EXPERIMENTS ON CO-COMPOSTING OF HUMAN EXCRETA WITH BIO-CHAR IN ARBA MINCH, ETHIOPIA:

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Abstract

The potential of human urine, faeces, and other bio-waste as sources of plant nutrients and soil organic matter is not yet fully utilized. Lack of appropriate technology for processing the waste streams is one of the major challenges for the limited success so far.

These experiments are aimed at improving human waste processing in Arba Minch, Ethiopia. The impact of biochar in co-composting of urine, faeces, and bio-waste is assessed. Extent of conservation and concentration of plant nutrients through the process is investigated.

Preliminary results have shown significant reduction in the volume to fertilizing value ratio of the end product. The addition of biochar is observed to improve operation in co-composting. The application of co-composted faeces, urine, and bio-waste with biochar has shown a better result over the mere application of composted or dried faeces or just stored urine. This study is in progress and shows that co-composting of urine and faeces with other bio-waste and biochar a potential method to generate nutrient and humus rich soil amendment agent.

Key words: Ecological Sanitation, Biochar, Terra Preta Sanitation, Co-composting, bio.waste management

Introduction

The concept, ecological sanitation, offers a better alternative to meet sanitation needs and to recover plant nutrients & organic matter from human waste at the same time.

So far, as results of researches worldwide, various high and low-tech/cost treatment and recovery pathways have been suggested to render human excreta (i.e. faeces and urine) innocuous and recover plant nutrients and organic matter for reuse in agriculture. While dehydration, alkaline stabilisation, thermal drying of anaerobicallly digested sludge, and cocomposting constitute some of the pathways suggested for the treatment and reuse of fecal matter; storage, sturvite recovery and fresh urine applications are suggested

treatment and reuse methods for urine in common literature.

However, those pathways, as practised today, are not yet at the same time effective, rapid, economical, and easily manageable. Therefore, there is a need for new pathways and further refining research works for specific socio-environmental conditions. Terra Preta Sanitation (TPS) is one such new pathway in ecological sanitation. It is a concept re-discovered from ancient soil conservation practices in the Amazon basin and aims at converting human waste into a safe, nutrients & organic matter rich soil conditioner (Factura et.al, 2010).

Terra Preta is a name given to patches of fertile soils in Amazonia. Terra means soil and preta is black, so it literally means black soil, which actually is owing to the high black carbon content of these soils. These patches of soils are characterized by having three times more soil organic matter and higher nutrients content than the surrounding infertile soils (Sombroek 1966; Zech et al. 1990; Glaser et al. 2001, Glaser, 2007). Scientific researches have now concluded that these soils are man made (Neves et al., 2003; Glaser et al., 2004a; Glaser, 2007; Woods and Denevan, 2009) through clever integrated waste management, putting together ash, bones, manure, excrements, urine, biomass waste, and biochar (Glaser & Birk, 2012).

On the the other hand soil degradation is one of the major pressing issues that pose major food security challenges in many parts of Ethiopia. Soil organic matter (SOM) , which a major building block of soil fertility, is being depleted at a very high rate. Therefore, there is a need to rebuild SOM through such activities as Terra Preta composting. Though there is a good initiative in the country to replenish SOM with composting, there is need to scale it up. Terra Preta Sanitation is, therefore, a potential concept in rebuilding soil fertility in Ethiopia. The drivers for Terra Preta Sanitation are waste management, soil quality improvement, climate protection, and local energy production. In the field of sanitation waste management component takes the biggest share. The current research approach is summarized in the figure below.

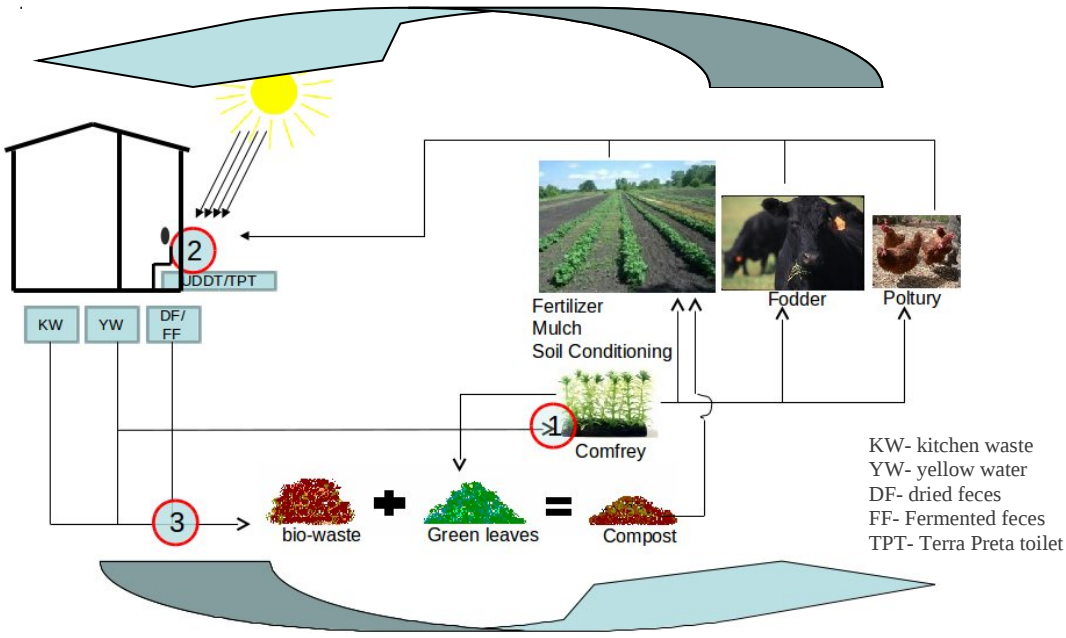

Illustration 1: The terra preta sanitation reseach approach

Materials and Methods

Study area: This study is conducted in the southern Ethiopia in a town called Arba Minch. Arba Minch is one of the fast growing middle sized towns in Ethiopia with a population of 94,000. On the western side, the town is surrounded by rift valley escarpment mountains. The town gets a mean annual rainfall of 880mm and has a mean annual temperature of 20^{o}c.

Data collection: In order to assess the composting potential of the town solid waste, a quantitative and qualitative data was collected through questioners and site visits. Urine diverting dehydrating toilets were also visited during this exercise to assess the volume of feces that is being generated from households. Visits to households who own fossa-alterna was made. Situation observation and analysis was conducted to find out possibilities of biochar amendment as an optional additive. Exploration of availability of charcoal powder was conducted during the visits.

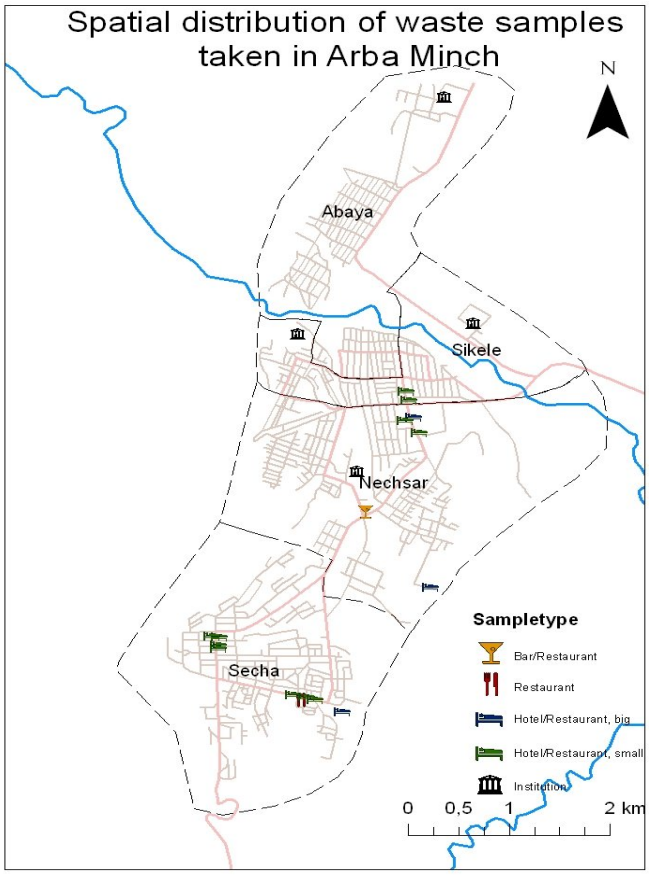

Illustration 2: Study area and sampling locations

Composter set up: A rotating composting drum was set up for composting experiments. It is made of a 60 litters poly ethylene container hinged on a wooden stand as shown in the figure below.

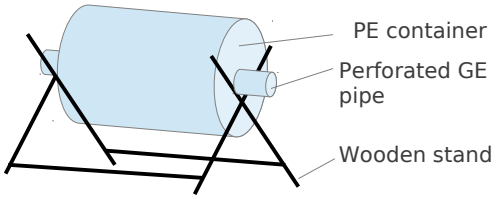

Illustration 3: Rotating drum composter for the experiments

Sampling and Analytics: Samples of solid waste and compost were collected in plastic bags for analysis. For pH 0.01M $CaCl_2$ was prepared by diluting 1.469gm of $CaCl_2$ in 1 liter distilled water and 1:10 (sample : 0.01M $CaCl_2$) mixed and results taken. For electrical conductivity 20gm sample was diluted to 200ml of distilled water and the reading taken. For nutrients analysis 20gm of sample was diluted to 0.0125M of $CaCl_2$. The organic fraction of the solid waste was determined through loss on ignition (LoI).

Plant test: Cress germination test was conducted to assess the impact of compost with biochar on germination.

Results and Discussions

In a study conducted to assess the organic fraction of the town solid waste, it was found out that 94% of the town solid waste is compostable. Furthermore, much of the household, restaurants, and university solid waste was readily available for cocomposting.

Though there exists this big potential of composting of the town waste, much of the collected solid waste ends up in a sort of dump site as it is. Only a relatively small amount goes for composting to the town's only small composting site. At the site, the solid waste is first sorted into compostable and non-compostable. The non-compostable part is transported to the solid waste disposal site. The compostable part is made into windrow piles. During the composing process, it is regularly, turned and during turning a mixture of urine and water is added.

Preliminary results of nutrients content from urine amended composting is summarized in the following table. The nutrients amount is higher in the urine amended compost. The urine apart from playing a big role in balancing C:N and moisture, it also gives away its nutrients to the compost by way adsorption. The results from biochar-urine amended composting is in progress.

Parameter	unit	With out urine	With urine
PO_4	[mg/l]	6.3	15.1
NH_4	[mg/l]	7.3	8.1
NO_3	[mg/l]	91	140
EC	µs/cm	1092	1163
pH	-	7.72	7.62

Table 1: Nutrinet content comparison

Odour is one of the major challenges in collection and cocomposting operation. In the field visits to households with urine diverting dehydrating toilets, it was observed that 40% of the toilets were technically misused. The faeces collection tanks were wet leading to an unpleasant seen and odour. These wet containers were, at times, delivered to the cocomposting site. Addition of 6% by volume of powdered biochar and mixing reduced the odour significantly and made the composting operation easier. Therefore, biochar can be taken as a potential correction measure against technical misuse of UDDTs. Addition of left over charcoal powder is experienced by a household owning a fosa alterna. It is

observed that there is a significant odour reduction with powdered charcoal addition. This a promising result because there is no competion for powder charcoal and powder charcoal is easily available ad it is inevitable to get some charcoal powder during crashing for burning.

In a cress germination test conducted to find out the optimum percentage of compost-biochar mixture, it was observed that addition of 10% biochar was the optimum as it is shown in the chart below. This is the optimum amount that is required to improve the soils nutrients and water holding capacity. Addition of more than 10% is observed to suppress germination. This might be due to the non-availability of nutrients and water as the biochar socks up much of it, making it unavailable for plants.

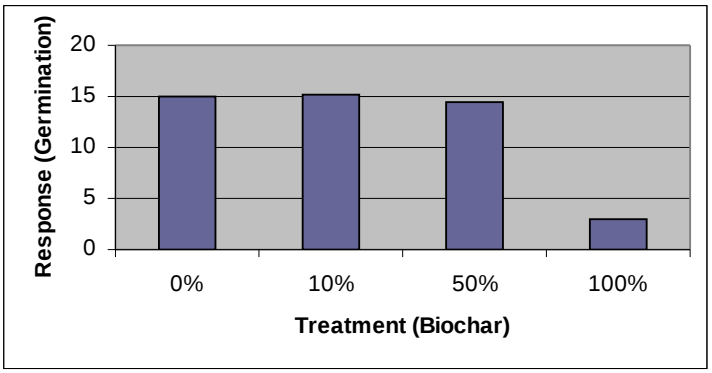

Illustration 4: Cress germination test result

Conclusion and further research

Biochar has a high potential in improving composting operations. The end result of biochar amended composting, in turn, has a high potential in improving soil quality through improvement of soils' water and nutrients holding capacity.

One of the major constraints in biochar applications is the non-availability of biochar and competition for biomass. In Arba Minch, the major fuel source for cooking is biomass. More than 2000 people make their living by selling fire wood or charcoal. There is a fierce competition for biomass for cocomposting and household application. Therefore, a study on possibilities of converting part of the town solid waste into biochar will be done. A study on dual purpose biochar producing cooking stoves is also deemed important.

Arba Minch solid waste has a big potential for cocomposting. The compost can be used for reforestation of the area around the town, which is the main source water for the town and which Is being depleted.

In this study the microbiological quality is not included. It is deemed important and will be included in future further studies.

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Acknowledgements
The work is carried out within the project CLARA (Capacity-Linked water supply and sanitation improvement for Africa's peri-urban and Rural Areas; Contract # 265676; duration: 1.3.2011 – 28.2.2014), a Collaborative Project funded within the EU 7th Framework Programme, Theme "Environment (including Climate Change)". The CLARA team is grateful for the support. Additionally, the PhD work of Mammo Bulbo is supported by Government of Ethiopia Engineering Capacity Building Program (ECBP) and German Academic Exchange Services (DAAD). Both are duly acknowledged. We would also like to acknowledge the interns involved in the work: Marie, Aude, and Shishay.