that intentionally defecates in water. Water toilet users will seek out water to poop in even when there is little to be found. One lady on another blog during California’s severe drought in 2017 wrote that her water well had dried up, as had all her neighbors’. Only one farm still had an operating well, and she had to drive over there to bring back the precious water in jugs. She had to shit in something, so she poured the water into her toilet.

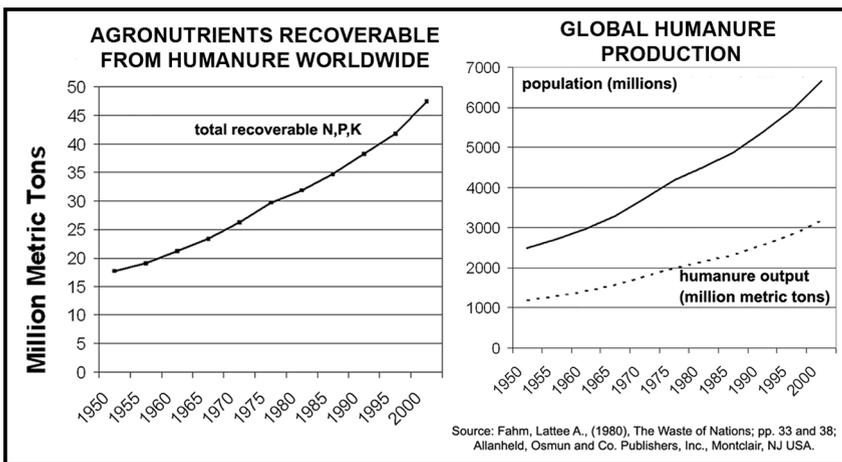
I would call this putting all one’s eggs in one basket, or else going way out on a limb. Water toilet cultures don’t have any viable alternative to defecating in their water supplies, other than to revert to open defecation or pit latrines again. This strikes me as being dangerous,

reckless, and imprudent, especially in this day and age when climate change can cause widespread power outages and other mayhem. A five-gallon receptacle utilized as a compost toilet and a bag of compressed peat moss for cover material can service one person for one week. If the receptacle is regularly emptied into a compost bin, then it can last until the peat moss runs out, which would be weeks. A steady supply of cover material and a compost bin or bins can yield a compost toilet system that can last a lifetime. And compost bins can be built easily and quickly. A durable pallet bin can be built in 10 minutes. A wire bin can be thrown up in a very short time, too. But I digress.

“Bucket toilets” are a thing. They are not compost toilets. Bucket toilets were commonly used in, for example, prisons, where inmates had to defecate in open buckets. No cover material was used, and the bucket contents were simply dumped outside somewhere, or maybe down a sewer hole. They smelled horribly, attracted flies, and severely detracted from the quality of life. People hated them.

Bucket toilets date back generations, are widely condemned by sanitation professionals, and are not to be confused with compost toilets. For example, the World Health Organization describes a bucket toilet as an “example of containment technologies that does not reduce the likelihood or severity of exposure to hazardous events.”²¹

Even when a compost toilet utilizes buckets as toilet receptacles, it is still not a bucket toilet. The best approach is to avoid the use of the



word “bucket” altogether when discussing compost toilets. Most people know little about compost toilets, but bucket toilets have a long history. They are not to be confused.

An interesting example of a bucket toilet system involved the city of Syracuse, New York, where Skaneateles Lake, located in the Finger Lakes region of New York State, serves as its primary drinking water source. The lake is one of the few remaining unfiltered drinking water supplies left in the US. The village of Skaneateles, on the north-end of the lake, is connected to a municipal sewer system. But the residents of the village are only 8 percent of the residences located within the watershed. Forty percent of all watershed houses are on the lakefront. The potential for water pollution should be obvious. Any leaking out-house, septic system, or pit latrine could pollute and endanger the drinking water supply of an entire city.

For a hundred years, a municipal service was provided to collect pails of raw sewage from outdoor toilets (privies) located at the residences around the lake. Cottage owners using this service were accustomed to the foul odors, unsanitary conditions, and inconvenience associated with using an outdoor toilet in wintry New York, where the toilet was nothing more than a stinky bucket. Collecting the buckets at least kept the sewage out of the lake, but the outdoor pail privies had to be an unpleasant aspect of living on a lake shore. The sewage was hauled away and disposed of, most likely down sewer drains.

After a *century* of this, the residents switched to on-site dry toilets. Cottage owners were closely involved with selecting the toilet models and deciding where to put them, either in the cottages or in the existing privies. A total of seventy-four dry toilets were installed.

For a hundred years the residents surrounding the lake had to use bucket toilets. However, New York is a heavily forested state, and sawdust from the timber industry is plentiful and has been for generations. Such sawdust is a 100 percent effective biofilter, if they had utilized it as a cover material in their toilets, there would have been no odor or flies. The toilets could have been located comfortably indoors. The resulting container of feces, urine, and sawdust, instead of being dumped

into sewers as a waste material, could have been dumped into compost bins and recycled. In fact, the cottage owners could have had their own compost bins and had a completely decentralized, ecological sanitation system located right on their own property, if they wanted to have the compost for growing things. They could have had beautiful shrubbery and fruit trees instead of a stinky bucket toilet and the associated waste if they had used odorless, indoor compost toilets. But nobody knew.²²

FECAPHOBIA

We don't grow food with "human waste," nor do we grow gardens with "night soil." We feed microorganisms in a compost environment with humanure. We also feed those microorganisms with a lot of other things — other animal manures, banana peels, coffee grounds, meat, bones, fats, all sorts of food scraps, animal mortalities, garden residues, grass clippings, leaves, and so on. The microorganisms, over time, convert the organic materials into compost. Then we feed the compost to soil, which makes it available to plants. Then either we eat the plants or we feed the plants to animals, then eat the animals or their byproducts.

It's a mistake to apply human excrement directly to soil; that's why we don't. Just as with defecating on soil, there are too many opportunities for pathogenic organisms to find their way back to their human hosts when violating Jenkins' second rule of sanitation. However, when we compost humanure, we break the cycle of pathogen infection. Although this is well-established science, there are plenty of skeptics.

The belief that compost is unsafe for agricultural use when humanure is a feedstock is what I call "fecaphobia." People believe that it's dangerous and unwise to use human excretions for making compost. Yet humanure is best rendered hygienically safe by composting. Nevertheless, in Finland, for example, compost that included human manure as a feedstock cannot be used in commercial agriculture. In Arizona, compost made from *any* manure can't be used for remediating public roadsides. A person managing a commercial composting oper-

ation posted a question on a blog, “Can I still compost food scraps collected at a public venue if there was a tissue in it from a restroom?” So don’t expect humanure composting to go mainstream in the US or elsewhere any time soon. The exception is where water toilets are not in use. Those communities aren’t afflicted with fecaphobia and are enthusiastic about humanure composting because compost toilets offer an alternative to a pit latrine. Like the water closets in the late 1800s providing a sanitation revolution for people who were tired of out-houses, compost toilets can provide the same revolution for many people worldwide today.

The day will come when municipally collected organic materials will include toilet materials. There are already opportunities for Americans to start to develop some expertise in the field of ecological sanitation. For one, anywhere portable toilets are used, such as at large gatherings, music festivals, camp sites, and so forth, where plumbing or even electricity is not available, compost toilets can be a solution. The regulatory hurdles and statutory barriers must be removed; otherwise there is no way this solution can be developed. For example, some states define human excrement as a waste product that *must* be disposed of. Yet human excrement can be constructively recycled by composting, not wasted at all, and not referred to as “human waste,” anymore, but instead referred to as “humanure.” When humanure is composted, there is no sewage, no waste, and no pollution. Instead, there is compost. Compost toilets are waste-free toilets. No waste goes into a compost toilet, and none comes out.

BACK TO ASIA

Did Asians really make compost, historically? It is well known that Asians have recycled humanure for centuries, probably millennia, but historical information concerning the *composting* of humanure in Asia seems difficult to find. Rybczynski et al. state that composting was only introduced in China in a systematic way in the 1930s and that it wasn't until 1956 that dry toilets were used on a wide scale in Vietnam.²³

A book published in 1978 and translated from the original Chinese indicates that composting had not been a cultural practice in China until only recently. An agricultural report from the Province of Hopei states that the standardized management and hygienic disposal (i.e., composting) of excreta and urine was only initiated there in 1964. The composting techniques being developed at that time included the segregation of feces and urine, which were later “poured into a mixing tank and mixed well to form a dense fecal liquid” before being piled on a compost heap. The compost was made of 25% human feces and urine, 25 percent livestock manure, 25 percent miscellaneous organic refuse and 25 percent soil.²⁴

A report from a hygienic committee of the Province of Shantung lists three traditional methods used in that province for the recycling of humanure:

1) Drying — *"Drying has been the most common method of treating human excrement and urine for years."* It is a method that causes a significant loss of nitrogen.

2) Using it raw, a method that is known to allow pathogen transmission.

3) *"Connecting the household pit privy to the pig pen. . . . a method that has been used for centuries."* This is an unsanitary method in which the excrement was simply eaten by a pig.²⁵

No mention is made whatsoever of composting being a traditional method used by the Chinese for recycling humanure. On the contrary, all indications were that the Chinese government in the 1960s was, *at that time*, attempting to establish composting as preferable to the three traditional methods listed above, mainly because the three methods were hygienically unsafe, while composting, when properly managed, would destroy pathogens in humanure while preserving agriculturally valuable nutrients. This report also indicated that soil was being used as an ingredient in the compost, or, to quote directly, “Generally, it is adequate to combine 40 to 50 percent of excreta and urine with 50 to 60 percent of polluted soil and weeds.” Generally speaking, soil is not a recommended additive for composting. Weeds yes, soil no. Soil

doesn't hurt compost, but the microbes don't eat it, they produce it.

Rybczynski's World Bank research on low-cost options for sanitation considered over twenty thousand references and reviewed approximately twelve hundred documents. Their review of Asian composting includes the following information, which I have condensed:

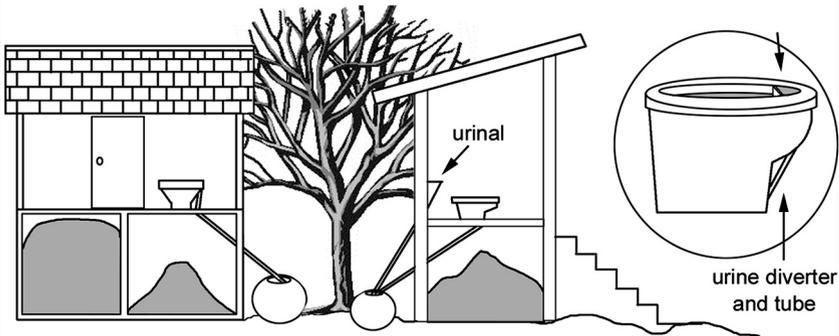
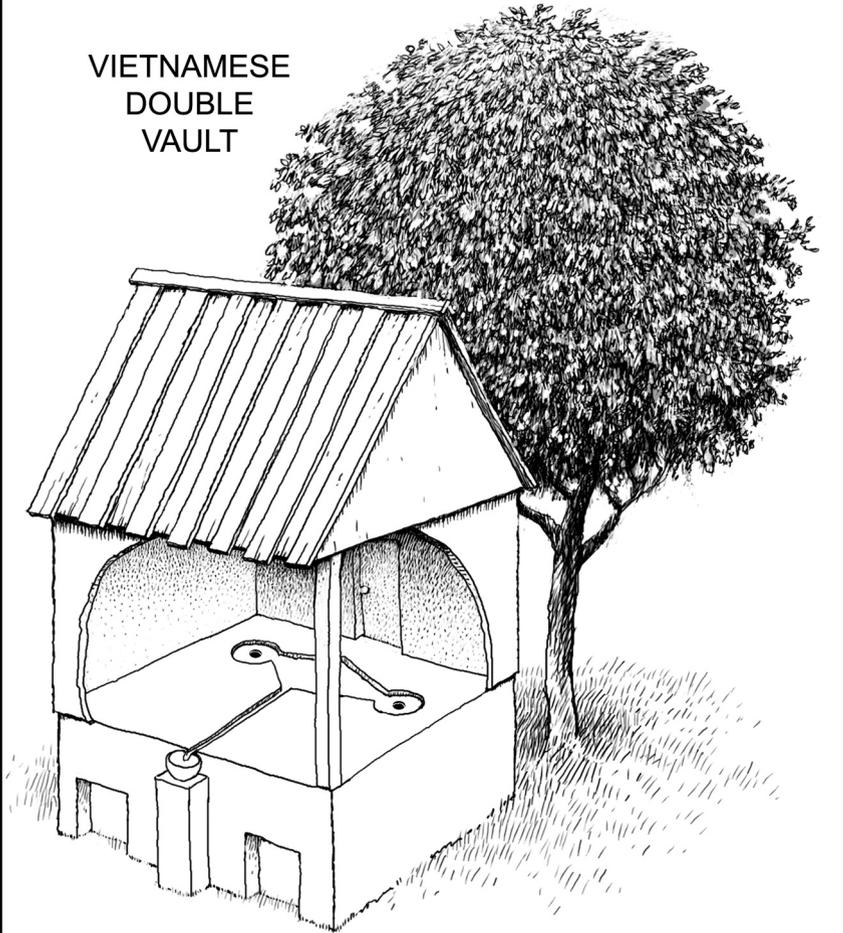
There are no reports of dry privies or toilets being used on a wide scale until the 1950s, when the Democratic Republic of Vietnam initiated a five-year plan of rural hygiene and a large number of anaerobic dry toilets were built. These toilets, known as the Vietnamese double vault, consisted of two aboveground watertight tanks, or vaults, for the collection of humanure. For a family of five to ten people, each vault was required to be 1.2 meters wide, 0.7 meters high and 1.7 meters long (approximately 4 feet wide by 28 inches high and 5 feet, 7 inches long). One tank was used until full and left to decompose while the other tank was used. The use of this sort of dry toilet requires the segregation of urine, which is diverted to a separate receptacle through a groove on the floor of the toilet. Fecal material is collected in the tank and covered with soil, where it anaerobically decomposes. Kitchen ashes are added to the fecal material to help reduce odor.

Eighty-five percent of intestinal roundworm eggs, one of the most persistent human pathogens, were found to be destroyed after a two-month period in this system. Organic material from such latrines is reported to increase crop yields by 10 to 25 percent in comparison to the use of raw night soil. The success of the Vietnamese double vault required "long and persistent health education programs."²⁶

When this system was exported to Mexico, the result was "overwhelmingly positive," according to one source, who adds, "Properly managed, there is no smell and no fly breeding in these toilets. They seem to work particularly well in the dry climate of the Mexican highlands. Where the system has failed because of wetness in the processing chamber, odors, and/or fly breeding, it was usually due to non-existent, weak, or bungled information, training, and follow-up."²⁷

Another anaerobic double-vault dry toilet used in Vietnam included using both fecal material and urine. In this system, the bottoms

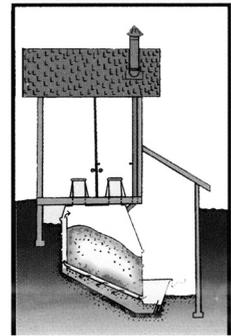
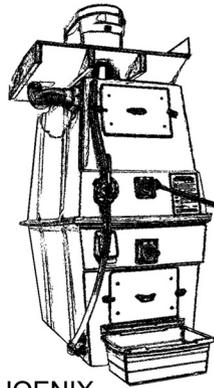
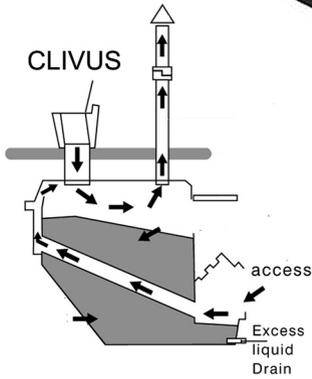
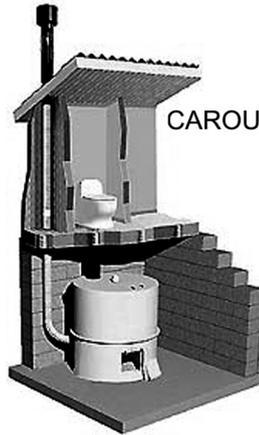
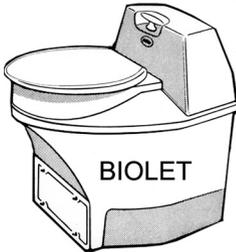
VIETNAMESE
DOUBLE
VAULT



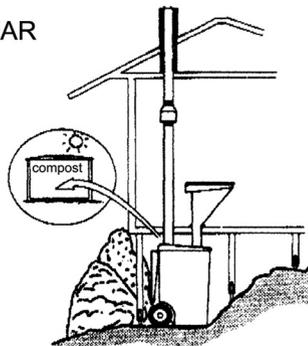
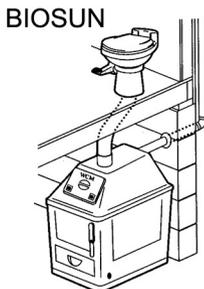
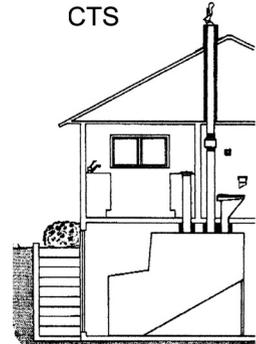
GUATEMALAN DRY TOILET

COMMERCIAL DRY TOILETS

A few of many examples.



PHOENIX



of the vaults were perforated to allow drainage, and urine was filtered through limestone to neutralize acidity. Other organic refuse is also added to the vaults, and ventilation is provided via a pipe.

COMMERCIAL DRY TOILETS

Because no water is used or required during the operation of dry toilets, human excrement is kept out of water supplies. A single person using a Clivus (pronounced Clee-vus) Multrum will produce 88 pounds of organic material per year while refraining from polluting 6,604 gallons of water annually.²⁸ The finished septage can be used as a soil additive where the material will not come in contact with food crops.

Dry toilets, when used properly, should provide a suitable alternative to water toilets for people who don't have water to waste. Inexpensive versions of dry toilets were introduced into the Philippines, Argentina, Botswana, and Tanzania, but were not successful. According to one source, "Units I inspected in Africa were the most unpleasant and foul-smelling household latrines I have experienced. The trouble was that the mixture of excreta and vegetable matter was too wet, and insufficient vegetable matter was added, especially during the dry season."²⁹ Too much liquid will create anaerobic conditions with consequent odors. The aerobic nature of the organic mass can be improved by the regular addition of carbonaceous bulking materials. Your nose will soon let you know if you're doing something wrong.

A variety of other dry toilets is available on the market today. Some cost upward of \$10,000 and can be equipped with insulated tanks, conveyers, motor-driven agitators, pumps, sprayers, and exhaust fans.³⁰ According to a dry toilet manufacturer, waterless toilets can reduce household water consumption by forty thousand gallons per year.³¹ This is significant when one considers that only 3 percent of the Earth's water is not salt water, and two-thirds of the freshwater is locked up in ice. That means that less than 1 percent of the Earth's water is available as drinking water. Why shit in it?