

The Humanure Handbook

Shit in
in a
Nutshell
4th Edition



Joseph Jenkins

THE HUMANURE HANDBOOK

FOURTH EDITION

SHIT IN A NUTSHELL

by Joseph C. Jenkins

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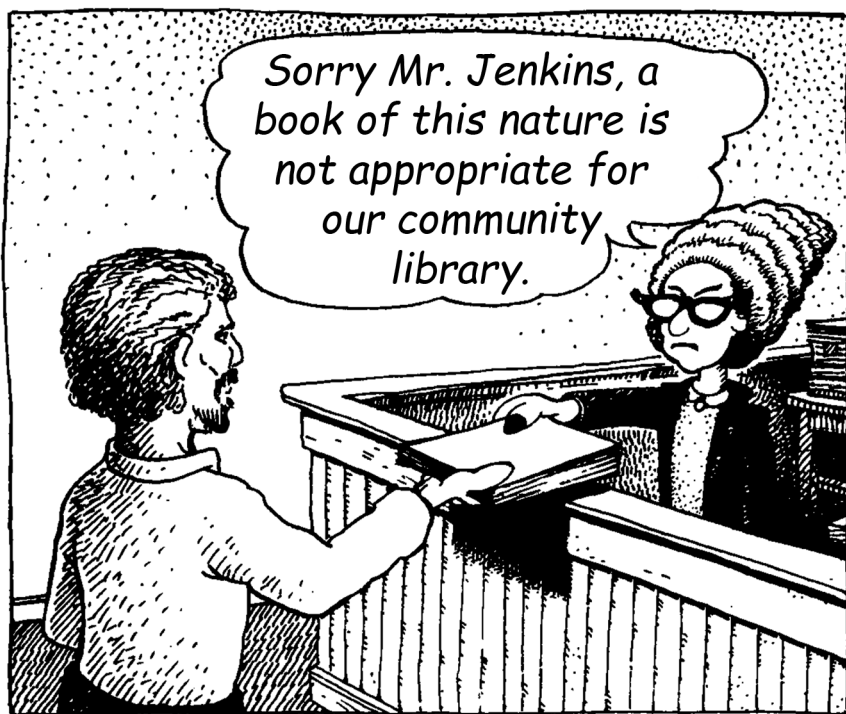
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Introduction

This book began as a graduate thesis at the Slippery Rock University Master of Science in Sustainable Systems program in northwestern Pennsylvania in the mid-1990s. I had been living “off the grid” for ten years and had been using a compost toilet system of my own design for fifteen years. Nothing fancy, very simple, but I wanted to research what was going on with my system, so I chose my toilet as the subject of my thesis.

I never turned the thesis in to my thesis committee, and I never finished the master’s program. Instead, I converted the manuscript into “popular” language (rather than “academic” language) and then self-published it as an amateur book. I wanted to learn how to self-publish. This was before the internet, even before personal computers, if you can imagine. No cell phones either. I started writing with a pen

and paper and advanced to a manual typewriter, and then an electronic typewriter when they became available. I assembled my first computer on the floor of my office in 1995, the year the first edition of the *Humanure Handbook* was published.

Although I found the book's subject matter fascinating, I didn't think anyone else would be interested, so I only printed six hundred copies of the book and assumed I would be staring at them for the rest of my life, collecting cobwebs stacked in my garage, passing a book out here and there as time went by to whoever would take one. The book could always be used for emergency toilet paper, I told them.

Well, I was wrong. The first edition sold ten thousand copies rather quickly, so I wrote a second edition. It sold just as well, so I condensed and redesigned it into a third edition. Now, with seventy thousand copies in circulation, I'm doing a fourth edition. The second and third editions were translated into numerous languages. The first translation was published in South Korea, the second Israel, and then editions came out in French, Norwegian, Portuguese, Finnish, and partial translations in Cambodian, Chinese, Dutch, German, Hungarian, Italian, Kenyan, Mongolian, Russian, Slovenian, Spanish, and Vietnamese. Don't misinterpret this as bragging. I freely gave the foreign rights on request, and over all those years and all those translations I have never made a penny from any foreign edition. Nor did I want to.

In the years the book circulated, I continued to make compost from "humanure," and I continued to refine and tweak my methodology as my experience and knowledge grew. My first ever compost pile was in 1975. My first ever humanure compost pile was in 1976. Now, as I write this forty-two years later, I have never *not* had a compost pile, or several, and I have always used humanure as a feedstock for the compost. I have also used all the finished compost to grow my food (some has gone to houseplants), and I have raised a healthy family on my garden produce.

I now realize that we as a nation are *shit illiterate*. Any society that grows up with water toilets, also called flush toilets, seems to have an arrested development when it comes to the recycling of organic material, especially what comes from its own bodies.

My compost-related travels opened my eyes to a lot of things, especially when traveling to those parts of the world where people don't use toilets because they don't have them. Americans make up about 4 percent of the human population, meaning that 96 percent of all people are not Americans, and they don't think and act like Americans. About two and a half *billion* of those people don't have water toilets. They never had flush toilets, their ancestors before them never had flush toilets going back to the beginning of time, and quite likely, their descendants after them will also never have flush toilets. The infrastructure, water, and wealth required for flush toilets simply do not exist in much of the world. There must be something else for them — a different way to deal with shit. Most flush toilet people don't care about any of this; they can't understand the acuteness and immensity of the global sanitation problem, and they have little constructive advice to offer.

This improbable book has taken me to Mongolia three times. It has taken me to Haiti four times, Finland four times, Morocco, Mozambique, Nicaragua, India, Tanzania, Kenya, Uganda, and from coast to coast in the USA and into Canada. I have turned down many invitations to travel the world to help people, schools, or villages get compost toilet systems started because there just aren't enough days in the year, and I have a garden to tend at home. I don't know how many more countries I will travel to before my life ends, but I suspect that my traveling is not over yet.

My challenge with the fourth edition of this book is to try to distill down over forty years of experience into as few pages as possible. I also need to update and correct some of the language I have used in previous versions. I have learned so much, and it seems so important, that I believe the effort is worth it. I must confess that there's no way I can write what I've learned in only one book, so my plan is to spin off a second book, *The Compost Toilet Handbook*, and I hope to have it in print before too long. Time will tell.

Joe Jenkins, January 2019

ATTENTION EARTHLINGS, I AM GIRDLOK...
 FROM THE PLANET TURDNOK IN THE
 CONSTELLATION ALPHA ROMEO. WE HAVE
 DISCOVERED AN ANCIENT
 MANUSCRIPT IN ONE OF OUR
 ARCHEOLOGICAL RUINS, AMAZINGLY
 IT IS WRITTEN IN EARTHLING
 ENGLISH AND IT IS ABOUT YOUR
 ODOROUS EXCRETIONS.
 IT IS CALLED THE HUMANURE
 HANDBOOK AND IT IS THE
 KEY TO THE SPIRITUAL
 SALVATION OF YOUR PITIFULLY
 INSIGNIFICANT SPECIES.
 AS AN ACT OF INTERGALACTIC
 GOOD WILL WE HAVE CHOSEN
 TO PUBLISH AND DISTRIBUTE
 THIS BOOK ON EARTH.
 WE ASK FOR NOTHING
 IN RETURN ETC... ETC...
 DRIBBLE... DRIBBLE...



Close Encounters of the Turd Kind

I was once accused of being abducted by aliens.

This may not be the wisest way to begin a book. Skeptics, myself included, might consider this “starting off on the wrong foot.” But the accusation is true, and it makes for an interesting story.

My well-meaning friend had had a couple of beers before she presented her postulation. “Why else would anyone write a book like the *Humanure Handbook*?” she asked.

She theorized that somehow, I was sucked up into an alien space ship, without my knowledge, where the aliens inserted a chip somewhere in my body, then dropped me back down to Earth with my mission safely encoded inside the chip.

“*Uranus!*” she blurted out, laughing.

“What?”

“*Uranus!* That’s where they’re from!” Then she started laughing like a hopeless inmate at an insane asylum.

I later decided to have some fun with my friend’s theory when I was asked to speak about humanure at a national conference. I titled my talk, “*Close Encounters of the Turd Kind*,” a title that caused some consternation among the conference organizers, some of whom didn’t want the word “turd” in their conference brochure. I prevailed, however, and ended up in front of a crowd one sunny afternoon in Northern California. The place was filled to capacity, standing room only, with a number of people standing in the back behind the seating area.

I started my talk with my friend’s theory about my abduction, and I was intentionally serious about it. The audience clearly wasn’t sure what to make of me. Anyone who talks about UFOs, aliens, or abductions is immediately suspect in the eyes of many people, including a lot of the people at this conference.

“Let’s assume my friend’s theory is correct,” I stated. “Let’s assume an advanced civilization with an intelligence level we can’t begin to

fathom, capable of traveling light years across solar systems or galaxies, sucked me up one night into their space ship and sent me back down to Earth with a chip embedded in my ass. What was the mission I was being programmed to do? What did they want me to communicate to the people of Earth?”

There was a lady in the front row squirming in her seat, frowning, squinting at me with skepticism. I stood on the floor in front of her with a microphone in my hand.

I stretched my free hand out in front of me with my fingers extended and slowly swept it across the crowd. “Any ideas? Anyone? What do you think the aliens want me to say? What is the message they want me to deliver? What information do they want me to convey to you humans?”

No one responded. You could hear a pin drop.

“Well, I know what they wanted me to tell you.” I hesitated a moment for dramatic effect.

“They wanted me to tell you about the *Invisible Beings*. Who here has *seen* the *Invisible Beings*?” At this point my sweeping outstretched hand turned into a pointed finger as I slowly swept it across the crowd. “Anyone? Anyone at all? Who has seen them, the *Invisible Beings*?”

Of course, the question was ridiculous, you can’t see something that’s invisible. Nobody is going to say they saw an invisible anything. That would make them look as nutty as I was looking at that moment. The front row lady’s eyes were now wide open, and her jaw was hanging down to her neck. Flies could have flown in and out of her mouth; it was open that far. It had apparently dawned on her that I was a raving lunatic standing right in front of them. I was one of those people who believed in aliens and invisible people. Shock was written all over her face. The rest of the audience wasn’t far behind.

“*Who here has seen the invisible beings!?*” I asked again, louder, even more seriously, starting to sound impatient, pointing to the crowd with my arm outstretched before me, moving my finger from person to person, making everyone nervous, while people fidgeted in their seats. “The aliens want me to tell you about the invisible beings! Has any-

body here seen them?” Nobody moved. Nobody said a word. The audience froze. I stood motionless and silent in front of them, pointing.

Then a hand slowly rose up, way in the back of the crowd. A young lady was standing there.

“YOU!” I yelled, pointing straight to her. “Where did *you* see the invisible beings!?”

“In a microscope?” she squeaked, barely audible.

“What, I can’t hear you. . . .”

“IN A MICROSCOPE!”

“BINGO!”

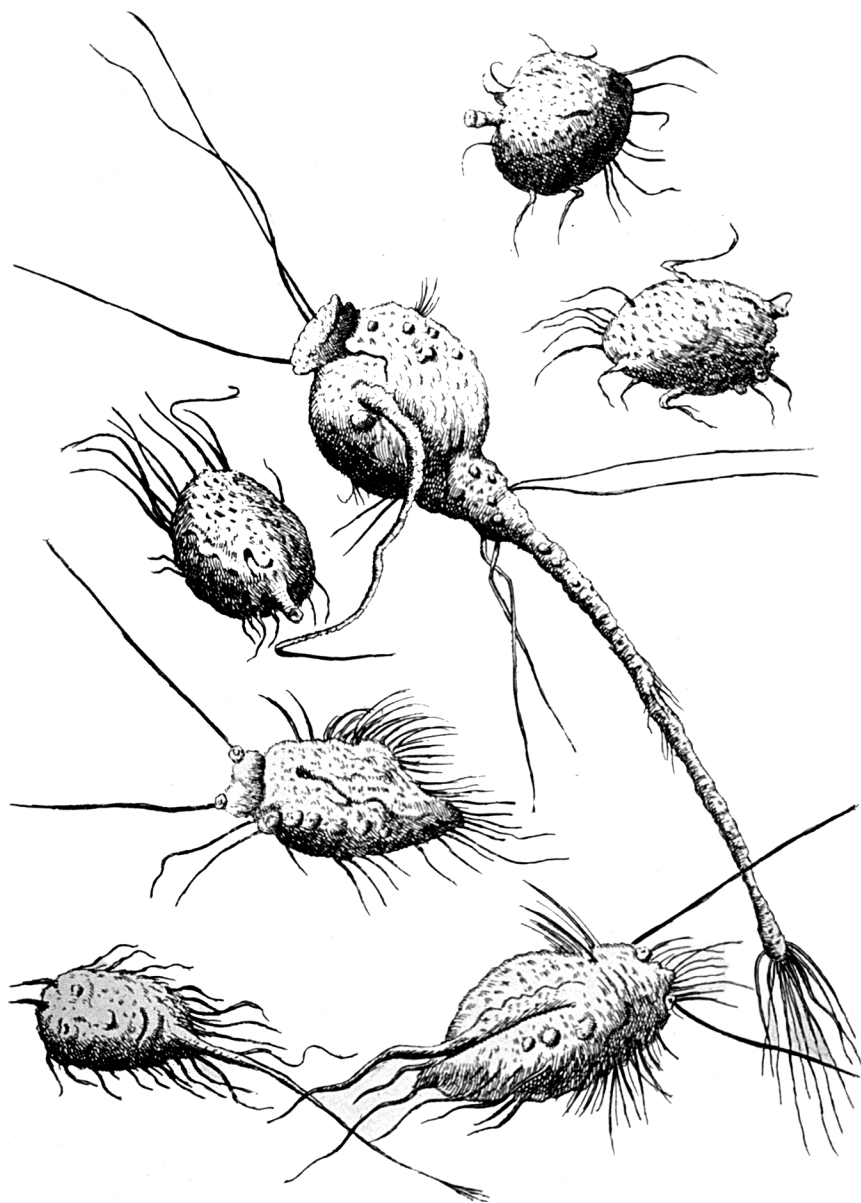
My talk then segued directly into a discussion about microscopic organisms, beings so tiny as to be invisible to the human eye without magnification. But not before I lectured the crowd about making judgments based on ignorance. Granted, my alien angle was “over the top” and was included simply for effect, but the mention of invisible beings was perfectly rational, factual, and necessary to my discourse. I told them that people have been historically condemned, imprisoned, tortured, and put to death for conveying information that was factual, but misunderstood. People who could cure diseases using herbs and natural procedures a couple of centuries ago, for example, were labeled witches and executed by the church. Galileo is perhaps one of the most well-known scientists persecuted for presenting factual but misunderstood scientific information. The idea that the Earth revolved around the sun contradicted the teachings of the church at that time, so Galileo was branded a heretic and was forced to spend the last decade of his life under house arrest.

Just because we don’t understand what someone is saying doesn’t mean it’s wrong. It’s important to keep an open mind and hear a person out before jumping to conclusions.

That’s what I told them. Then I talked about the invisible beings.

DRAWINGS OF MICROBES

1750



Source: <https://collections.nlm.nih.gov/catalog/nlm:nlmuid-101403151-img>

The Invisible Beings

Whoever said “The meek shall inherit the Earth” must have been a microbiologist. Except that was thousands of years before microbiology even existed. In fact, microbes (microscopic organisms, or “invisible beings”) already own the Earth, have always owned the Earth, and are allowing humans to borrow it, briefly. Once we humans kill ourselves off through pollution, consumption, greed, hatred, warfare, disease, and extinction, our brief time on this planet will end and microbes will carry on as though nothing had happened, as they’ve already done for billions of years.

Scientists believe the Earth to be about four and a half billion years old, but for the first half billion years or so, they believe there was nothing on Earth that could be considered life as we know it today. Yet somehow, complex molecules were created by natural forces (think heat, pressure, maybe lightning, and meteorites). The molecules combined and coagulated to the extent that single-celled organisms eventually evolved on this planet eons ago, as evidenced by three-and-a-half-billion-year-old microbial remnants found in Australia and South Africa.¹

I well remember the day I stood on a mountainside in remote Africa to conduct an outdoor presentation about compost toilets for the local tribe. “Half of all life on Earth is invisible,” I told them. “Furthermore, if you scraped up all the microorganisms in and on your body, single-celled organisms that are not *you*, the resulting mass would weigh as much as your brain.” They stared at me as if what I had just said didn’t register at all, and it probably didn’t (with you either). Allow me to elaborate.

The number of individual microbes on our planet today is estimated to be as high as 10^{30} (a “nonillion”).² Ten to the 9th power is a billion, so ten to the 30th power is a number that’s impossible to grasp. To put it in perspective, scientists estimate that there are 10^{24} stars in

the universe, roughly equal to the number of grains of sand on Earth (i.e., much fewer than a nonillion). The number of microbes on Earth eclipses the number of stars in the known universe by a factor of somewhere between a million and 100 million, depending on whom you ask. The number of single-celled organisms (“invisible beings”) on our planet, with an estimated ten million to one billion species, is so immense that their collective mass is greater than that of all of Earth’s visible plants and animals combined.³

A hundred million microbes can be found in only a liter (roughly a quart) of pond or sea water, containing maybe thirty-five thousand different kinds of bacteria. Incredibly, the number of different kinds of microbes in soil can be much greater than in sea-water.⁴

Then there are viruses, the most abundant biological entities on the planet.⁵ There can be ten million viruses in the form of bacteriophages (a virus that kills bacteria) per milliliter of sea water, which means ten billion in a quart of water, outnumbering bacteria by a hundred to one. Viruses are noncellular, parasitic, non-living critters (wrap your brain around that) that must infect bacterial host cells to reproduce.⁶ They appear to play crucial and beneficial roles on our planet.⁷

Humans evolved on a planet that was already teeming with life, most of it microscopic. If you stretch out your arm and use it as a measure of time since life began on Earth, humans would only represent the edge of the farthest fingernail, or if life on Earth were compacted into twenty-four hours, humans showed up two seconds ago.⁸

This means the microbes were already here and had been for billions of years before humans arrived. It means humans did not evolve independent of microbes; instead, we evolved in a soup of microorganisms; we *coevolved* with microbes, as did every other living thing. Microbes are in us and they are on us and they belong there. The statistics are astonishing. For example, scientists estimate that there are at least ten times and maybe a hundred times more bacterial cells living on our skin, in our mouth, and in our gastrointestinal tract (our digestive system from mouth to anus and everything in between) than there are human cells in our bodies. Did you get that? Ten to one hundred times

- Tribune Association: New York.
- 14 Ibid.
 - 15 Ibid.
 - 16 Ibid.
 - 17 Ibid.
 - 18 Ibid.
 - 19 Ibid.
 - 20 Reeder, M. M. (1998). *The radiological and ultrasound evaluation of ascariasis of the gastrointestinal, biliary, and respiratory tracts*. Semin Roentgenol 1998, 33:57.
 - 21 Guidelines on Sanitation and Health.
 - 22 Abbott, Rich. (2004). *Skaneateles Lake Watershed Composting Toilet Project*. Small Flows Quarterly, Spring 2004, Volume 5, No. 2.
 - 23 Rybczynski, W. et al. (1982). *Appropriate Technology for Water Supply and Sanitation — Low Cost Technology Options for Sanitation, A State of the Art Review and Annotated Bibliography*. World Bank. Transportation and Water Department: Washington, DC.
 - 24 McGarry, Michael G., and Jill Stainforth (Eds.). (1978). *Compost, Fertilizer, and Biogas Production from Human and Farm Wastes in the People's Republic of China*. International Development Research Center: Ottawa, Canada. pp. 9, 10, 29, 32.
 - 25 Ibid.
 - 26 Winblad, Uno, and Wen Kilama. (1985). *Sanitation Without Water*. Macmillan Education Ltd.: London and Basingstoke. pp. 20–21.
 - 27 Winblad, Uno (Ed.). (1998). *Ecological Sanitation*. Swedish International Development Cooperation Agency: Stockholm. p. 25.
 - 28 *Clivus Multrum Maintenance Manual*. Clivus Multrum Inc. Lawrence, Mass.
 - 29 Pickford, John. (1995). *Low-Cost Sanitation*. Intermediate Technology Publications: London. p. 68.
 - 30 *Garbage*, Feb/Mar 1993, p. 35.
 - 31 Composting Toilet Systems, PO Box 1928 (or 1211 Bergen Rd.), Newport, WA 99156, phone: (509) 447-3708; Fax: (509) 447-3753.

CHAPTER 13: WORMS AND DISEASE

- 1 Kristof, Nicholas D. (1995). *Japanese Is Too Polite for Words*. Pittsburgh Post Gazette, Sunday, September 24, 1995. p. B-8.
- 2 Beeby, John. (1995). *The Tao of Pooh* (now titled *Future Fertility*). Ecology Action of the Midpeninsula: Willits, CA. Disclaimer and pp. 64–65.
- 3 Ibid. pp. 11–12.
- 4 Barlow, Ronald S. (1992). *The Vanishing American Outhouse*. Windmill Publishing Co.: El Cajon, CA. p. 2.
- 5 Warren, George M. (1922, revised 1928). *Sewage and Sewerage of Farm Homes*. U.S. Department of Agriculture, Farmer's Bulletin No. 1227. As seen in Ronald S. Barlow. (1992). *The Vanishing American Outhouse*. Windmill Publishing Co.: El Cajon, CA. pp. 107–110.
- 6 Shuval, Hillel I. et al. (1981). *Appropriate Technology for Water Supply and Sanitation — Night Soil Composting*. International Bank for Reconstruction and Development (World Bank): Washington, DC. p. 8.
- 7 Tompkins, P., and C. Boyd. (1989). *Secrets of the Soil*. Harper and Row: New York. pp. 94–95.
- 8 Howard, Sir Albert. (1947). *The Soil and Health: A Study of Organic Agriculture*. Schocken: New York. pp. 37–38.
- 9 Ibid. p. 173 (in the 2011 Oxford City Press edition).
- 10 Ibid. 174 (in the 2011 Oxford City Press edition).
- 11 Feachem et al. (1980). *Appropriate Technology for Water Supply and Sanitation*. The World Bank, Director of Information and Public Affairs: Washington, DC.

- 12 Sterritt, Robert M. (1988). *Microbiology for Environmental and Public Health Engineers*. E. & F. N. Spon Ltd.: New York. p. 238.
- 13 Jervis, N. (1990). *Waste Not, Want Not*. Natural History. May 1990. p. 73.
- 14 Winblad, Uno (Ed.). (1998). *Ecological Sanitation*. Swedish International Development Cooperation Agency: Stockholm. p. 75.
- 15 Sterritt. pp. 59–60.
- 16 Palmisano, Anna C. and Morton A. Barlaz (Eds.). (1996). *Microbiology of Solid Waste*. CRC Press, Inc.: Boca Raton, FL. p. 159.
- 17 Gotaas, Harold B. (1956). *Composting — Sanitary Disposal and Reclamation of Organic Wastes*. World Health Organization, Monograph Series Number 31: Geneva. p. 20.
- 18 Sopper, W. E. and L. T. Kardos (Eds.). (1973). *Recycling Treated Municipal Wastewater and Sludge Through Forest and Cropland*. The Pennsylvania State University: University Park, PA. pp. 248–251.
- 19 Ibid. pp. 251–252.
- 20 Shuval et al. p. 4.
- 21 Sterritt. p. 252.
- 22 Cheng, Thomas C. (1973). *General Parasitology*. Academic Press, Inc.: New York. p. 645.
- 23 Shuval et al. p.6.
- 24 Feachem et al.
- 25 Ibid.
- 26 Olson, O. W. (1974). *Animal Parasites — Their Life Cycles and Ecology*. University Park Press: Baltimore, MD. pp. 451–452.
- 27 Crook, James. (1985). *Water Reuse in California*. Journal of the American Waterworks Association, v77, no. 7. As seen in van der Leeden et al., *The Water Encyclopedia*. (1990). Lewis Publishers: Chelsea, MI.
- 28 Boyd, R. F., and B. G. Hoerl. (1977). *Basic Medical Microbiology*. Little, Brown and Co.: Boston. p. 494.
- 29 Cheng. p. 645.
- 30 Sterritt. pp. 244–245.
- 31 https://www.health.ny.gov/environmental/water/drinking/coliform_bacteria.htm.
- 32 Pokharel, Krishna, and Preetika Rana. *Troubled Waters*. The Wall Street Journal, October 21–22, 2017. p. C1.
- 33 Epstein, Elliot. (1998). *Pathogenic Health Aspects of Land Application*. Biocycle, September 1998. The JG Press, Inc.: Emmaus, PA. p. 64.
- 34 Solomon, Ethan B., et al. (2002). *Transmission of Escherichia coli 0157:H7 from Contaminated Manure and Irrigation Water to Lettuce Plant Tissue and Its Subsequent Internalization*. Applied and Environmental Microbiology, January 2002. Amer. Soc. for Microbiology. pp. 397–400.
- 35 Shuval et al. p. 5.
- 36 Feachem, et al. (1980). p. 231–236.
- 37 Franceys, R. et al. (1992). *A Guide to the Development of On-Site Sanitation*. World Health Organization: Geneva. p. 212.
- 38 Schoenfeld, M., and M. Bennett. (1992). *Water Quality Analysis of Wolf Creek* (unpublished manuscript). Slippery Rock University, Applied Ecology Course, PREE, Fall Semester (Prof. P. Johnson), Slippery Rock, PA.
- 39 USEPA. *Biosolids Technology Fact Sheet, Use of Composting for Biosolids Management*. EPA/832-F-02-024. (2002).
- 40 USEPA. Environmental Regulations and Technology, Control of Pathogens and Vector Attraction in Sewage Sludge, (Including Domestic Septage). Under 40 CFR Part 503. EPA/625/R-92/013. (2003).
- 41 Ibid.
- 42 Ibid.
- 43 Pomeranz, V. E., and D. Schultz. (1972). *The Mother's and Father's Medical Encyclopedia*. The New American Library, Inc.: New York. p. 627.

- 44 Chandler, A. C., and C. P. Read. (1961). *Introduction to Parasitology*. John Wiley and Sons, Inc.: New York.
- 45 Brown, H. W., and F. A. Neva. (1983). *Basic Clinical Parasitology*. Appleton-Century-Crofts: Norwalk, CT. pp. 128–131. Also Pinworm destruction by composting mentioned in Gotaas. p. 20.
- 46 Ibid. 119–126.
- 47 Ibid.
- 48 Ibid.
- 49 Haug, Roger T. (1993). *The Practical Handbook of Compost Engineering*. CRC Press, Inc.: Boca Raton, FL. p. 141.
- 50 Shuval. p. 4.
- 51 Franceys, R. et al. p. 214.
- 52 Shuval. p. 7.

CHAPTER 14: TAO OF COMPOST

- 1 <https://en.wikipedia.org/wiki/Tao>.
- 2 Pan, Tian-Hao, et al. (2017). *Comparison of Cassava Distillery Residues and Straw as Bulk-ing Agents for Full-scale Sewage Sludge Composting*. Compost Science and Utilization, 2017, Vol. 25, No. 1. pp. 1–12.
- 3 LaMotte Chemical Products Co., Chestertown, MD 21620.
- 4 Rodale, J. I. et al. (1960). *The Complete Book of Composting*. Rodale Books: Emmaus, PA. p. 650.
- 5 Kitto, Dick. (1988). *Composting: The Organic Natural Way*. Thorsons Publishers Ltd.: Wellingborough, UK. p. 103.
- 6 World of Composting Toilets Forum Update No. 3, Monday, November 2, 1998.
- 7 Del Porto, David, and Carol Steinfeld. (1999). *The Composting Toilet System Book* — editor’s draft. Center for Ecological Pollution Prevention: Concord, MA.
- 8 Olexa, M. T. and Rebecca L. Trudeau. (1994). *How is the Use of Compost Regulated?* University of Florida, Florida Cooperative Extension Service, Document No. SS-FRE-19.
- 9 Pennsylvania Solid Waste Management Act, Title 35, Chapter 29A.
- 10 Pennsylvania Municipal Waste Planning, Recycling and Waste Reduction Act (1988), Title 53, Chapter 17A.
- 11 King, F. H. (1911). *Farmers of Forty Centuries*. Rodale Press, Inc.: Emmaus, PA. pp. 78, 202.

CHAPTER 15: BUM RAP

- 1 Searchinger, Tim et al. (2018). *World Resources Report — Creating a Sustainable Food Future — A Menu of Solutions to Feed Nearly 10 Billion People by 2050*. Synthesis Report, December 2018. World Resources Institute.
- 2 Saber, Mohammed, Hussein Fawzy Abouziena, Essam Mohamed Hoballah, Wafaa Mohamed Haggag, and Alaa El-Din Mohamed Zaghloul. (2016). *Sewage Farming: Benefits and Adverse Effects*. Research Journal of Pharmaceutical, Biological and Chemical Sciences.
- 3 Ibid.
- 4 Conrad, Z., M. T. Niles, D. A. Neher, E. D. Roy, N. E. Tichenor, L. Jahns. (2018). Relationship between food waste, diet quality, and environmental sustainability. PLoS ONE 13(4): e0195405. <https://doi.org/10.1371/journal.pone.0195405>.
- 5 US Environmental Protection Agency. (May 1998). *Characterization of Municipal Solid Waste in the United States: 1997 Update*. Report # EPA530-R-98-007. US Environmental Protection Agency: Washington, DC. pp. 29, 45.
- 6 State of the World 1998. pp. 101, 166.
- 7 *Basic Information about Landfill Gas*. Landfill Methane Outreach Program (LMOP).

- <https://www.epa.gov/lmop/basic-information-about-landfill-gas>. 8 World Resource Foundation. (1998, April). Warmer Bulletin Information Sheet — Landfill.
- 9 Golden, Jack, et al. (1979). *The Environmental Impact Data Book*. Ann Arbor Science Publishers, Inc.: Ann Arbor, MI. p. 495.
- 10 National Resources Defense Council. (1997). *Bulletin: Stop Polluted Runoff — 11 Actions to Clean up Our Waters*. <http://www.nrdc.org/nrdcpn/fppubl.html>.
- 11 Bitton, Gabriel. (1994). *Wastewater Microbiology*. Wiley-Liss, Inc.: New York. p. 86.
- 12 Solley, Wayne B., et al. (1990). *Estimated Water Use in the United States in 1990*. U.S. Geological Survey Circular 1081, Table 31. United State Geological Service: Denver, CO. p. 65.
- 13 US Department of the Interior, U.S. Geological Survey. <http://water.usgs.gov/edu/qa-home-percapita.html>.
- 14 <https://www.epa.gov/watersense/how-we-use-water#Daily%20Life>.
- 15 National Resources Defense Council. (December 24, 1996). *Population and Consumption at NRDC: US Population Scorecard*. National Resources Defense Council: Washington, DC.
- 16 *State of the World 1998*. Worldwatch Institute. W. W. Norton and Company, New York. p. 100.
- 17 Sides, S. (1991, August/September). *Compost*. Mother Earth News, Issue 127. p. 50.
- 18 *World Fertilizer Trends and Outlook to 2018*. (2015). Food and Agriculture Organization of the United Nations (FAO): Rome. p. 8.
- 19 *Vital Signs 1998*. Worldwatch Institute. 1400 16th St. NW, Ste. 430, Washington, DC 20036. p. 132.
- 20 Cannon, Charles A. (1997). *Life Cycle Analysis and Sustainability Moving Beyond the Three R's — Reduce, Reuse, and Recycle — to P2R2 — Preserve, Purify, Restore and Remediate*. As seen in the 1997 Organic Recovery and Biological Treatment Proceedings, E. I. Stentiford (Ed.). International Conference, Harrogate, United Kingdom. 3–5 September 1997. pp. 252–253. Available from Stuart Brown, National Compost Development Association, PO Box 4, Grassington, North Yorkshire, BD23 5UR UK (stuartbrown@compuserve.com).
- 21 Livingston, James D. (1996). *Driving Force — The Natural Magic of Magnets*. Harvard University Press. p. 42-45. Also: Veraschuur, Gerrit L. (1993). *Hidden Attraction — The Mystery and History of Magnetism*. Oxford University Press. p. 180. Also: Wei Lin, Jinhua Li, and Yongxin Pan. (2012). *Newly Isolated but Uncultivated Magnetotactic Bacterium of the Phylum Nitrospirae from Beijing, China*. *Applied and Environmental Microbiology*, February 2012, Volume 78, No. 3. p. 668. Also: Lefevre, Christopher T. et. al. (2010). *Moderately Thermophilic Magnetotactic Bacteria from Hot Springs in Nevada*. *Applied and Environmental Microbiology*, June 2010, Volume 76, No. 11. p. 3740

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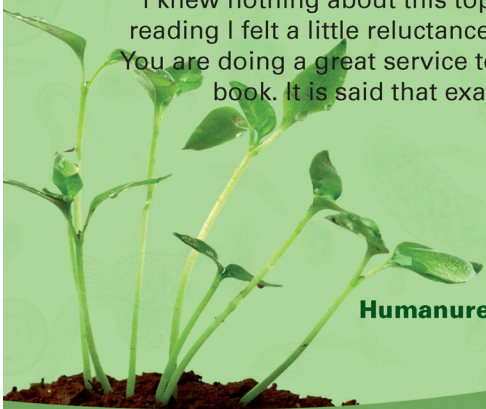
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