THERMOPHILIC COMPOSTING AS A SANITATION ALTERNATIVE GIVELOVE.ORG PROJECT, SANTO VILLAGE, LEOGANE, HAITI - A CASE STUDY

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ABSTRACT

After Haiti’s devastating earthquake in January of 2010, sanitation became non-existent there in many areas. GiveLove.org, founded by actress Patricia Arquette and Rosetta Getty, with Program Director Alisa Keesey and Compost Instructor Lucho Jean, taught local personnel how to establish sanitation systems based on thermophilic (hot) composting. Visits to Haiti by the author, who was also a volunteer composting consultant for GiveLove during this time period, documented these systems in schools and orphanages. By 2012, the organization had built over 30 toilets for over 4,000 users, and trained 15 Compost Managers. The most recent project, started in 2012, involved a village-wide system that serviced about 250 households. The “small village system” at Santo Village in Leogane, Haiti, is the subject of this paper.

The self-managed system utilized sugar cane bagasse as the primary carbon-based cover material. It was used to cover the contents of the toilets as well as the contents of the compost bins. The toilets are designed with either 20 liter or 60 liter recycled plastic receptacles used to collect toilet material (primarily feces, urine, paper). The toilet contents are covered with bagasse inside the toilet, then the contents are composted in compost bins located on-site, away from the toilets and the houses. Urine is not separated, nor is toilet paper. Food materials are also used as a compost feedstock, if available. Temperatures of the compost piles are monitored. The compost system requires no turning of the piles. The bins are walled using recycled wooden shipping pallets turned on edge, and are approximately 2.4 meters wide by 3.2 meters long by 1.2 meters deep.

The sanitation system is based upon the utilization of the thermophilic, or heat-producing composting process, which is effective in eliminating human pathogens. The objective is to create an above-ground static organic mass, made primarily of material collected in toilets, that reaches a temperature of at least 55C (131F) sustained for at least three days throughout the entire mass. The U.S. Environmental Protection Agency requires a three day period at 131F for static aerobic compost piles to be considered hygienically safe, because this time and temperature combination has been shown to be deadly to human disease organisms. The compost piles in Haiti are sustaining temperatures at or above 55C for weeks or months, much more than the required time period. The use of sugar cane bagasse as a cover material in the bins minimizes the exposed surface area of the compost and maximizes heat retention. This containment system also eliminates odors and flies and helps prevent vermin such as dogs and other animals from accessing the compost. Soap and water used to clean toilet receptacles are added to the compost piles, thereby creating a closed system.

The process relies on local management by Haitians, compost training, a dedicated compost management crew, public education, access to and transport of carbon-based cover materials to the toilet sites, and constructive use of the finished compost. This project created many tons of odor-free, hygienically safe, agriculturally valuable, finished compost.

KEYWORDS: humanure, Haiti, thermophilic composting, compost toilet, sanitation, ecosan, dry toilet, ecological sanitation, village compost toilet system, bagasse, Santo Village, Habitat for

Humanity, Architecture for Humanity, GiveLove.org, Patricia Arquette, Alisa Keesey, Lucho Jean, sanitation without water, sanitation without electricity, Otji toilet, Leogane, Rosetta Getty

INTRODUCTION

A thermophilic compost sanitation system is based on the concepts and principles of ”hot composting.” There are three basic components required for such a system to operate successfully: 1) the toilet itself; 2) the carbon-based cover materials; and 3) the compost bins.

COMPONENT #1 — THE TOILET

The toilet is simply a collection container, or receptacle. Its purpose is only to collect human excrement, both urine and feces, in a waterproof container. The "toilet material" is collected in the receptacle before it comes into contact with the environment; human excrement does not contact soil or water. The toilet material is not referred to as "waste" because nothing that goes into a humanure toilet becomes wasted. The discarded organic material is all constructively recycled via composting. Hence, the word "humanure" has become popular when referring to human excrement that is recycled through composting systems.

The size and type of toilet receptacle can vary. Five-gallon (20 liter) plastic receptacles are commonly used in a small-scale system because the receptacle can be easily carried by a single person. These receptacles can also be inexpensive or free, are water proof, can have lids, and can last a long time. Larger toilet receptacles (for example, 60 liters or larger) can also be utilized in humanure systems.

The purpose of the toilet is to collect feces, urine, paper, and the cover material so as to prevent unsanitary contact with the environment. No composting takes place inside the toilet. No water is used, no electricity is needed, no ventilation is required, and since the toilets don’t smell when the contents are properly covered, they can be located indoors in any room where there is enough privacy.

The purpose of thermophilic composting is to subject the toilet materials to robust microbial and biological activity which produces heat generated by thermophilic, or heat-loving, bacteria. This process is scientifically proven to destroy human pathogens, rendering the toilet material hygienically safe and achieving the true essence of "sanitation." The finished compost is also an excellent agricultural resource for revitalizing soils and for growing food.

COMPONENT #2 — THE COVER MATERIAL

Carbon-based cover materials are required for the humanure toilet system to function successfully. These materials cover the contents inside the toilets as well as the contents of the compost piles. Enough cover material of the correct consistency and moisture content is needed to totally and effectively eliminate odor and flies. The correct amount of cover material can be gauged by simply smelling the toilets or the compost piles. If there is an offensive odor, more cover material, finer cover material, or cover material with slightly more moisture content must be used. Likewise, if flies can be seen accessing the contents of the toilet or the compost pile, then more cover material must be used.

The cover materials must originate from "carbon based" plant cellulose material in order to promote thermophilic composting. One of the most widely used cover materials, for example, is sawdust from trees. Others include peat moss and rice hulls. Sugar cane bagasse, left over from the crushing, shredding and processing of sugar cane, is widely available in tropical areas and is useful for compost toilet systems. Cover materials can be any somewhat dry plant material ground into the correct consistency, such as from coco coir and even from paper products. Wood ashes should not be used as a cover material, nor should lime (ground agricultural limestone). These mineral materials inhibit microbial activity, whereas composting is intended to increase microbial activity, not to inhibit it.

Cover materials are required for the compost bins as well as for the toilets. The compost bin cover materials can be coarser than the toilet cover materials. They can include grasses, hay, straw, pine needles, weeds, leaves, sugar cane bagasse or many other organic plant materials that are odor-free and do not attract flies. Such cover materials allow for the collection of large quantities of toilet materials in above-ground compost bins without creating unpleasant odors or attracting flies. They also contribute to the aerobic thermophilic microbial reaction by creating tiny interstitial air spaces in the compost piles. By using enough cover material of the correct consistency to prevent odors from escaping the humanure toilet system, the correct balance of carbon to nitrogen is coincidentally achieved so long as urine is included.

If appropriate cover materials are not available, a compost-based sanitation system is not recommended. If the cover materials are available in limited quantities, humanure toilets can be successfully used in limited numbers.

COMPONENT #3 — THE COMPOST BINS

"Composting," by definition, is managed, aerobic, decomposition of organic material in such a manner that internal biological heat is generated by microorganisms. It typically involves an above-ground pile of organic material (a compost pile) and the pile may or may not be enclosed in a container (a bin). If a system is unmanaged, anaerobic, or not generating biological heat, it is not considered to be composting by today's industry definitions. Most "dry toilets" are incorrectly referred to as "composting toilets," when in fact no composting is occurring.

All toilet materials that are collected must be composted above ground in an aerobic, thermophilic manner in order to achieve maximum sanitation. This requires the depositing of the organic materials into compost bins. The bins must make the toilet material inaccessible to children, animals, vermin, or insect vectors.

The compost bin walls may be constructed of wood boards, masonry materials such as bricks, blocks or concrete; straw or hay bales (which can be reused as cover material after their function as side walls is completed); bamboo; poles or logs; wood shipping pallets turned on their sides, etc.

The bins should be located on bare soil with the bottom shaped into a slightly concave bowl, allowing for the pooling of any excess liquid into the center of the bin, thereby preventing leaching out the bottom should unexpected heavy rains drench an uncovered bin, for example. Bins can also be constructed on concrete or other hard surfaces, although this is not recommended. A soil base encourages beneficial soil organisms, including earth worms, to migrate into the compost pile. The soil will absorb moisture and act as a buffer for leachate, whereas concrete will not. Once the thermophilic phase begins, liquid is absorbed by the robust biological activity, hence there is a need for urine and possibly for rain water or graywater to moisten the compost mass. After a bin is filled, the compost should be covered with additional cover material and left undisturbed for approximately a year. This is called the "retention time." In a hot, tropical environment, nine months retention time may be adequate.

THERMOPHILIC COMPOSTING

Thermophilic composting is aerobic decomposition of organic matter that includes a hot stage dominated by heat-producing bacteria. The hot stage may last days, weeks or months, depending on factors such as the organic ingredients, the size of the compost mass, ambient temperatures, geographical location and/or time of year, and moisture content, among others. Thermophilic temperatures are generally in the range of 45 degrees Celcius or hotter.

Much scientific research has been conducted regarding the efficacy of the thermophilic compost environment in destroying human pathogens such as viruses, protozoa, intestinal worms, and bacteria. Refer to Table 1 for a partial list of pathogen thermal death points.

The compost must undergo a prolonged aging period of typically nine months to a year after it is collected. Otherwise, the compost will be immature and phytotoxic (it will kill plants). Maturity is reached when the compost pile cools down and the internal temperature is approximately the same as ambient temperature. At this point, the compost is suitable for growing food. There is no waste in this system. Instead, where other sanitation systems produce sewage and pollution, composting produces fertile soil and food for humanity.

SANTO VILLAGE SANITATION

The Santo Village was a Habitat for Humanity (HFH) project[1] (see Figure 1). Habitat for Humanity and Architecture for Humanity (AFH) collaborated with the Leogane community to create a starter home village at Santo, near Leogane (see map), for the purpose of housing persons displaced and left homeless by the 2010 earthquake. A projected 500 homes were to be constructed and owner-occupied, each on a 150 square meter lot. Each home was expected to have its own toilet to avoid the maintenance concerns associated with shared sanitation systems. The primary concern was to establish a system with relatively low maintenance, cost and labor, based on a reliable and proven technology.
For practical considerations, one of which included poor access to water on the site, the options were narrowed down to:

1. Thermophilic Composting as implemented by Give Love (www.givelove.org)
2. Enclosed Long-Term ”Composting” Toilet
3. Pour Flush Septic System
4. Pit Latrine
5. Urine Diversion Dehydrating Toilets as implemented by SOIL (www.oursoil.org)

OTJI TOILET — AFH’S FIRST CHOICE

Out of the five options listed above, Architecture for Humanity selected the Otji Enclosed Long-Term ”Composting” System, a dry toilet that was developed in Otjiwarongo, Namibia. AFH cited advantages in maintenance, operational costs, social acceptability, health risk, reliability of the technology, environmental factors, and economics. The proposed cost for this system was $533,700.00 USD.

The hot composting system proposed by GiveLove.org and priced at $191,500.00 USD, had its drawbacks, according to AFH, including social acceptability. *“The social acceptability of this system would probably be quite low as there is repeated contact with the humanure. Having to store humanure for collection may also be undesirable.”*

AFH’s additional concern was health and risk. They stated, *“There are large numbers of people coming in direct contact with the humanure, increasing the risk of contamination by pathogens. The toilet seat may have to be secured to ensure children cannot gain access to the humanure. Storage of humanure in the household prior to collection is a potential risk as is securing the bins when left out for collection. Compost managers will need to ensure compost stations are also kept secure to ensure they are not accessed by unauthorized personnel. All tools and transport associated with the composting stations will have to be cleaned properly after use. Compost station staff will need to be very well trained and know what measures to take if temperatures are not being maintained according to guidelines.”*

AFH described the chosen Otji toilet as *“a dry toilet system which collects humanure in a large perforated bucket in a chamber beneath the toilet [see illustration]. A specially designed urine diversion toilet is used to divert 80% of the urine directly into a soak pit in the ground. This type of urine diversion toilet does not need special instruction for use. The remaining urine and solids are collected in the 90 liter bucket below. The remaining urine percolates through the solids and seeps into the soil. The bucket for a single family use usually fills up within 6 months. It is removed to the rear part of the chamber below the ventilation chimney to dry out the remaining solids and replaced* *with an empty bucket. When the second bucket fills, the dry solids are removed and returned to a hole in the soil, unless further composted. A black painted panel and large chimney vent help to remove smells from the toilet. Orientating the ventilation stack towards the sun is important for efficiency. On occasion this system has been installed with a small solar-operated fan for night ventilation."* According to Ecosur South Network (EcoSur.org), the Otji toilet is considered *"ideal for dry and hot climates."*

Average annual rainfall in Otjiwarongo, Namibia, is 18 inches (0.457 meters). Average annual rainfall in Leogane is more than three times as much at 57.52 inches, or 1.461 meters[2]. Despite the fact that Haiti tends to be much wetter than Namibia, the Otji system was installed anyway and in use for a period of time at Santo.

The Santo villagers eventually complained about unpleasant odors coming from the Otji toilets, which could be smelled in the air throughout the village. The toilets became so unpleasant that villagers refused to use them, some preferring open defecation, and the system became abandoned.

A preliminary, unpublished internal review of the Otji toilet system yielded the following:

1. The toilet contents had a soupy consistency that was very wet, odorous and unpleasant.
2. When full, the 90 liter containers of raw excreta were expected to be lifted out of the sunken toilet chamber, removed to another location, and buried safely according to the discretion of the user.
3. There were unknown costs for the Otji toilet user related to the removal and burying of the excrement. Costs include labor, transportation and possibly a disposal fee.
4. Wet fecal slurry was in the Otji buckets, on the buckets, and around the chamber floors. The chambers omitted strong odors. All of the 90 liter containers observed were covered with notable insect infestations, flies, fly larvae, and feces.
5. The odors and flies may be a result of the spillage or overflow of feces and urine in the chamber due to a drop shoot that is too long or not designed properly for the toilet contents to fall entirely into the Otji bucket.
6. The fly infestation may pose a significant health risk since flying insects can spread disease. The uncleanliness of the chambers and hundreds of flies present a psychological barrier for the users. The Otji toilet chamber is very unpleasant and less likely to be cleaned or maintained.
7. Users were pouring "Clorox" and other household cleaning products into the toilets to control odors. They complained that the toilets "smelled very bad at night in the house," despite the toilets being located outside.
8. A user reported that her family of 5 had already filled one Otji bucket in just 2 months.
9. A user reported that they had exchanged the 90 liter Otji bucket for a smaller container so they could dump it more easily.
10. A user reported that they were going to stop using the Otji toilet because they would rather go outside than deal with the buckets.
11. Several users reported that they were concerned about the flies in the Otji chamber and did not want to touch the Otji buckets at all because they were very dirty.
12. Users expressed fear about disease and cholera, and fear of moving the Otji buckets or going into the chamber to clean it.

DINEPA

The main Haitian public water institution is the National Directorate for Water Supply and Sanitation in the Ministry of Public Works, called DINEPA. Minimum DINEPA standards for ecological sanitation require, among other things, that *"where thermophilic composting is used, the standard rule for pathogen destruction is that temperatures throughout the pile must attain 50C for at least one week."*[3]

GIVELOVE'S HOT COMPOST SANITATION SYSTEM AT SANTO

GiveLove's hot composting system was subsequently installed to replace the Otji toilets. After the community accepted the system by voting, the project was scaled up from 24 pilot homes to nearly 300 homes in February, 2012, over the course of one week. The small Otji toilet buildings became the housing for the humanure toilets with plenty of room left over for general storage. The hot compost system had been in use at Santo for two years and 10 months when the data for this paper was collected.

GiveLove constructed two composting sites at Santo (Figures 2 and 3), each surrounded by chainlink fence and razor wire to keep out vandals. Inside the compounds they constructed compost sheds with padlocked doors for storing equipment and materials (Figure 4). Water sources were situated in the compost sites to allow for cleaning purposes. Gravel "soak pits" were installed for dumping the final rinse water after cleaning toilet receptacles (Figure 5). The compost yards allowed access to large trucks through gates for the delivery of bagasse. Toilets were set up inside the compost yards for workers (Figure 6). Bagasse was dumped in large piles inside the fenced-in area and was delivered on a regular basis (Figure 7). The bagasse was free, but the hauling was expensive. The cost of hauling bagasse constituted about 1/3 of the operating costs of the program.

Sixteen compost bins were constructed in each compost yard. Each bin had a holding capacity of 10 cubic meters. Each bin was labeled (Figure 8). A compost team was trained (Figure 9).

Each household was provided with 20 liter, waterproof, plastic toilet receptacles, with lids, for the collection of toilet material. The receptacles were housed in "Loveable Loo®" style wooden boxes (Figure 10), where they could be easily removed. A toilet was located inside each Otji toilet stall located behind each home (Figure 11).

The community received training in how the toilet system works and how to use it. Instructions are posted at the toilets (Figure 12). When a toilet was used, the user covered the contents of the toilet with bagasse. When one looked inside a toilet, all that should be visible is bagasse. In this way, no odors escaped and no files were attracted to the toilet.

When a toilet receptacle became full, the user simply lifted the 20 liter container out of the toilet and set it aside in the toilet room, with a lid on it. In this manner, all toilet material was collected and nothing was leaked or drained out into the ground. There was no human contact with excrement and nothing was polluting the environment or creating a health hazard.

Twice a week, as needed, the toilet user would carry his or her toilet receptacle, with lid, to one of the two compost yards, early in the morning when it was still cool outside. Here, inside the fenced compound, they would simply set their full (actually about 2/3 or 3/4 full) toilet receptacle on the ground for the compost workers to take care of. The user would then take a clean, empty receptacle as supplied by the compost workers, put clean bagasse in it if they needed it, and carry it back to their home toilet.

The compost workers would then empty all of the toilet receptacles at once into a designated compost bin. Approximately 150 to 200 receptacles were collected twice a week and a single bin was filled in approximately a month's time. The 32 bins in use in the village each had a capacity to hold about ten cubic meters of organic material.

Once a bin was filled, it was covered over with a generous layer of bagasse and then allowed to compost undisturbed for a full nine months or more of retention time. Temperatures of the piles were monitored and recorded (Figure 13), by probing the temperatures at various locations in the pile. Data showed that the average temperatures remained above 131F (55C) for three months or more, far above the EPA required three day period or the DINEPA required 50C for one week. These temperature results are typical for the humanure compost operations as seen by the author of this paper at other Haitian sites and elsewhere in the world. See Figures 14, 15 and 16.

Prior to adding any toilet material to a compost bin, first a "biological sponge" is constructed in the bottom of the bin (Figure 17). This is simply a thick layer of bagasse, approximately 1/2 meter deep. This provides an absorbent cushion of organic material to allow the first layer of toilet material to bed into. The sponge does not need to be bagasse. It can be any clean organic material such as straw, hay, leaves, weeds, grasses, etc., as long as the material is somewhat absorbant and in sufficient quantity.

The compost workers were equipped with long rubber gloves, high rubber boots, and coveralls (Figure 18). The collected toilet containers are all dumped at once over the surface of the pile (Figure 19), then the pile is covered with clean bagasse. The bagasse covering prevents odors from escaping, keeps flies from being attracted to the compost, and acts as protection from heavy rains and from drying sun. In effect, the organic material becomes layered into the bins in this manner — first a biological sponge, then a layer of toilet material (itself about 2/3 bagasse), then a layer of clean bagasse, then more toilet material and food scraps if available, more bagasse, etc., until the bin is heaping full (Figure 20). The contents will shrink to about half the original volume, or less, after the compost has fully aged (Figure 21), which is why the bins should be initially filled to capacity.

When the next dumping occurs, the bagasse cover is raked to the sides and the fresh toilet material then added. This causes the creation of a bagasse edge around the fresh material and prevents toilet material from falling through the openings in the pallets. It also insulates the sides of the compost and prevents the open, exposed surfaces that are characteristic of windrow composting. Because the toilet material is contained and enclosed in this manner, there are no exposed surfaces and no need to "turn" the compost piles as is necessary when open piles, or windrows, are used.

Windrows and open, uncovered piles have a high surface area to volume ratio. The center of the pile gets hot, but the outside surface of the pile does not. In order for the entire mass to be subjected to the internal, biological heat, it must be completely stirred up and the outer surfaces turned into the center, numerous times. This process is very labor intensive. Open compost piles with large, exposed surface areas also tend to be odorous and fly covered. These problems are easily solved by piling the organic material in an above-ground container such as the pallet bins used at the Santo site, and covering the compost with a clean cover material at all times. When the cover material is correctly managed by pulling it aside when adding fresh material, a blanket of cover material is formed around the edges of the compost pile, thereby eliminating exposed edge surfaces, allowing the entire mass to heat, while simultaneously preventing odor and fly problems. High temperatures can be confirmed along the edges of the compost using a compost thermometer. Figure 22 is a screen grab from a video taken by the author of such a compost bin in Haiti. The thermometer is reading 131F (55C) at a depth of approximately six inches (15 centimeters) near the edge of the pile. Bagasse surrounds and covers the compost in this bin, preventing loss of heat.

After emptying, the toilet receptacles are given an initial rinse with water by the compost management team. This water can be dumped from receptacle to receptacle while they are being scrubbed with a long handled brush. The initial rinse water, or "black water," is dumped into the active compost bin (the same bin the toilet receptacles are being emptied into). Then the receptacles are sprayed inside and out with a diluted bleach solution using a hand-pumped sprayer. This water is dumped into the soak pit. The diluted bleach solution is used as a disinfectant for the handles and exterior of the toilet receptacle as well as the inside. The cleaned receptacles are set in the sun to dry and are then stored on site under a tarp until further use (Figure 23). The look and smell clean inside.

The finished compost has been independently lab tested (Soil Control Lab,Watsonville, CA USA). It is considered, mature, very stable, safe (tested for fecal coliform, salmonella and heavy metals), average in nutrients, a low nitrogen provider, high lime content, with an average nutrient release rate, a neutral nitrogen demand, and high ash content. The compost sprouted healthy test plants (see test results).

It is unfortunate that prejudices about hot composting persist in some sanitation and urban planning communities. All of the very serious sounding issues listed by AFH turned out to be non-issues after all. There were not large numbers of people coming into direct contact with humanure and the very idea is preposterous. What AFH failed to consider was that the hot composting system produced no waste and no environmental pollution and is relatively inexpensive, whereas the Otji toilet, although perhaps perfectly suitable for Namibia, collected "waste" for disposal, cost half a million U.S. dollars, and failed miserably in Haiti.

When properly managed and carried through to total fruition, the hot composting alternative can produce real monetary profit from the sale and use of the finished compost and thereby create a sanitation system that pays for itself.

DATA FROM SANTO SITE[5]

PARTICIPANTS
• Average number of households participating in the compost activities/compost day: 170-200.

COMPOST BINS
• Construction of bins: recycled shipping pallets on edge, fastened together.
• Number of compost bins needed to compost for 270 households: 32.
• Area needed to build compost bins with 1.5 meter walk area between each pile: 290 m2.
• Dimension of compost bins: 2.4m X 3.2m X 1.2m.
• Internal volume of compost bins: 8 cubic meters.
• Capacity of compost bins when full: 10 cubic meters (piled high).
• Volume of compost in bin at maturation (after shrinkage): 4-5 cubic meters.

QUANTITY OF ORGANIC MATERIAL COLLECTED
• Approximately (400) 20 liter toilet receptacles are collected each week (averaged over the life of the project), each approximately 2/3 full = 1,333.33 gallons toilet material collected/week = 5.047 cubic meters toilet material collected/week per 250 households.
• 20.19 cubic meters of toilet material is collected per month for 250 households.
• Collection is done twice per week.

COVER MATERIAL
• For every cubic yard of toilet material collected, two cubic yards of bagasse are needed.
• The bagasse is sources from 2km away at a sugar factory where it can be obtained free.
• 13.46 cubic meters of toilet cover material are needed per month for 250 household toilets.
• Assuming 250 households are using the toilets, then each household is using .054 cubic meters/month of toilet cover material = 14.26 gallons/month, rounded to 15 gallons per household per month for cover material utilized at the home.
• Assuming 13.46 cubic meters are needed per month for the household toilets, or 161.52 cubic meters per year, but we double that quantity to make sure we have enough for the bins (biological sponge, top cover, etc.), then we need 323 cubic meters per year for 250 households, or approximately 1.3 cubic meters per household/year.

COMPOST MANAGEMENT
• One team leader and five compost workers (four are women and two are men) work 4 hours each per week total (3 persons at each compost site), or 24 “man hours” per week total, to compost and clean approximately 300-400 toilet receptacles per week, total, at two sites. It takes less than a minute to clean each 20 liter toilet receptacle.
• Composting is done every Tuesday and Friday, at both sites. Households drop off full toilet receptacles and retrieve clean ones and bagasse as needed.
• The five-gallon toilet receptacles are usually no more than 75% full when delivered.
• Composting is done between 5 and 6 am because of the heat.
• Water from the first rinsing of toilet receptacles is deposited into a compost bin.
• Second rinsing contains Effective Microorgansims (EM) and is dumped into soak pit.
• Final rinse is with mild bleach solution (to disinfect the outside of buckets and handles) and is also dumped into soak pit.
• Buckets are dried in the sun to further sanitize, then set underneath a tarp.

• Total training time for compost workers was about 8 weeks, with a pilot group of 24 houses. After the community accepted the system by voting, the project was scaled up from 24 homes to 300 homes over the course of one week, in February, 2102. In a survey, 80% of households said they knew this system protected the ground water as well as their drinking water, which they collected on site.

COMPOST HARVEST
• Compost harvested/bin after 1 year processing: (45) 30 lb. bags or 2.5 cubic meters/bin.
• Number of compost bins harvested per year: 25 (33,750 lbs. compost total harvest).
• Number of cubic meters or bags harvested per year: 62.5 cubic meters or (1,125) 30 lb. bags.
• Tons compost harvested per year: 16.875.
• Metric tonnes of compost harvested per year: 15.30.

CONCLUSIONS

Compost sanitation systems can provide safe and pleasant toilet alternatives in developing countries where electricity, water, or money are in short supply, so long as carbon-based cover materials are available and ”compost sanitation” personnel are trainable. Santo provided a unique demonstration project because the users of the toilets participated in the process by delivering their toilet material to a trained composting crew.

The toilet users did not directly make any compost themselves or deal directly with humanure other than to excrete it into the toilets and cover it with bagasse. There were no reports of illness or diarrhea among any compost crew personnel.

There was no excrement draining into the ground or seeping into the environment from this sanitation system, as is common with other systems such as urine diversion toilets where urine is drained into soakpits. In fact, there is no organic ”waste” at all since all of the organic material is collected and recycled by composting.

The compost heated up to the extent that any human disease-causing organisms, including cholera, can be expected to be reduced to non-detectable levels or eliminated entirely. This fact alone sets this system apart from any other toilet system. There are no other toilet systems that completely and constructively recycle all toilet materials and in the process sanitize and convert the material to create a valuable end product, and do it all without the need for electricity.

The composting system can easily be expanded to include all food scraps and other organic materials that are typically discarded in a village setting, including animal mortalities. If the finished compost were sold, the income generated could finance a sustainable enterprise, perhaps to the extent that door to door collection of the toilet receptacles would be economically feasible. Other potential sources of income from this system include constructing toilets, constructing toilet stalls (if needed), supplying cover material, and working on a composting crew. The finished compost can support gardens, farms, orchards, nurseries and landscaping operations.

The fact that ”compost sanitation” systems are waste-free and instead produce compost suitable for growing human food should make this an attractive sanitation alternative anywhere in the world. GiveLove.org has started a new humanure project in a village in Nicaragua in the spring of 2015. Interest has also developed for additional large-scale projects such as in India, where there are massive tea plantations that need to improve their soils and well as to provide sanitation for thousands of their workers. In Africa, 50,000 farmers belonging to farm cooperatives are interested in learning how to safely recycle toilet material to enrich their soils. The recycling of toilet materials, and of organic materials in general, is within the reach of billions of people around the world who simply need to be better educated, trained, and assisted. Interest continues to grow world-wide.

ABOUT

Joseph Jenkins is best known for authoring the Humanure Handbook — A Guide to Composting Human Manure — first published in 1995 and now in its 3rd edition. The book has been sold worldwide and published in foreign editions on four continents. He has been a compost practitioner in the United States since 1975 and has grown food with humanure compost for the past 37 years. His web site at HumanureHandbook.com offers videos, instructions and the complete Humanure Handbook free of charge. Jenkins also provides compost sanitation consulting services internationally. More information about the author can be found at http://www.CompostSanitation.com.

GiveLove.org was founded by oscar-winning actress Patricia Arquette and Rosetta Getty. Its program director is Alisa Keesey and its primary educator in Haiti is Lucho Jean. More information is available at GiveLove.org.

To see videos of the Santo Village compost project:

Village Compost Toilet System in Santo Village, Leogane, Haiti, Part 1 of 2 (https://youtu.be/VY5K2Jn7Om0)

Village Compost Toilet System in Santo Village, Leogane, Haiti, Part 2 of 2 (https://youtu.be/tKdZOeTaPo4)

To see more humanure compost videos: http://humanurehandbook.com/videos.html

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[1] More information is available online at: http://openarchitecturenetwork.org/projects/santo_community_plan
[2] http://www.levoyageur.net/weather-city-LEOGANE.html
[3] Santo Community Development Plan, Sanitation Recommendations Sept 4, 2011
[4] Source: U.S. EPA (October 1997). Compost-New Applications for an Age-Old Technology. EPA530-F-97-047.
[5] Provided by Alisa Keesey of GiveLove.org