water for people
UGANDA

Deep Row Entrenchment of Faecal Sludge in Small Towns in Uganda

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BACKGROUND

Water For People is an international non-governmental organization (NGO) that works with people and partners to develop innovative and long-lasting solutions to the water, sanitation, and hygiene problems globally. The organization strives to continually improve, experiment with promising new ideas, and leverage resources to multiply its impact.

Water For People, Uganda is promoting a market-based approach to sanitation by working with sanitation businesses and testing different approaches to increase demand and supply of sanitation services. A key component of Water For People, Uganda's sanitation work is its research, which is done through the SaniHub, that researches and tests different sanitation technologies to best meet community sanitation needs.

Water For People, Uganda also supports various sanitation businesses, connecting them to the tried and tested SaniHub technologies and providing them business support. Water For People works to identify sanitation entrepreneurs, whether they be pit toilet emptiers, sanitation technology fabricators, or masons to construct toilets, and connects them to the financial capital necessary to run their business, while also providing direct business development services.

Through Sanihub, Water For People piloted deep row entrenchment (DRE) as an innovative solution for both faecal sludge disposal and reuse in small towns, within their areas of operation, that do not have any formal faecal sludge treatment plants (FSTPs) and where pit emptiers have to haul emptied sludge over long distances. Due to lack of FSTPs in these towns, pit emptiers almost always opt for dumping options that allow them to achieve the most profit and therefore for towns with weak regulation, many turned to illegal dumping of faecal sludge (FS) in the environment. The proposed solution was deep row entrenchment of faecal sludge as a safe burial option.

INTRODUCTION

Deep Row Entrenchment (DRE) is an innovative idea that is utilized as both a faecal sludge disposal and reuse mechanism. Its simplicity in design, as shown in Figure 1, and low cost of operation and maintenance make it an attractive solution for small towns without faecal sludge treatment plants (FSTPs). DRE involves placement of sludge into trenches that are immediately covered with soil, eliminating odour problems and safely containing human pathogens in the sludge. The area can then be planted with trees that have high nutrient consumption rates, for example, eucalyptus. It is a method that can be considered as both a treatment and disposal option and is an adequate solution where emptying or treatment is not possible or feasible or where there is space to continuously dig new pits and no groundwater contamination risk.

DRE has been piloted in several countries across the world including Malaysia, India, South Africa, and Benin as an interim or longer-term solution. Across these four countries, DRE was chosen because of its low cost, and the simplicity of its design (Simone Soeters et al., 2021). While further research on the benefits and risks associated with DRE is warranted to better understand the interaction of entrenched sludge with the environment and with the species of tree or other crop, sludge producers can begin to implement this method with proper management and monitoring (Partners in Development, 2022).

Water for People explored this concept in two small towns, that is, Kamwenge and Kole, which both have growing pit emptying businesses but no existing or functional faecal sludge treatment facilities. The main objective of the study was to investigate the potential of DRE as an interim solution for FS disposal and reuse in these towns. It examines main considerations for a site to qualify for DRE, changes in FS characteristics buried in the trenches, tree planting as the reuse option of sludge entrenchment, and possibilities of pollution of nearby water points from the buried sludge.

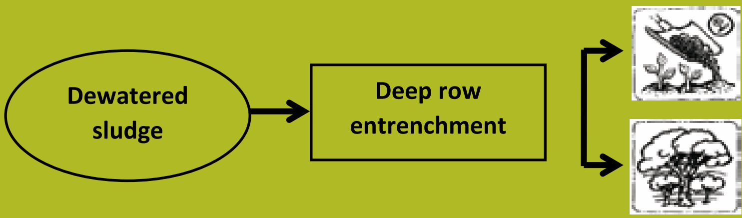

Figure 1: *Deep Row Entrenchment Process (Eawag-Sandec, 2016)*

LITERATURE REVIEW

Literature reported the earliest occurrence of burial of faeces and other household waste as a soil management system to have been as early as the period 5000 BC-1450 AD by inhabitants of the Amazon Basin, where the technique produced a deep nutrient and organism rich soil which continues to have the capacity to support intensive agriculture and a high population density. Literature also highlighted that DRE has been piloted in several countries across the world including Malaysia, India, South Africa, and Benin as an interim or longer-term solution where it was chosen because of its low cost, and the simplicity of its design.

Literature reported the benefits of DRE to include; adequate management of odour and the risk of disease transmission, can hold sludge that contains solid waste, benefit to forestry, wildlife habitats, reclamation of land, improved soil fertility, increased agricultural productivity, enhanced growth of timber or other non-edible commercial crops, food security - improved nutrient value of fruit grown by households, and environmental rehabilitation - restoration or enhancement of ecosystems through remediation of poor or disrupted soils and stabilization of carbon in the soil, thus reducing greenhouse gas emissions. Literature also pointed out that DRE is a more appropriate method for application of pit latrine sludge, even if sludge was stabilized and sterilized, due to the solid waste content than surface application.

Literature suggests that for a site to qualify for DRE, it should have the following characteristics; good soil permeability - for easy leaching of percolate from FS, flat surface - for easy operations, a water table deeper than 15ft from bottom level of the trench, surface water body minimum distance - 45ft with least possibility of trespassing by human or animals and should not be a in a shallow or flood prone area. For a site that meets these standards, literature reports that the variables to be considered for entrenchment of sludge include trench dimensions, spacing, and method of filling (layered with soil or co-composted with vegetable matter), plant species, composition and density of vegetation and end purpose.

Literature reviewed also indicated that sludge characteristics are an important consideration when choosing a technology because FS characteristics are highly variable and are influenced by a wide range of existing technologies. The recommended faecal sludge (FS) characterization tests included;- solids concentration, chemical oxygen demand (COD), biochemical oxygen demand (BOD), nutrients, pathogens, and heavy metals. Literature also reported that the major environmental concern with DRE is the potential for contamination of groundwater by nitrate (NO3) and phosphorus (P) leached from sludge.

METHODOLOGY

Sites were selected based on several factors highlighted in literature including good soil permeability, flat surface, distance from surface water, ground water depth, etc. Site set up was then done which included site clearing, excavation of trenches and fencing. Site layout was as shown in Figure 2. Warning signs were also put up.The trench type selected was the shallowtrench and this depended on the volume of sludge and the ground waterdepth.The volume of sludge to be disposed of in the trenches was calculated to be 2.4 m3. Given that the trenches were shallow, lining with sand barrier and/or agri-film cover was not required as the vertical distance between the bottom of the trenches and the ground water level was within the permissible limits highlighted in literature,that is,15ft or three timesthe depth of the pit. Faecal sludge was collected from residential and commercial buildings (like schools and offices). No industrial or toxic sludges were deposited in the trenches. Faecal material was obtained from already existing pit emptiers within the towns who delivered it to the designated site. The pit emptying mechanism used by the pit emptiers was the Gulper IV and sludge was transported in barrels on a pickup truck to the site. Sludge was dumped into the trenches leaving an allowance of 0.3 m for backfill. After each dump, sludge was left to de-water for 2 to 3 days and then backfilling done to prevent exposure to air and vectors. This process would then be repeated for a new layer of sludge. Following final backfill, an allowance of 3 months was given for decomposition of the faecal sludge after which eucalyptus trees were planted on the trenches. Site monitoring was done monthly to ensure that pit emptiers were practicing safe discharge and SOPs at these sites. Analysis of faecal sludge characteristics was done in intervals of 6-months and test parameters included; moisture content, total suspended solids (TSS) & total solids (TS), biological oxygen demand (BOD), chemical oxygen demand (COD), nitrogen, phosphorus, and potassium.

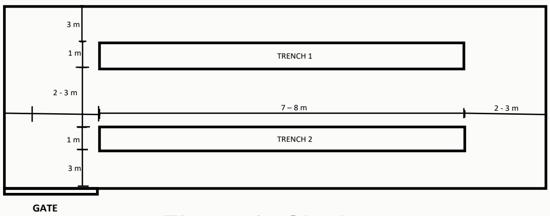

Figure 2: *Site Layout*

RESULTS AND DISCUSSION

1. Site Selection

Site selection was done in collaboration with the towns and district officials including the Town Clerks, Mayor, District Health Officers, and Natural Resources Officers. Pictures 1 & 2 were taken during inspection of sites done together with the towns and district officials.

Sites selected in Kole and Kamwenge town councils were found to have key characteristics that made them suitable for DRE including;-

- Distance from surface and point water sources was more than 50m.
- The water table was deeper than 5m from the bottom level of the trench.
- Flat surface which enabled easy operations.

The challenge encountered with selection of a site in Kole town council was that the bulk of the land is communally owned which made it difficult to earmark a site for this activity. Because of this, the selected site was located close to a village walkway which increased the possibility of trespassing by people or animals.

Picture 1 & 2: *Inspection of Prospective Sites with the Town Clerk of Kole Town Council (left) and District Health Inspector of Kamwenge District (right)*

2. Faecal Sludge (FS) Stabilization within the Trenches

FS tests were done to analyze the characteristics of fresh FS as received at the site. Results of these tests revealed the values of total suspended solids (TSS), chemical oxygen demand (COD), phosphorus, potassium, and total nitrogen (TN) to be high, and therefore sludge was concluded to be of mid - high strength. In addition, results revealed no risk of nitrate and nitrite contamination of ground water as no concentrations of these were found in the fresh FS.

Entrenched sludge samples were found to have undergone stabilization with significant reductions total solids, nutrient content and biological oxygen demand (BOD5) as shown in Figure 3. COD results were reported to have reduced for the 6-month and 9-month samples, though an increase was reported for the 14-month samples. This could be due to reported increase in moisture content within the trenches for the 14-month samples. The same was reported for the helminth eggs (viable) with reductions reported for the 6-month and 9-month samples but an increase in the 14-month sample as shown in Figure 4.

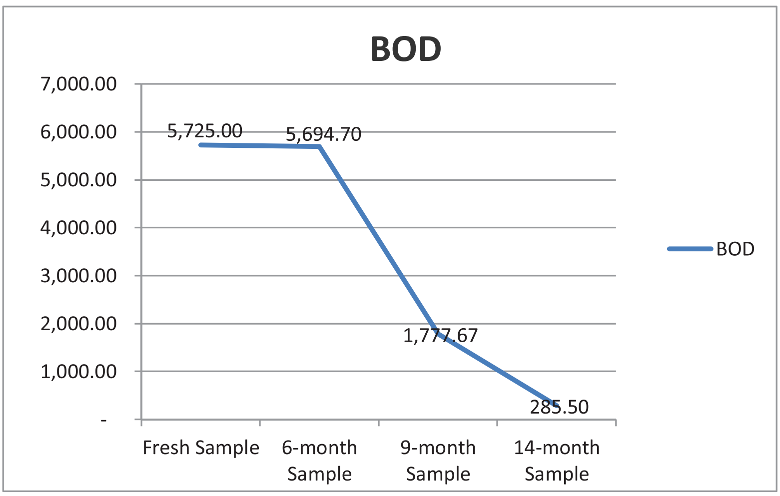

Figure 3: *Changes in BOD*

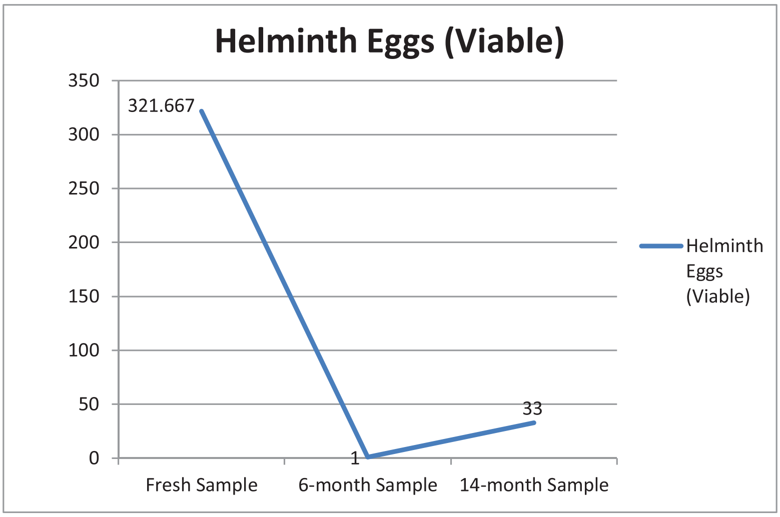

Figure 4: *Changes in Helminth Eggs (viable)*

3. Reuse of the Trenches

Tree planting was the reuse option for the trenches. Following backfill of the trenches, three months were given for decomposition of the sludge to progress. Eucalyptus trees were then planted on the trenches.This tree species was chosen because it has a high nutrient consumption rate and ability to absorb large amounts of water therefore reducing the risk of pollution of ground water sources through leaching. A control plot was also set up to compare tree growth on and off the trenches. Tree growth is to be monitored basing on height and number of leaves.This activity is still ongoing.

Picture 3 & 4: *Eucalyptus Trees Planted at the DRE Site in Kole*

CONCLUSIONS

Selected sites were found to be suitable because of key characteristics such as, distance from surface and point water sources was more than 50m, water table was deeper than 5m from the bottom level of the trench and flat surface which enabled easy operations. In addition, site set up was not complicated and sites were found to require minimal operation and maintenance.

Feacal sludge was found to undergo stabilization in the trenches overtime. A comparison of the characteristics of fresh sludge as received at the site and sludge exhumed at six, nine and fourteen months from the trenches indicated that there were changes in the composition of the sludge with time. Reduction in total solids, nutrient content and BOD was realized as shown in Figure 3 above. This revealed that sludge stabilization occurred with time in the trenches.

The risk of pollution of water sources was found to be minimal. Sites were located at a distance further than 30m from any point water sources and the water table was deeper than 5m from the bottom level of the trench, hence minimal risk of pollution through leaching. In addition, results revealed no risk of nitrate and nitrite contamination of ground water as no concentrations of these were found in the fresh FS.

RECOMMENDATIONS

• For future design of FSTPs in these towns, DRE can be considered as a method to reliably estimate the FS quantity and quality to develop cost efficient FSTPs.
• Further research on other reuse options of entrenchment, such as crop growth.
• Further study on the effects of entrenchment on septage. This study only investigated the effect of entrenchment on pit latrine sludges. The findings of this study are not transferable to septage.

WAY FORWARD

• Further monitoring of faecal sludge stabilization in the trenches.
• Monitoring of tree growth characteristics on the trenches vs the control plot.
• Scaling technology to other sites.

REFERENCES

1. David Still, Simon Lorentz, Goitom Adhanom. (2015). Entrenchment Of Pit Latrine and Wastewater Sludges An Investigation Of Costs, Benefits, Risks And Rewards.
2. University of Maryland. (2021). Best Practices for Deep Row Entrenchment (DRE) of Biosolids Using Hybrid Poplar Trees (EB-453).
3. Partners in Development. (2022). Guidelines for Deep Row Entrenchment of Faecal Sludge and Secondary Wastewater Sludge.

PICTORIAL


Picture 5,6: Trench Layout and Excavation

Picture 7: Excavated Trench


Picture 8 & 9: Pit Emptiers emptying FS for the first time in the trenches