Faecal sludge reuse interventions: the Arborloo and Fossa Alterna

Case studies of multiple use of water in Ethiopia (MUStRAIN case 4a)

As part of the MUStRAIN project in Ethiopia, various approaches to rainwater harvesting, multiple use of water and ecological sanitation have been studied. Here two methods of ecological sanitation are presented.

Ecological sanitation in Ethiopia at a glance: the Arborloo and Fossa Alterna

Technical features:

The **Arborloo** or 'tree latrine' consists of a single shallow compost pit and a slab[1]. Soil is added after each use, ideally combined with ash and leaves. Once filled, the pit is covered up with good topsoil. A new pit is dug and the slab (plus superstructure where there is one) is moved. A tree seedling is planted right above the old pit, so that the nutrients from the composted faecal matter and urine are directly used by plants.

The **Fossa Alterna** or 'dual latrine' is a double-pit compost toilet[1]. Again, soil and other materials are added after every use. When the first pit fills, it is covered with top soil, while the structure and toilet slab are moved to the second pit. When the second pit is full, the contents of the first pit have composted (the process can be improved by regular mixing) and can be shovelled out and used for gardening. Then the slab and superstructure and slab are moved again and the process is repeated.

Implementation: The Catholic Relief Services (CRS) and its implementing partners began to pilot the Arborloo and the Fossa Alterna in 2005 for crop trials and cultural acceptability, e.g. by constructing such toilets on compounds of implementing partners for regular use by staff and priests[2]. In addition, between 2006 and 2010 Arborloos and Fossa Alternas were tested in the town of Arba Minch, in an EU-funded project on decentralized sustainable sanitation concepts. Uptake was fast: between 2005 and 2009 almost ten times as many Arborloos were constructed by households than the number of conventional latrines built between 1995 and 2004 in Ethiopia[3].

Main advantages: While both the Arborloo and Fossa Alterna are composting toilets, the Fossa Alterna consists of permanent concretised structures, whereas the Arborloo is a non-re-enforced shallow pit for short-term use. Every time an Arborloo pit is full, a new pit is dug.

Challenges for uptake: Ecological sanitation, especially the Arborloo, was found to be acceptable for all types of communities, particularly in rural areas[2]. In urban and peri-urban settings with smaller and permanent compounds, the Fossa Alterna was the preferred ecological sanitation technology[4].

Introduction

Blackwater is the substance held in septic tanks or cess pits, with human excreta as main component. Faecal sludge is the general term for the raw (or partially digested) slurry or solid that results from the storage of blackwater or excreta, and is the content found inside pit latrines. The composition of faecal sludge varies significantly depending on the location, the water content and the storage facility. Faecal sludge is rich in phosphorus, potassium and nitrogen, which makes a rich fertilizer and soil conditioner.

The use of untreated faecal sludge may bring health risks, as emphasized in the Public Health Proclamation ("… no person shall dispose of solid, liquid or any other waste in a manner which contaminates the environment or affects the health of the society." Art. 12 No. 2)[5]. However, many farmers are well-aware of the crop growth attributes of faecal sludge. In Awedy, an urban municipality and major *qat* growing area in Eastern Hararghe, the productive benefits of blackwater are highly rated as various farmers pay septic truck drivers to dump the contents of the tanks directly onto their fields.

In Ethiopia, open defecation is common, particularly in rural areas. In case households do use toilets for excreta disposal, these are usually simple shallow pits, commonly un-lined with a temporary superstructure made from leaves or rags. In rural areas, when a pit is full, a new one is dug; in urban areas, pits are often emptied manually and the contents dumped informally in the river bed or at allocated but unprotected locations[6]. In unlined pits, the liquid fraction is often absorbed by soil in the dry season, while pits may overflow during the rainy season. The majority of trucks, where available, are old and have limited suction and agitation power. Hence in practice, even the lined pits are often (partially) emptied manually.

Implementation

Alternative ecological sanitation interventions are implemented by several organisations.

The *Catholic Relief Services* (CRS), operating in Ethiopia since 1968 on emergency, humanitarian relief and development issues, has used the PHAST methodology to promote sanitation systems. "Understanding the link between good health and the use of a toilet was the main reason households gave for wanting improved sanitation in their communities"[3]. In 2005, the CRS sanitation program took off with the promotion of the Arborloo and the Fossa Alterna (and also urine harvesting for fertilizer) for cultural acceptability and crop trials. An important aspect to the implementation strategy of the pilots (which probably contributed to the overall acceptability) was that toilets were constructed on compounds of implementing partners for regular use by staff and priests. "It was thought that field staff and priests could not promote a toilet they themselves did not use and could not promote urine and compost as fertilizer unless they had conducted crop trials themselves"[2]. In the pilot CRS worked with the Wonji Catholic Consortium (WCC) in East Arsi, and Hararghe Catholic Secretariat (HCS) in Eastern Hararghe.

The *Horn of Africa Regional Environment Centre* (HoA-REC) is an autonomous body, part of Addis Ababa University that advises the Addis Ababa City Administration on environmental issues. Operating primarily in the Central Rift Valley, HoA-REC aims to achieve sustainability through a neutral carbon footprint by bringing together issues such as energy, water and sanitation. The focus of its sanitation programme is on ecological sanitation, where a baseline assessment of households' sanitation situations was conducted, to be followed by a pilot project.

In the town of Arba Minch (100,000 residents) in the Southern Nations, Nationalities and Peoples Region, an EU-funded project '*Resource-Oriented Sanitation concepts for the peri-urban areas in Africa*' (ROSA, 2006-2010) piloted the local uptake of decentralized sustainable eco-san technologies, incl. urine diverting dehydration toilets (UDDTs), Arborloos, Fossa Alternas, greywater towers, biogas units, aerobic wetlands, and septic tank sludge disposal.

The *Sanitation for Peri-urban areas in Africa* (SPA) project (2009-2014), with Dutch funding, builds on the findings of the ROSA project by focusing on the up-scaling of on-site sanitation through a business approach. The SPA project aims to create access to sustainable sanitation services for households in peri-urban areas by constructing 1,000 urine diversion toilets, 2,200 Fossa Alternas and 1,000 Arborloos.

The Arborloo

The Arborloo, or 'tree toilet' is the simplest and least expensive of toilet designs, designed by Peter Morgan in Zimbabwe[1,3]. It is an "ecological toilet" in that it allows waste to be used as a fertilizer once it is composted. The Arborloo consists of a single shallow compost pit for short term use and a slab, sometimes with a light superstructure. The pit is 1-1.5 m deep and has a diameter of 0.8 m, though CRS makes them 0.6 m so that they fill quicker and the return on investment is higher. Soil and ash are added to the pit after each use to reduce bad smells and flies. Fresh carbon from leaves, maize or rice husks, coffee hulls, and coarse grasses promotes ecological breakdown of pathogens and improves the compost[7].

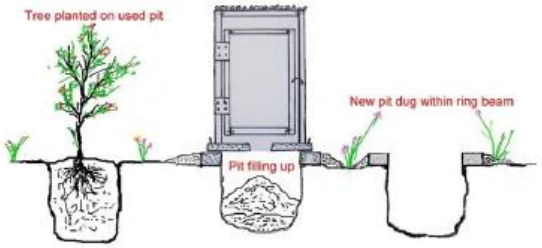

Figure 1. Schematic drawing of Arborloo[1].

Once filled, the pit is covered with good topsoil. A new pit is dug and the slab (and superstructure) is moved. A fruit, vegetable or shade tree seedling is planted in the soil above the composted material in the old pit, so that the nutrients from the urine and faecal matter are directly used by the plants. Seedlings should ideally be planted during the rainy season[1]. Alternatively, it is also possible to allow the pit contents to sit and turn into compost, 6-12months later for use on garden or fertilizing trees[8].

Arborloos in Wonji

For ten years, the Wonji Catholic Consortium (WCC) has been operating in three districts (woredas): Dodota, Adama and Sire (all in the East Arsi sub-region). The selected wards (kebeles) are part of the Productive Safety Net programme, with 29,000 beneficiaries out of the 56,000 residents. As part of this program, in the ward of Lodesharbe a water point with showering facility was built at the end 2012, as well as a water point with laundry basin.

In addition, Arborloos have been constructed at household level, often without a superstructure. Set in a back corner of the compound, Arborloos can provide enough privacy by the fence so that women feel comfortable using the latrine during the day as well. Household heads said they plan to grow "valuable crops" like mango, papaya or avocado. The interviewed farmers had an understanding that "instead of contaminating our house or even our plate with faeces, we learned that the things in human excreta make plants grow well." The choice of seedlings depends on what is available at nearby nurseries or fruit market. For watering the garden, the residents intend to use water from the newly constructed water points nearby.

Figure 2. Arborloo without superstructure, East Arsi (March 2013).

The Fossa Alterna

Essentially the Fossa Alterna or 'dual latrine' is a double-pit compost toilet with permanent concretized structures. As with the Arborloo,

urine and faeces need not to be separated (however in the ROSA pilot these were), and three cups of soil and one cup of ash are added after every use. When the first pit fills, after one to two years – depending on the number of users – the pit is covered with top soil, and the structure and toilet slab are moved to the second pit. The second pit is used whilst the contents of the first is composting[1,3]. When the second pit fills, the contents of the first pit should have composted and as such can be shovelled out and used for gardening. Then the superstructure and slab are moved to the first pit again and the process is repeated.

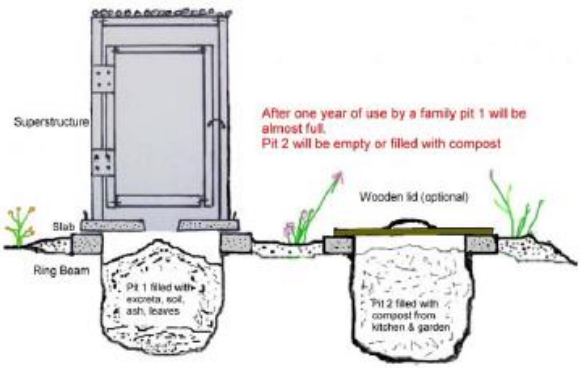

Figure 3. Schematic drawing of Fossa Alterna[1].

Contrary to the Arborloos that are often constructed without superstructure, the more permanent Fossa Alternas are usually equipped with a moveable structure. Especially in more densely populated (peri) urban areas, the offered privacy is much appreciated. Arborloos *with* superstructure (concrete slab, door, roof and walls) are recognized by the Ministry of Health as improved sanitation facilities. As such, the arborloos present a way up onto the sanitation service ladder.

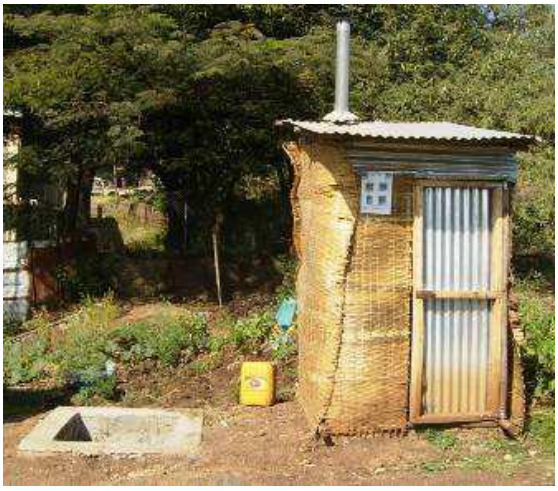

Figure 4. Fossa alterna with organic woven superstructure, Arba Minch[4].

Costs and benefits

CRS initially promoted the Arborloos (together with the less popular Fossa Alterna) through PHAST, until the Ethiopian Government implemented its national strategy for sanitation provision, in which no subsidies are allowed. CRS is moving in this direction by following a more market-based approach that follows sanitation marketing principles. Eventually a well-functioning sanitation supply chain should deliver the required building materials.

Currently, saving groups are set up for the construction of slabs. The 0.7m wide and 0.05m thick slabs should be engineered with reinforced concrete to last some 15 years. The selling price of slabs is determined by the community WASH committee, and thus varies between wards, though commonly the price is around ETB 15-20 (~EUR 0.7). Total costs of the Arborloo vary between EUR 5 and 6, excluding the superstructure and promotion activities.

Table 1. Costs of Arborloo according to two implementers[3,8].

Item	Cost CRS (EUR)	Cost ROSA (EUR)
Slab	5.10	4.85
Substructure (excavation)	labour	1.35
Subtotal	5.10	6.20
Superstructure (woven bamboo, eucalyptus poles, corrugated sheeting)	none	32.40
Promotion & education	7.25	-
Total	**12.35**	**38.60**

Table 2. Costs of Fossa Alterna according to two implementers[3,8,9].

Item	Cost CRS (EUR)	Cost ROSA (EUR)
Slab	5.10	18.90
Two concrete pits	20.00	
Substructure (excavation)	labour	2.70
Subtotal	25.10	21.60
Superstructure (woven bamboo, eucalyptus poles, corrugated sheeting)	labour	32.40
Promotion & education	7.25	-
Total	**32.35**	**54.00**

Costs for concrete slab and excavation are common for both types of ecological sanitation. The costs for constructing a superstructure are currently excluded as few affordable and easily constructible designs exist, so the responsibility is placed with the household. Construction materials, in particular the slabs, may be more easily sourced in peri-urban settings, where many private artisans have been trained to make slabs for the Arborloo. However, raw materials are often subsidized and the price at which slabs are sold do not usually cover the full costs[2]. With the market-based approach this will change.

The total production cost for the Fossa Alterna range between EUR 21 and 25, three to five times as high as for the Arborloo because concrete pits are used.

Benefits of the Arborloo and the Fossa Alterna are similar: the compost provided. In the ROSA-project it was suggested that "if there is no space for applying this compost in the household's compound, it could be collected by solid waste collectors" at a small fee[10].

The benefits and constraints of the two ecosan toilets are summarized in Table 3.

Table 3: Benefits and constraints of two ecosan technologies piloted in Ethiopia.

	Arborloo	Fossa Alterna
Benefits	• Suited for rural areas • Produces compost • No handling of faecal material • Low cost • Easy to construct; shallow pits can be dug by women • Fast return on investment	• Suited for urban areas • Produces compost • Requires less space in long run • Deeper pits – longer filling time
Constraints	• Fills quickly	• Requires artisan for construction of pits

Comparison Arborloo – Fossa Alterna

According to CRS' experience of piloting the Arborloo, the design suits various Christian and Muslim rural communities. The avoidance of handling of faecal material is a major health and cultural advantage. In addition, the Arborloo is cheap, easy to construct and supports food security[2]. Some households in various regions in Ethiopia are now building Arborloo type pits specifically for animal excreta in order to plant more trees[3]. Parents are encouraging their children to consistently use the latrine (instead of 'wasting' their faeces through open defecation) and even invite neighbours for this purpose, so that the Arborloo pit fills quickly and more seedlings can be planted[2].

The way people are placing and using the Arborloo, indicates a good understanding of its benefits. According to CRS, the country-wide promotion of the Arborloo is an extremely positive contribution to meet the MDGs by 2015. "The demand for eco-toilets is growing. […] If this level of acceptance and demand remains steady, the communities we serve will soon have full coverage and many fruit trees"[2].

Furthermore, "in 2007 CRS decided to pilot the Arborloo among pastoralists, who normally do not grow crops or fruit trees. The Arborloo proved to be popular among them as well, as women in particular appreciated the privacy and the ease of construction. Over 20,000 were constructed among pastoralists. The Arborloo can be used to grow any food plants, such as pumpkins, tomatoes, spinach, bananas or papayas"[2].

The Fossa Alterna is also promoted by CRS but hardly as popular due to the higher costs and probably because it takes longer to have compost ready for fertilizer"[2,3].

The experience in the ROSA project is quite the opposite. In Arba Minch "some users do not like the toilet because of the shallow depth of the pit and may not add ash and soil after defecation fearing that the pit may get filled in a short period of time"[8]. Instead, people are interested in toilets that can be used for at least two years[8]. Hence, out of the resource-oriented toilets tested, here the Fossa Alterna was the most popular, possibly because of the similarity to the traditional toilet[4].

This difference in findings can largely be explained by the rural vs. urban setting. Compounds are generally smaller in denser urban areas, offering insufficient space for a tree toilet that changes location regularly. A fixed location for the ecological toilet, such as the Fossa Alterna, may be more desirable[11]. In addition, households in Arba Minch experienced difficulties in getting seedlings for the Arborloo and often did not take sufficient care of the plants on the filled Arborloo pits[8]. This might be related to a lack of understanding on the opportunities to reuse household wastewater for such purposes.

The difference may also be due to a different mentality of rural and urban residents towards sanitation. Whereas rural residents wish for a high return on investment with seedlings quickly developing into productive fruit trees or shade trees, urban residents wish for a technology that is simple to use, prevents soiling of the compound, and does not fill too quickly.

Technical issues

Regarding the slab, raised foot seats were a design request from pilot users[10]. The slab designed by CRS has raised foot seats, but the slab designed by ROSA-project did not.

Additionally, the ROSA-project suggests that for those Muslim households that use water for anal cleansing, an additional hole be added to the slab for draining the wash water, possibly diverting this into a gravel soak pit[10].

Figure 5. Close up of Arborloo slab, East Arsi.

The material inside the composting pit of a Fossa Alterna and Arborloo, especially when it is not mixed with soil and other organic matter, may not necessarily decompose. Contents may 'freeze' and still contain viable pathogens even after several years. Ash may keep the compost dry and help prevent flies and bad odour, but the ash might dry it out too much, thus slowing the composting process. Hence regular mixing of the composting pit is necessary to encourage ecological breakdown[1]. The addition of fresh carbon, like grain husks, maize, etc. may encourage the critical bacteria to grow[7].

Up-scaling

As the Government of Ethiopia does not endorse subsidies for sanitation, households therefore must pay for their own slabs and other building costs[2]. In communities where previously slabs were provided free of charge, community members are now reluctant to make the purchase, and request the slab for free. However, in those wards new to the sanitation awareness programme, households are eager to make the investment[12].

Moreover, ecological sanitation is not (yet) a government strategy, and as such, the Arborloos and Fossa Alternas are not promoted through the Health Extension Worker's package. Instead, Health Extension Workers promote a deep pit latrine with mud structure for privacy, in order to avoid the purchase of the slab and regular re-construction. Still, the VIP latrine costs approximately EUR 34, and with superstructure EUR 77.50[3]. According to CRS' experience "continued promotion of the VIP latrine and conventional pit latrines in poor areas of rural Ethiopia is not cost effective for achieving rapid and widespread sanitation"[2].

While the linkage with the Ministry of Health through the Health Extension Workers is weak, ecological sanitation has no links at all with the Ministry of Agriculture. Improved collaboration with the Ministry and Regional Bureaus of Agriculture would help the promotion of ecological sanitation for its productive value, with sanitation as a secondary motivation only[13]. Similarly, opportunities exist to work with small and micro enterprises for the supply of slabs to the sanitation market.

Conclusion

Ecological sanitation has high potential in Ethiopia, because of the benefits for productive use of the compost. In rural areas the Arborloo is the preferred technology, because of the low costs, ease of construction and quick return on investments. In peri-urban areas the Fossa Alterna is more suitable, taking up less space, with a longer time for the pit to fill up. Support along the value chain, such as the involvement of small enterprises in the fabrication of slabs and the provision of tree seedlings and other plants by nurseries, will facilitate up-scaling of ecological sanitation in Ethiopia.

The MUStRAIN project

The goal of the MUStRAIN project is "to address the critical water problems in water scarce rural areas of Ethiopia by collaboration, implementation of innovative and alternative solutions and exchange of knowledge and mutual learning". Scalable approaches to rainwater harvesting (RWH) and shallow groundwater development (Self-supply) for multiple use services (MUS) has been the focus.

MUStRAIN brings together the strengths and builds partnerships of a consortium of Dutch-based organisations (IRC International Water and Sanitation Centre, RAIN Foundation, Quest and Water Health) and Ethiopian partners and experts with complementary interests in the sustainable development of approaches to MUS. MUStRAIN is led by IRC and funded by the Partners for Water (PvW) programme.

MUStRAIN aims to promote uptake of Multiple Use Services in different contexts within Ethiopia, by documenting replicable water access/MUS models. In eight case studies cost-benefit relations are analysed, as well as opportunities and challenges for implementation.

The MUStRAIN case studies are:

1. MUS from sand rivers
2. MUS and Self Supply
3. Mechanized pumping and MUS
4. MUS and wastewater reuse:
    a. Ecological sanitation
    b. Greywater reuse
5. MUS and livestock
6. MUS and the Community Managed Project (CMP) approach
7. MUS and the WASH business case
8. MUS and manual drilling

The methodology for the current case study includes a review of documented blackwater reuse projects and pilots in Ethiopia; the exploration of NGO and CBO initiatives; exploration of initiatives and projects through the Susana Forum and field visits.

A first analysis showed that biogas and urine-diverting dry toilets are often implemented in Ethiopia. Hence, this case study focused on the less documented alternative interventions (Arborloo and Fossa Alterna), as implemented in East Arsi and Eastern Hararghe, in the Central Rift Valley, and in Arba Minch. Sources of information were project documents, interviews with implementing staff and a field visit to the rural ward of Lodesharbe in the Dodota district in East Arsi (12 March 2013).

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The IRC International Water and Sanitation Centre is a knowledge-focused NGO working with a worldwide network of partner organisations to achieve universal access to equitable and sustainable water, sanitation and hygiene (WASH) services. IRC's roots are in advocacy, knowledge management and capacity building. IRC was set up in 1968 by the Dutch government on request of the World Health Organization as a WHO Collaborating Centre. Currently, IRC is established as an autonomous, independent, not-for-profit NGO with its Headquarters in The Netherlands, and local representation in the countries where IRC implements programmes. IRC has profiled itself over the years with innovation and action research to achieve equitable and sustainable WASH services.

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