Evolution of Simple, Modified, DIY Terra Preta Sanitation for the Home

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Background on Terra Preta (TP)

- There has been found unusually fertile, highly productive soils in the Amazon River basin that have been determined to have been engineered by native inhabitants, perhaps hundreds or even thousands of years ago.
- This TP soil contains an increased level of organic matter and charcoal, thought to have been deliberately designed and maintained by native peoples, through social behavior for the purpose of food production. The native rainforest soil is shallow and leached of nutrients.

Terra Preta Sanitation (TPS) Components

- Brought to my attention by Carol McCreary of PHLUSH by the work of Ralf Otterpohl , et al. Hamburg University of Technology @ http://www.terra-preta-sanitation.net/cms/index.php
  - Utilizes biomass burned under conditions with limited oxygen supply to make charcoal for the purpose increasing soil fertility = Biochar
  - Fermentation of Feces with, among other microbes, Lactobacilli (think sauerkraut and sourdough)i.e. pickling poo
  - Urine Diversion/ Separation used to
  - Vermiculture for homogenization and pathogen reduction

Advantages to TPS

- Waterless : conserves precious natural resource
- Decentralized : resilient to disruptions in central sewer, especially during disaster situations
- Restores nutrient cycle while building healthy, productive soil
- Saves money : avoids buying water for flushing, sewer connection charges, buying fertilizers for crops
- Sequesters carbon from the atmosphere in the form of biochar aka agrichar : recalcitrant slowly decomposing over decades or centuries (Lehmann at Cornell)
- Enables participants to become more intimately involved with natural cycles

Disadvantages

- Potential code issues
- Labor intensive
- Variable tendencies for odors to form as this this system becomes perfected with continuous flow design utilizing a human powered Archimedes screw and / or conveyor belt to enclosed chamber

TERRA PRETA SANITATION

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Terra Preta do Indio is the anthropogenic black soil that was produced by ancient cultures in the Amazon region through the conversion of biowaste and fecal matter into long-term fertile soils. These soils have maintained high amounts of organic carbon even several thousand years after they were abandoned. It was recently discovered that around 10% of the originally infertile soils in the Amazon region was converted this way from around 7,000 until 500 years ago. A hectare of meter-deep Terra Preta can contain 250 tones of carbon as opposed to 100 tones in unimproved soil. One of the surprising facts is that this soil is highly productive without fertilizer addition.

Terra Preta Sanitation (TPS) is a low-cost dry sanitation system based on urine diversion and the addition of charcoal that produces lasting and highly fertile soils with properties similar to the recently discovered Terra Preta soils. Through natural processes of lacto-fermentation (silage) and vermicomposting fecal material is converted into Terra Preta like soils that can be utilized in (urban) agriculture and act as a carbon sink. In TPS systems urine and feces are collected in 2 separate compartments. Urine is collected in a jerrican and feces fall into a bucket that is placed airtight underneath the toilet bowl to allow for anaerobic conditions in the bucket. After each defecation a mix of charcoal powder together with a finely cut wood source and some limestone/volcanic soil needs to be added to cover the feces. In addition a few dashes of a lacto-bacilli containing microbial mix should be added. Left under anaerobic conditions a lacto-fermentation process will be initiated inside the bucket. Unlike in anaerobic digestion no methane is produced and no odor will occur in the bucket which makes it particularly interesting for larger scale indoor application in urban areas. The toilet lid needs to be closed after each use to provide as anaerobic conditions as possible. The occasional opening of the lid during the use will not significantly affect the process. As soon as the bucket is full it will be put aside, closed and stored for around 1 month to let the lacto-fermentation fully take place. It will then be subjected to a vermicomposting process. The final product is a Terra Preta soil with a high organic carbon content that allow for a long lasting fixation of essential nutrients, water retention and reduced leaching of nutrients.

TOILET DESIGN & USE

Toilet design and infrastructure needed

- Essential components needed are a urine separation devise and 2 containers for urine and feces collection
- The feces collection should take place under as anaerobic conditions as possible (air tight bucket, sealable bowl)
- Various designs are possible (in & outdoor), ranging from simple buckets to classic UD models similar to 1-chamber UDDTs

Urine treatment

- About ½ liter of the microbial mix (liquid mix of effective microorganisms) should be added to the urine container prior to the urine collection
- The microbial mix prevents the bacterial urease process that hydrolyses urea into ammonia and bicarbonate, and that is usually happening when urine is conventionally stored
- Without the bacterial urease process no volatile ammonia is produced which leads to a reduced loss of nitrogen of the system and hardly any odor

Add-on to the feces

1. Mix of ground charcoal powder, ideally mixed with a finely sliced wood source (e.g. sawdust, sliced-cut wood, coconut husks etc.) and limestone or volcanic soil
2. Microbial Mix (liquid mix of effective microorganisms and lacto-bacilli)

- After each defecation the charcoal mix will be added to cover the feces and dashes of the microbial mix will be sprinkled on top

Lacto-fermentation under anaerobic conditions

- Under anaerobic conditions and with addition of the lacto-bacilli containing microbial mix a lacto-fermentation (or silage) process will take place inside the bucket and no gas/methane will be produced
- Therefore the lid needs to be closed after each use to allow for anaerobic conditions inside the bucket
- After the bucket is full it should be stored for 2-4 weeks to let the lacto-fermentation take place
- Due to the lacto-fermentation no bad odor will occur

REUSE OPTIONS

Direct urine use

- Urine can be used the conventional way as a liquid nitrogen-rich fertilizer
- The advantage of the microbe-enriched urine over pure urine reuse is that hardly any smell and ammonia loss will occur

Urine composting

- Urine can be applied to a mix of a finely sliced wood source (80%), ground charcoal power (10%) and existing soil (10%)
- Through subsequent vermicomposting the material is converted into a humus-like material with no significant N,P,K losses

Comfrey production

- Application of urine to Comfrey (Symphytum officinale)
- Comfrey can take up huge amounts of nutrients, particularly Nitrogen
- It can then be added to the compost, used as mulch or as liquid fertilizer, since it breaks down quickly to a thick black nutrient rich liquid

Vermicomposting of lacto-fermented feces

- Decomposition of lacto-fermented feces with the addition of earthworms for 2-4 weeks
- The initial addition of a sliced cut wood source to the feces and the inoculation of *Baoilus subtilis* (part of the microbe mix) helps facilitating the vermicomposting process even without adding other biowaste
- The final product is a nutrient-rich vermicast with properties similar to Terra Preta soils

Some of the graphics used are taken from Tilley et al. (2008)

Disclaimer about Evolution of my TPS System

- The TPS system that I demonstrate is modified at this time in that it only utilizes the acid fermentation of kitchen and some household paper scraps, rather than dedicated feces stream
- Urine is diverted to inoculate biochar
- Biochar absorbs nitrogen and phosphorus from urine : charging the biochar with nutrients
- Feces deposits are layered with sawdust/ woodchips and crushed biochar mixture
- System in only in production phase, utilization studies to follow in 2012


Bucket for Toilet Cover Material = Free
Sauerkraut for inoculant= $2 USD
Micro Aerobic Bucket = acid fermentation of kitchen scraps= $15 USD
Bucket with Toilet Seat + Lid for Feces =$10 USD
Urban Scrap Wood Waste for Biochar = Free
Garden Biochar Stove from SeaChar.org design with bag of crushed char for cover = $8 USD
Bucket for Soaking Biochar with Urine USD
Urine Diversion into Jug = Free
PORTLAND COMPOSTS!


Micro Aerobic Bucket = acid fermentation of kitchen scraps
WARNING
AVISO

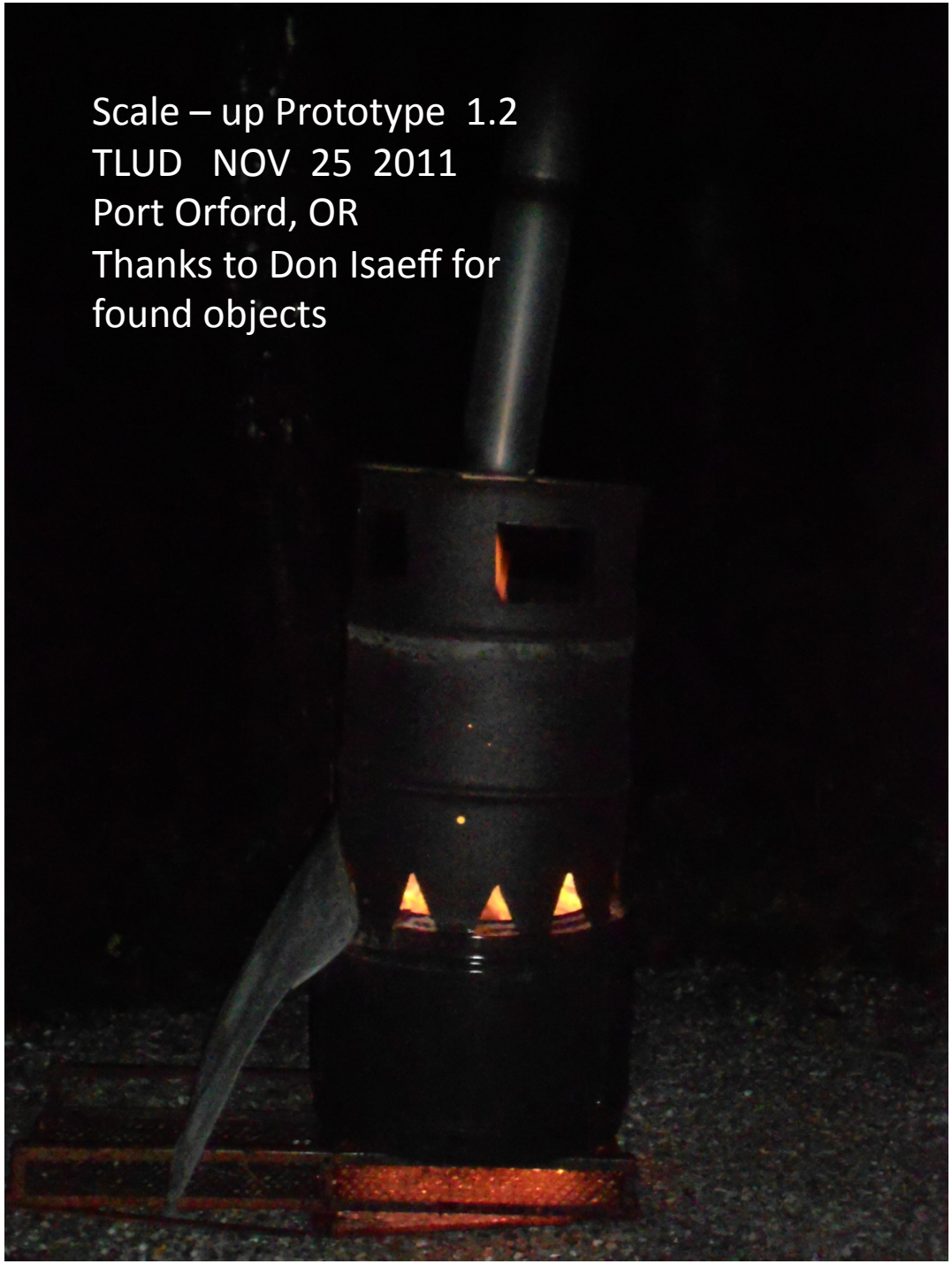

Top-Lit Up-Draft= TLUD stove
ALL PURPOSE CLEANER


Worms: create
the right
conditions and
they will
come=free


Tarp to cover the bed during winter months to repell rain and retain heat
Purging finished product for perineal crops to make room for next batch to be integrated into the wo

Opportunities for further Evolution

- Pathogen Reduction studies in conjunction with Aqua Pura Para Pueblo
- Soil analysis with Soil Food Web folks
- Scale up TLUD in order to increase biochar production
- Capture heat for cooking and thermal hot water
- Initiate feces acid fermentation utilizing 55 gallon drumand 275 gallon cube totes
- Integrate urban food waste streams into system
- Relocation of trials to rural setting
- Horticulture production trials
- MycoChar Custom Soil amendment R & D for soil enhancement and remediation technologies with Jordan Weiss


Scale – up Prototype 1.2
TLUD NOV 25 2011
Port Orford, OR
Thanks to Don Isaeff for
found objects

Scale up TLUD Prototype 1.3 made with Tyler Franzen scheduled to be fired Jan 2012 with after installing Primary and Secondary Air Slide Dampers for maximizing efficiency