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LOCAL ACTION WITH INTERNATIONAL COOPERATION TO IMPROVE AND SUSTAIN WATER, SANITATION AND HYGIENE SERVICES

Learning from Oxfam's Tiger Worm Toilets projects

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The world is witnessing the highest levels of forced human displacement on record, leading to people being housed in urban centres and camps. Generally the sanitation needs of these people are initially met by external agencies. The long-term costs of operating and maintaining traditional sanitation systems can be unviable when communities or local authorities take over their management. Therefore Oxfam has been trialling the Tiger Worm Toilet (TWT) in peri-urban and camp settings. The aim of this paper is to review Oxfam's TWT projects and to share the learnings, together with the innovations that have occurred. The learnings are that TWTs are not the solution to all sanitation problems, but they have been proven to work well at household level. Monitoring and documenting the trials has been an ongoing problem due to a number of issues, which are linked to short term funding, and the use of project rather than program approaches.

Introduction

The world is witnessing the highest levels of forced human displacement on record, over 65 million people were displaced (asylum seekers = 3.2 million, refugees = 23.1 million, and internally displaced people (IDP) = 40.8 million) in 2015 (UNHCR, 2015). Just over 25% of refugees (excluding IDPs) are housed in camps (UNHCR, 2015); with the average refugee camp housing 11,000 people. Although the largest camps have a population of ten times this (UNHCR, 2012). People are also being displaced for longer periods, using the UNHCR's definition of a protracted refugee situation (which excludes IDPs), 41% of refugees were living in a protracted situation at the end of 2015 (UNHCR, 2015). Furthermore, the average duration of protracted displacement has increased; the current estimate of protracted displacement is 26 years (Kleinschmidt, 2015, UNHCR, 2015).

As the lifespan of camps are ever increasing many agencies are exploring more sustainable sanitation options. This is due to the prohibitive cost of managing traditional onsite sanitation systems such as pit latrines, cesspits and septic tanks. Camps are often situated in isolated areas where it can be challenging to find the equipment or services for emptying, and the land to treat and/or dispose of the faecal sludge. In the short-term external agencies such as INGOs tend to meet the cost of emptying, but the long-term costs of operating and maintaining traditional systems can be unviable when communities or local authorities take over their management, hence the need to explore more sustainable options.

It is often forgotten that a majority of refugees and IDPs live in urban centers (UNHCR, 2015). These people often live in peri-urban communities with low-quality or no sanitation. Again, it is often external agencies that initially build and manage sanitation in these communities, but as with camps more viable and sustainable options need to be found.

Due to this challenge, Oxfam has been involved in developing and trialling the Tiger Worm Toilet (TWT) in peri-urban and camp settings. The TWT also known as the Tiger Toilet, is a simple vermifilter (a filter containing worms), which consists of an organic bedding layer (e.g. coconut husk or woodchip) and a drainage layer. The vermifilter is typically contained in an open bottomed tank which is attached to a flushing toilet (Furlong et al., 2016). The TWT has been designed to treat faecal sludge *in-situ* and to reduce the volume of by-product (vermicompost) that needs to be emptied, therefore reducing the emptying frequency, maintenance costs and size of the system (Furlong et al., 2016).

The aim of this paper is to review Oxfam's TWT projects and to share what it has learnt over the past nine years. It also highlights how Oxfam has developed and evolved the TWT over this period.

The Tiger Worm Toilet and Oxfam

Oxfam was involved in the development of the TWT from its inception, as members of the advisory panel on the Sanitation Ventures project (http://blogs.lshtm.ac.uk/sanitationventures/). The aim of this project was to identify and test solutions to reduce or eliminate pit latrine filling. This project included a technology landscaping exercise where composting worms were identified as a possible solution. Within this project research was undertaken to prove that composting worms could eat fresh human faeces (Furlong et al., 2014) and the first prototype vermifilter was developed and tested at Centre for Alternative Technology (Furlong et al., 2015). The funding was then cut, so the planned field trials could not be undertaken, at this point Oxfam funded two in-house trials in Dire Dawa, Ethiopia and Monrovia, Liberia (Figure 1). Oxfam then became a partner in a USAID-funded program where the TWT was trialled in Kachin, Myanmar (Figure 1). This trial was managed by Bear Valley Ventures Ltd and other partners included Water for People (Uganda) and PriMove (India) (Furlong et al., 2015). Oxfam currently has three ongoing trials of this technology in Gambella (Ethiopia), Sittwe (Myanmar) and Sierra Leone (a pilot in 2016 and new two-year project to be started in 2017). A timeline of Oxfam's involvement and TWT projects can be seen in Figure 1.

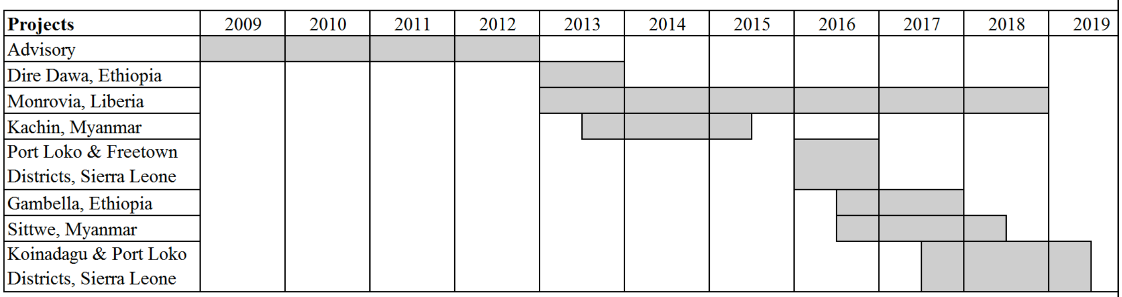

Figure 1. A timeline of Oxfam's TWT trials

Trial contexts and TWT designs

An overview of each Oxfam trial is given in this section this includes a brief description of the context, trial, general design and main challenges. In Table 1 the details of each design are given and the main innovations are highlighted.

Dire Dawa trial, Ethiopia

Dire Dawa is a city located in the east of Ethiopia on the Dechatu River. It has an arid hot climate (BSh) with an average annual temperature of 25°C and rainfall of 637 mm (Climate-data, 2016). The trial was undertaken in Kelebe 9, a peri-urban Somali community that did not have sanitation facilities. The soil in this area is sandy and the water table varied throughout the year, but ranged from 5 to 10 m. The TWT trialled in this area was a household or shared household system for a maximum of 10 users. It was a pour-flush system with an open bottomed tank that was partially above ground. The bedding material woodchip and the drainage layer was graded gravel (Figure 2).

There was high staff buy-in, as the trial was initiated by the local staff, but still there were some challenges. Composting worm supply was an issue as local supplies were expensive. An external supplier was found from South Africa and an import permit was gained. It was difficult to source low-volume pour-flush pans, so traditional pans were used. Although water was used for anal cleansing, the amount of water required to flush these pans was problematic, as this was a water scarce community. Additionally there was a high staff turnover in the team, meaning there was a lack of monitoring and documentation.

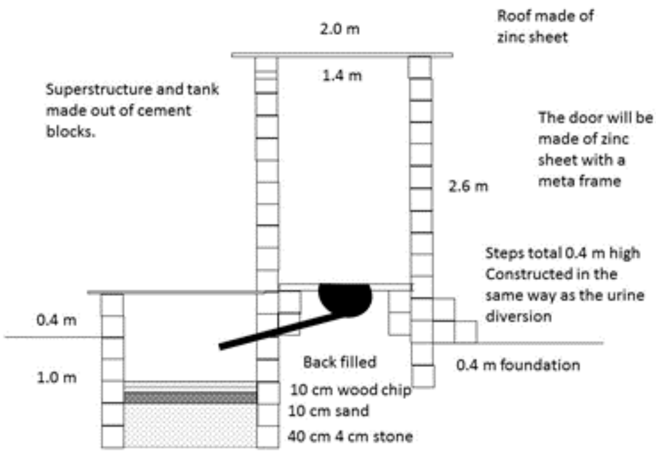

Figure 2. TWT design from Dire Dawa

Monrovia trial and scale-up, Liberia

Monrovia is the capital of Liberia and located on the Atlantic Coast. It has a tropical monsoon climate (Am) with an average annual temperature of 26°C and rainfall of 4540 mm (Climate-data, 2016). The trial and scale-up started in 2013 and is ongoing. The preliminary trial was in the Doe Community, but TWTs have now been installed in other peri-urban areas. These areas have extremely high water tables (above 1 m) and are prone to flooding. There is an abundance of locally available composting worms (*Eudrilus eugeniae*), which were used. Household TWTs were constructed via community mobilisation. The toilet is located in the house, but the tank is outside and above ground. The tank has a sealed bottom (due to the high water table), initially there was an effluent sump, but later a drainage system was designed. A unique feature of this design it is that it incorporates a charcoal layer and a permeable slab to aid the treatment of the effluent (Watako et al., 2015). This project was documented in Watako et al., 2016. There are now 400 TWTs throughout Monrovia and many have been functioning for four years without being emptied. They have been widely accepted by the community and the sector, including the Liberian Water & Sewer Corporation. Although this technology has been adopted and is being scaled-up, very little data is available on how they are functioning; also the effluent quality from these systems has not been tested.

Kachin trial, Myanmar

Kachin is in the northeast of Myanmar and borders China. It has a temperate climate (Cwa) with an average annual temperature of 24°C and rainfall of 2000 mm (Climate-data, 2016). There are many IDPs in this area due to the civil war, many of whom live in IDP camps. The most common systems in these camps are communal holding tanks (referred to as septic tanks), each toilet having between 15 and 30 users. These systems require emptying between once every two months to yearly, due to their design and high usage. The cost of emptying and disposal is approximately US$ 100 per tank (Furlong, 2014-2015).

This was the first TWT trial to be undertaken in a camp setting (Maina IDP camp). The TWTs were household units which included a superstructure (Figure 3). The tank was attached to a pour-flush pan, which did not have a water trap (known as Myanmar style). The surface area was reduced from the standard design of 1m^2 to 0.78 m^2, due the lower number of users and to allow for the use of the standardised concrete rings (Figure 3).

The plan was to monitor these systems for one year, but this proved to be challenging due to travel restrictions, high staff turnover and capacity, and restricted communication. The worms were extremely expensive US$ 210 per kg (in 2015), this was thought to be due to the governments monopoly of the composting worm market. The camp was flooded for two months, including the TWTs. After the flood, the TWTs recovered quickly (Furlong, 2014-2015). User acceptance was found to be high (Furlong, 2014-2015) and it is believed that these systems are still working well, although there is limited data to support this.

Freetown and Port Loko Districts trial, Sierra Leone

This was a trial of the Monrovia TWT design with a soakaway pit, in rural towns in Sierra Leone (in Freetown and Port Loko districts) using community mobilisation. A total of 24 TWTs were built in Port Loko and 30 in Freetown. The toilets were built for individual families of 6-10 members. The preliminary trial was deemed successful and a larger program is due to start later this year.

Gambella trial, Ethiopia

Gambella is situated in the west of Ethiopia, approximately 80 km from the South Sudan border. This trial is ongoing and the aim is to install 100 TWTs and to document the learning. The toilets are being constructed at Jewi refugee camp which is approximately 18 km from Gambella Town. The camp was set up in 2015 and houses approximately 56,000 people. A majority of the people at this camp are children (73%) and of the adults most are women (82%) (Oxfam, 2016). The average number of people per household is five and the camp strategy is to install household toilets. The climate in this area is tropical savanna (Aw) with an average annual temperature of 28°C and rainfall of 1148mm (Climate-data, 2016). The soil type is thought to be fine to course loam with stony outcrops (Jensen and Friis, 2001).

This is a trial of a direct drop household system using either the Satopan or a modified u-bend with a lower worm density, the design can be seen in Figure 4. The main challenge in this project has been obtaining the worms, but learnings from the Kachin trial have been adopted and worms are being grown onsite. Another initial issue is that the household population is transient, increasing and decreasing over time. Initially it was thought that the household size was five, but after interviews it was found to be closer to 10. This means that the current system may be undersized. Presently 30 TWT have been built, but there is limited monitoring data as this trial has just started.

Figure 3. TWT design from Kachin

Source: Claire Furlong

Figure 4. Gambella prototype

Source: Angus McBride

Sittwe trial, Myanmar

Sittwe is the capital of Rakhine State in situated the Bay of Bengal (west coast). The climate in this area is tropical monsoon (Am) with an average annual temperature of 26°C and rainfall of 4664mm (Climate-data, 2016). Generally this area has sandy soils and high water tables (>1m) that suffers from saline intrusion.

There is civil unrest in this area which has led to the internal displacement of approximately 150,000 people, a majority of them being Rohingya (IDO, 2015). Funding was gained to trial communal latrines in these camps, but due to political sensitivities the trial is being undertaken with both the Rohingya and

Rakhine IDPs. Meaning that both household and communal latrines are being tested. A communal design is being tested in Say Tha Mar Gyi (STMG) camp, while in the Mingan Resettlement Area (MRA) a household pour-flush TWT design is being trialled, where the worms are added after it has been in use for one month. A total of 14 communal and 45 household TWTs will be built during this project. To date, 10 household and three communal TWTs have been constructed and are being used. The construction is being done in phases, due to the availability of worms. As with the trial in Gambella the worms are being grown onsite and there is limited data as this trial has just started.

Learnings

The major learning from these projects and nine years of experience is that TWTs are not the solution to all sanitation problems. They have currently been proven to work well at household level, in various climates and in communities that are traditionally flushers. Communities have expressed positive feedback, due to no smells or flies, and lower emptying requirements. These systems require a certain amount of water, so they are not appropriate for water scarce communities. The various designs prove that this technology can be adapted to use locally available materials. Although most trials have had quality control issues with the build, especially at the interface between the lid and the tank which needs to be a close fit to prevent flies and predators entering. In a majority of the designs (except in Liberia and Sierra Leone) the effluent infiltrates directly into the ground, meaning the soil needs to have the capacity to absorb this liquid. To ensure this, especially in high water table areas, a design which is at least half above ground is required. To date, four kinds of worm species have been used and it can be said that three (*E. fetida* & *andrei*, *E. eugeniae*) have been proven to digest fresh human faeces. In the larger scale trials worm supply has been an issue, but recent trials have incorporated worm breeding programs to overcome this. Another option, which has been explored to overcome this issue is, the exportation of worms as in Furlong, 2014. An unexpected challenge across all trials has been the sourcing of low-volume pour-flush pans (used to reduce the water requirements of the system and the volume of effluent), as they were not available in any of the areas where these systems have been tested.

Table 1. Summary of the designs and innovation across all of the Oxfam TWT trials

Project area	Toilet type	Pan type	Number of users	Surface area	Worm species	Bedding material	Mass of worms	Main innovation
Dire Dawa	Household with superstructure	Pour-flush	10	1 m^2	*Eisenia fetida*	Wood shavings	2 Kg	Proof of concept
Monrovia & Sierra Leone Trials	Internal toilet with external tank	Pour-flush pedestal	5 to 10	1 m^2	*Eudrilus eugeniae*	Coconut or palm husk	2 Kg	Different worm species Sealed tank
Kachin	Household with superstructure	Myanmar style	5-7	0.78 m^2	*Eisenia andrei*	Woodchip	1.5 Kg	Smaller surface area
Gambella	Household with superstructure	Direct drop pour-flush	~5-10	0.70 m^2	*Eisenia fetida*	Fine woodchip	0.5 Kg	Direct drop
Sittwe STMG	Communal with superstructure	Direct drop pour-flush	~30	6 m^2	Mixed mainly *Perionyx excavatus*	Coconut fibre	4 Kg	Communal design
Sittwe MRA	Household with superstructure	Myanmar style	5	0.70 m^2	Mixed mainly *Perionyx excavatus*	Coconut fibre	1 Kg	Addition of the worms after 1 month

Costing has not been explored in any detail in this paper, as the context of the cost should be taken into account. This is because the cost of materials varies significantly in each context. More importantly the operations and maintenance costs need to be explored alongside those of traditional systems that are in use.

Community engagement and mobilisation has been central to all of the trials and community buy-in is critical. To gain this, staff have focused on the technology and its benefits, rather than the worms. Appropriate information, communication and education materials are required to aid this process.

Monitoring and documenting the trials has been an ongoing issue due to high staff turnover in the sector leading to a loss of institutional memory and staff capacity. Adding to this knowledge management can be difficult in these challenging environments, due intermittent communication. The importance of monitoring and documenting these or any innovation trial is critical, but is often neglected. This is believed to be linked to the staff turnover, lack of project management and research experience, and due organisations taking a project rather than a program approach. All are linked to the inherent short term funding situation in the sector. Long term funding and longitudinal trials are required, as it is not known how long these systems take to fill and this data is required to optimise management plans.

The next steps

After the success of the trial and scale-up in Liberia Oxfam is now undertaking an extended TWT project in Sierra Leone (peri-urban and rural areas). Oxfam intends to undertake a West African learning review to consolidate knowledge in Liberia and Sierra Leone. This will be feed into the new Sierra Leone project, as will the learnings from previous trials. In Ethiopia Oxfam will produce a 'TWT Manual' for refugee camps. This will include the bills of quantities, specifications, drawings, community engagement framework, and training materials. A concerted effort is being made to increase capacity and commitment to data collection, so an evidence base can be built for the TWT.

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