TERRA PRETA SANITATION

Sustainable Sanitation Center
Xavier University, Cagayan de Oro, Philippines

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.

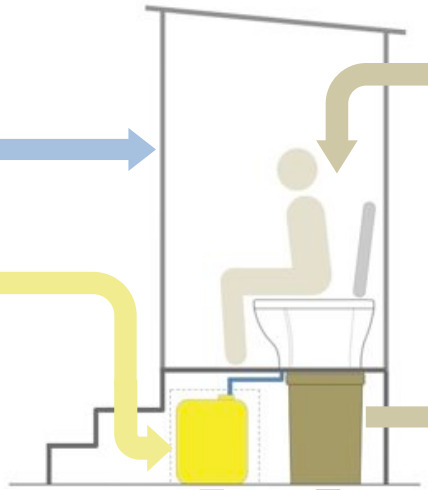
TOILET DESIGN & USE

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 *Bacillus 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)

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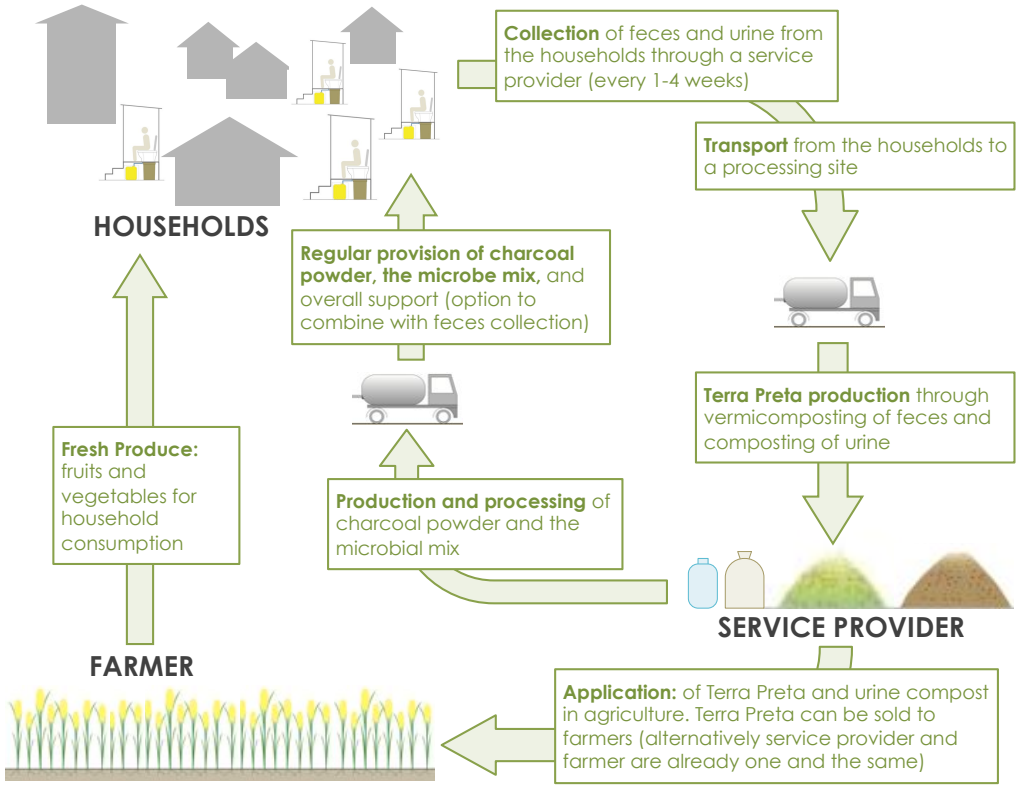
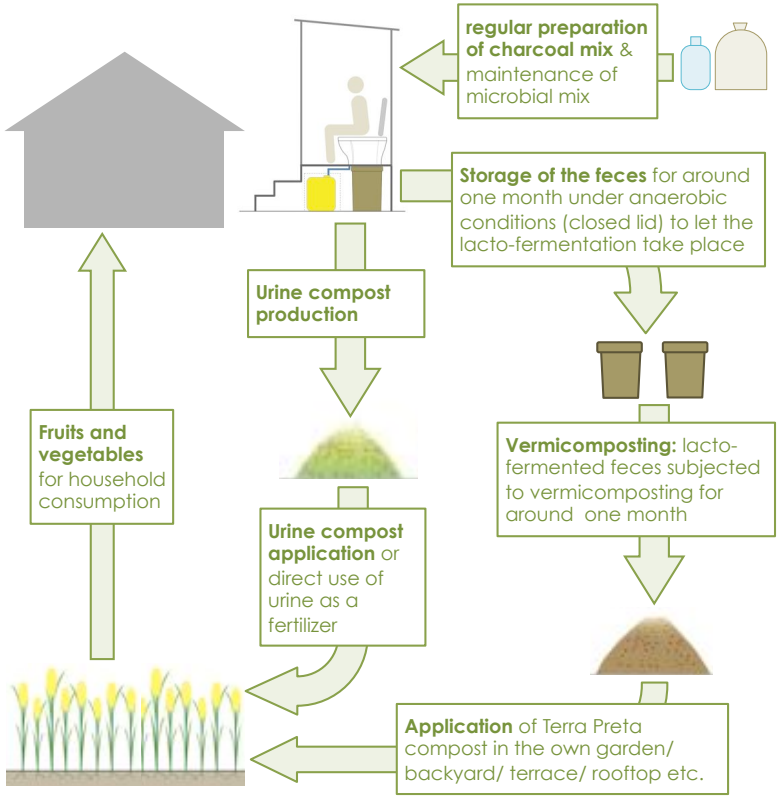
MANAGEMENT OPTIONS

I. COMMUNITY LEVEL



II. HOUSEHOLD LEVEL



MICROBIAL MIX

Microbes in the mix

- **Bacillus subtilis** (generates microbial mucus, aids in formation of humified substance, enzymes & special hormones for supporting plant growth, suppresses soil-born diseases, heat resistant)
- **Bacillus mesentericus** (aids in humification of crude organic matter at lower temperatures)
- **Geobacillus stearothermophilus** (aids in formation of microbial enzymes and lactic acid decomposes potentially toxic substances, heat-resistant)
- **Azotobacter croococcum** (generates organic nitrogen through biologic nitrogen fixation)
- **Lactobacillus spec.** (forms lactic acids, suppresses putrescent germs)

Regular feeding of microbes

- Microbes can be duplicated every 2 days but should be fed at least once a week with a mix of water, a sugar source (blended bananas, sugar cane juice etc.) and sterilized milk. Sugar content in the solution should be around 3-5 %.
- Entire solution should be cooked (sterilization) first and added to the microbe mix after it has cooled down
- around 2/3 of the bottle should be left for air to allow for microbial respiration

Use of microbe mix

- Inoculation to urine collection jerrican to avoid urease process and ammonia losses & considerable odor reduction
- Add-on to feces during collection to reduce odor & kick-start lacto-fermentation process
- Ad-on to kitchen waste to reduce odor & increase microbial activity
- **Bottles with microbe mix have to be clearly labeled and kept away from children!!!**

For further information please contact:
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