An Ecological Approach to Sanitation in Africa

A compilation of experiences

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18. Health implications of handling compost derived from human excreta

The health and welfare of people results from many diverse factors influencing the life of each individual. The availability of food, shelter, freedom, improved water & sanitation and the regular application of personal hygiene all provide their positive influences to help individuals gain the ideal of a healthier life.

Thus the provision of improved sanitation plays its part. In terms of providing sanitary facilities, the main aim of the pit latrine is to confine the excreta, as a preferred method to indiscriminate defecation. But even when confined, excreta can negatively influence the life of individuals. Flies can breed and carry pathogens on to food. Excreta stored in pits too close to domestic wells can contaminate the water, and without adequate hand washing facilities, soiled hands can pass on pathogens in a variety of ways.

We have seen in preceding chapters that many of these factors can be overcome in eco-toilets. Fly breeding (and odour) can largely be overcome by adding plenty of soil and ash to toilet pits and vaults. A screened vent pipe will also help in this way, and will also take away some excess moisture and smell. Excreta stored in shallow pits is less likely to pollute underground water compared to that stored in deep pits, since the potential source of contamination is further away from the water table. The encouragement of the conversion of excreta into humus (by the addition of soil and ash) may also greatly reduce the potential of underground contamination of water supplies, since the life of pathogens may be considerably reduced. The provision and regular use of simple hand washing will also cut off another potential pathogen carrying pathway. Hand washing facilities are a vital part of any toilet system.

However in ecological sanitation one factor is encouraged, that in most other sanitary disposal systems is discouraged. That is the handling of processed excreta in the form of composted or dried faecal matter. So it is important to assess the potential hazards of coming into contact with processed excreta. And also perhaps, what are the hazards of coming into contact with excreta which is thought to be fully processed, but is in fact not so.

The handling the compost withdrawn from urine diverting vaults, composting jars or humus derived from the ***Fossa alterna***, will always create a dilemma concerned with health and safety. It must be accepted that handling these products may pose a potential health risk, especially if the facilities have not been managed properly. Only where the ***Arborloo*** is used, are the risks of handling almost non existent – that is simply because the processed human excreta are not handled at all and lie below a generous layer of topsoil in which the young tree is planted.

In all other cases the handling of processed excreta is encouraged - more so if the products are introduced into agriculture, which is the recommended practice. The topic of health risks related to handling or coming into contact with excreta is a large and well documented subject (see bibliography: Feachem et al. 1983, Stenström 1999, Stenström 2001). The health risks associated with handling these products can largely be divided into those resulting from the persistence of pathogenic bacteria, and those resulting from the persistence of helminth (worm) eggs. The survival of bacteria may largely depend on the correct management procedures of the toilets being followed. Thus in the ***Fossa alterna,*** if soil is not added to the shallow pit at all, or in very small amounts, the conversion of the excreta/soil mix into a safe compost will be much slower than with the recommended mix of soil, ash etc being added. However bacteriological die off can be assured if the correct procedures are followed as the results below show. In promoting the ***Fossa alterna,*** in particular, every means should be taken to ensure that the simple management procedure of regularly adding soil and ash to the shallow pit are followed. This also applies to urine diverting systems.

The Bacteria

In order to give some sort of indication of "comparative risks" in handling different materials, the writer rubbed his hands in humus taken from a 30 litre ***Skyloo*** jars (after 3 months composting) and also in ***Fossa alterna*** humus (after 12 and 14 months of composting). The hands were rinsed in tap water after "soiling" and tested for *E. coli* and Salmonella. None of these bacteria were found. However large numbers of pathogenic bacteria were found in a tiny sample of raw excreta attached a pin head and also placed in tap water for sampling. This tiny sample of raw excreta was much less than the amount sometimes left on the fingers after anal cleaning. Not all hand wipes leave the hands clean, even with paper. This simple experiment reveals that the compounded daily risk of soiling hands by anal cleansing is far greater than risk of handling well composted faeces. That is why the availability and use of hand washing facilities next to the toilet is so important.

Further samples of humus taken from both 30 litre ***Skyloo*** composting jars (*mix of faeces, soil, ash and toilet paper*)and ***Fossa alterna*** (*mix of faeces, urine, soil and paper and composted for 12 and 14 months*) and also humus taken from 80 litre composting jars (*mix of organic kitchen scrap, animal manure, and soil*) were analysed by incubating samples on agar plates to reveal the presence of *Escherichia coli, Shigella sp, and Salmonella sp.* The following results (below) show that none of these organisms survived the processing in ***Skyloo*** jars after 3 months or compost pits of the ***Fossa alterna*** after 12 – 14 months. These preliminary results indicate that from a bacteriological perspective there were very minimal risks involved in handling humus derived from either of these sources after a specified period. However it is acknowledged that the presence of *Shigella* and *Salmonella* were not tested in the excreta before the composting stage. *E. Coli* is well known to be sensitive, and *Faecal Streptococci* (Enterococci) are more sturdy, but were not tested.

Die-off of some pathogenic bacteria in *Skyloo* jars and *Fossa alterna* pits

Material tested	Material processing time, pH and temperature	Organisms
Humus from 30 litre composting jars from ***Skyloo.*** *Mix of raw faeces,soil, wood ash and paper.*	3 months pH 6.72 Temp. 21 deg. C at sampling time	*E.coli (none)* *Shigella sp. (none)* *Salmonella sp.(none)*
Humus from 80 litre composting jars from kitchen composter. Mix of organic kitchen scraps, dog manure and soil (no human material)	9 months pH 7.2 Temp. 24.8 deg C	*E.coli (none)* *Shigella sp. (none)* *Salmonella sp.(none)*
Humus from ***Fossa alterna*** 1 Mix of human faeces, urine and soil (bagged)	12 months pH 6.75 Temp. 18.4 deg. C	*E.coli (none)* *Shigella sp. (none)* *Salmonella sp.(none)*
Humus from ***Fossa alterna*** 2 Mix of human faeces, urine and soil (bagged)	14 months pH 6.75 Temp 18.4 deg. C	*E.coli (none)* *Shigella sp. (none)* *Salmonella sp.(none)*

Further studies were also made of the die-off of *E. coli* in samples of a mix of faeces/soil/ash/paper removed from ***Skyloo*** composting jars. A total initial count of 325 000 colonies per gram of sample were recorded on the day of final addition of raw excreta and soil, with counts being reduced to 6 600 after one month of ambient temperature composting and no bacteria growth was observed on agar plates after 2 months of composting. The same samples were also analysed for Salmonella after 2 months of jar composting and no Salmonella could be found. The pH of these jars was near neutral. Jar temperatures varied during the day and night and also with season. Lowest temperatures recorded were around 11.3 degrees C. (July early a.m.) with higher temperatures of 21.5 being recorded early pm in mid August, 2003. The hottest month occurs in October.

Material tested	Material processing time	Organism. *E. coli* (colonies per gram)
Humus from 30 litre composting jars from ***Skyloo.*** *Mix of raw faeces, soil, wood ash and paper*	0 months (initial mix)	325 000
Humus from 30 litre composting jars from ***Skyloo.***	After 1months composting	6 600
Humus from 30 litre composting jars from ***Skyloo.***	After 2 months composting	zero


Keeping the jar of contents moist helps the composting process. The photo on right shows one method of sampling humus from a 30 litre jar with teaspoon. The uppermost soil is removed and soil a few centimetres down is taken and placed in a sample bottle.

In a repeat of earlier analysis of soil taken from ***Fossa alterna*** pits, humus was removed from a pit 3 months after the pit was finally closed off. Samples were withdrawn using an earth auger (see photos below). This toilet had been used by a family for 9 months. The slab and structure were moved over to the second pit and the pit contents were covered with soil and leaves. In this case soil and leaves had been added regularly to the pit, but no wood ash. The total depth of the soil/excreta mix was 64cms, 3 months after covering with soil. Samples were extracted from the pit at two levels – 30cms and 60cms. The hole was drilled and the samples withdrawn about 15cm from the central drop zone directly beneath the pedestal, so there could no doubt that the samples were indeed a composted mix of excreta and soil, with some leaves. As with the composting jars, the laboratory analysis showed no evidence of the presence of either *E. coli* or Salmonella in the extracted soil samples, at either level.

Material tested	Material processing time, pH and temperature	Organisms
Humus from ***Fossa alterna*** 3 Mix of human faeces, urine, leaves and soil sampled direct from pit. 2 Samples taken from 30cm and 60cm depth.	3 months pH 6.75 Temp at time of extraction 16.8 deg. C (upper sample) and 15.9 deg. C (lower sample)	*E.coli (none)* *Salmonella sp.(none)* *For both samples*


On the left samples of *Fossa alterna* soil are taken with an earth auger. The auger is drilled down to specific depths and samples withdrawn and placed in sample bottles. On the right the hole has been drilled down to 60cm (total soil depth was 64cms).


Each plug of soil removed is placed on one side in sequence. Once the samples have been taken the remaining soil is placed back down the hole. On the right the series of plugs placed on lids in sequence. After sampling, these plugs are placed back down into the pit for further composting.

Obviously further analysis is required on a much larger number of ***Fossa alterna*** samples, to establish what happens when the toilet is managed under a variety of conditions, and particularly when less care is taken over management. When the addition of soil, ash or leaves is irregular and a larger bulk of faecal matter accumulates without the addition of soil, ash or leaves, then the material takes much longer to convert. In the case sited here, the toilet had been well cared for and additions of soil and some leaves had been undertaken regularly. Thus the contents of the pit were able to compost under conditions which were more aerobic than the normal pit latrine. This helps the conversion of excreta into humus considerably.

However it is not known if *Salmonella* was present in the initial samples tested, although the ***Fossa alterna*** humus tested after12 and 14 months composting had originated in heavily used communal units. It is also acknowledged that *E. coli* is a sensitive organism, and likely to die off quickly.

Consequently a preliminary experiment was undertaken on jars of composting faeces and soil derived from the ***Skyloo,*** where the *Salmonella sp (not S. typhi), Staphylococcus pyogenes, Pseudomonas aeruginosa, E. coli, Klebsiella sp and Shigella flexner* were artificially introduced into the composting humus in a the form of a "lethal cocktail" prepared by the clinical laboratory. This "cocktail" prepared in a vial was diluted with water and applied to the soil within the jar. In this case there could be no doubt that the jar soil contained the range of species indicated. The soil in the jar was analysed one month after the "lethal cocktail" had been applied and none of the organisms originally applied could be detected.

Ilona Howards special "cocktail" of pathogenic bacteria. This was added to a bottle and diluted with water

The "cocktail" was then added to a jar of composting soil and excreta taken from the Skyloo.
After one month the soil was tested in the laboratory and none of the lethal bacteria could be found.

Whilst *Escherichia coli* is a sensitive bacterium, not well known for surviving outside the human body environment for long, it is the most widely tested indicator bacterium, showing the presence or absence of many enteric bacteria associated with disease and human suffering.

Salmonella is known to survive for longer outside the human body, and no doubt a series of more exhaustive tests need to be carried out. But these preliminary tests do indicate that from a bacteriological perspective the humus is relatively safe to handle provided that sufficient time is allowed to elapse for composting – that would be 6 months for composting jars and 12 months for ***Fossa alterna*** pit soil. Or putting the problem in another and far more practical way, the threat of picking up pathogenic bacteria on the hands is significantly greater from the daily routine of anal cleansing practiced by all people compared to the infrequent handling of composted faeces formed in jars and shallow pits.

Whilst pathogenic bacteria exhibit a natural tendency to die off when outside the human body, this dramatic change probably also resulted from the action of soil organisms at levels between pH 6 and pH 7 and at ambient temperatures between 10 - 22 degrees centigrade. The simple conclusion to be drawn is that the soil, when in close contact to human excreta acts as an excellent eliminator of enteric bacteria, with the process becoming more efficient if ash and other compostable material, like leaves, are present. This subject is still being investigated in more detail. In the real world, there will be few gardeners who do not wash their hands after handling the soil and planting vegetables, and certainly before eating or preparing food. The main problem may lie in the indiscriminate behaviour of very young children who have the habit of consuming many undesirable materials from their immediate living environment.

Parasitic worms

On the question of parasitic worms, worm eggs and cysts which will be present in excreta deposited by infected people may remain viable in the humus for a much longer period than pathogenic bacteria. The risks of hookworm (*Ancylostoma sp.*), roundworm (*Ascaris sp.*), tapeworm (*Taenia sp.*), *Giadia*, and other parasites must therefore form a part of this discussion of eco-san and health. Thus in areas where parasites like hookworm and round worm are common, there is potentially a much bigger risk in handling the humus. It is certain that worm eggs may survive in the soil for periods longer than 12 months, but this may depend on climate and other factors. Soil is known to be an excellent environment for the maturation of *Ascaris* eggs. Their life is known to be shorted at higher pH and higher temperatures, and the application of lime or ash has been recommended and is widely used in urine diverting toilets in Mexico and elsewhere (Stenström, 1999, 2001). However the widespread application of lime, or even very heavy doses of wood ash, may not be so practical for many areas in Africa where low cost sanitation is used. Certainly this problem is more common in hotter and damper climates and thus at the coast. Existing data shows that the viability of most worm eggs is eliminated or greatly reduced after 10 - 12 months of composting in tropical conditions (EAWAG/SANDEX information sheet on Pathogen Survival Periods in faecal sludge). For the East and Southern African region, 6 months composting is considered adequate in at least one authoritative account (*Communicable Diseases*. (Eshuis and Manschot 1978. African Medical and Research Foundation). In South Africa, Scott demonstrated a die off of *Ascaris* in 100 days (Richard Holden pers.comm.). So even with worm eggs, the threat is greatly reduced after the recommended 12 month period of composting. *Ascaris* eggs must be injested before an infection can take place. Infected soil must be taken in by mouth. For this reason *Ascaris* is most common in young children who eat infected soil. According to Eshuis and Manschot, except for the temporary symptoms during the lung passage, infection with *Ascaris* may be symptomless with vague abdominal discomfort. Complications may occur in very heavy infections.

By far the simplest and most practical way of dealing with this potential problem of worm (helminth) infections, is simply a matter of extending the time of composting the faecal/soil/ash mix in a protected environment. Thus extending the time of composting from 6 months to 1 year in composting jars will considerably reduce any health risks due to viable worm eggs being present. In the case of ***Fossa alterna*** humus, the material can be transferred from the pit directly into a series of bags for storage for a further period of 6 – 12 months before application to vegetable gardens. The process of "bagging" keeps the humus out of the reach of young children who are the most vulnerable (ref: S. Benenson 1990). After such an extended period of composting (2 years) the risks of viable worm eggs being present will be very low indeed. However the greatest potential threat will have been overcome within 12 months of composting.

In fact the bagging process will help to improve the humus further as well as making it slightly safer, as the turning of material improves aeration and this helps the composting process. It is also possible at this stage to add more soil and leaves to improve texture. The mix is bagged watered and left to mature further, with the bag closed off. Worms may naturally breed in such composting bags, or can be introduced. The end result will be humus of an improved quality and a potentially safer one. The process of bagging is a simple way of secondary composting of ***Fossa alterna*** humus.

The other alternative if there is doubt about the safety of the compost taken from shallow compost pits like the ***Fossa alterna*** is to transfer the compost directly from the composted pit into a pit dug nearby for planting a tree. Protective gloves can be worn if necessary and the period of time of exposed faecal compost is short. The transferred compost is covered with a generous layer of top soil (15cm) and a young tree can be planted.

Where the facility is used as a strictly family unit, such parasites will be recycled largely within the family itself, and family treatment of worms may reduce the potential of loading the pit with viable eggs considerably. It is wise therefore to assess the potential parasite risk in any area where ecological sanitation is being promoted. In Zimbabwe, problems associated with parasites have been relatively low over a period of two decades or more, but as health services deteriorate, the frequency of these and other health related problems is on the increase. Poverty is linked to poor health and the general state and stability of a nation is reflected in the health of its people. Hotter and more humid areas, as may be common in most coastal regions of East and South East Africa, may be associated with higher parasite rates and thus more care is required in such areas. Children may be particularly vulnerable.

It is important to reiterate again, that any risk of handling composted human excreta must be put in its rightful place amid many other risks that toilet users are subjected to. In particular it is important to compare, once again, the risk of handling eco-humus with the risks of spreading disease from hands soiled in the toilet. The potential risk of soiling hands occurs every time we use a toilet for defecation. And without appropriate hand washing facilities being available close by, the risk of passing on the pathogens contained in raw excreta to other people and to food is a very real one. The stark fact remains that in Africa countless millions of people to not have access to any form of improved toilet at all. And even for those fortunate ones that do, a hand washing facility is rarely available. And this situation poses a very real threat which promotes the spread of enteric diseases. It is quite likely that the hands of users may be badly soiled with raw human excreta many times during a single month. One must compare this health threat with the threat of handling processed toilet compost on far fewer occasions. The compost itself is dug out of the pit and also mixed with other soils with a shovel, which distances it from the hands. But the hands will be involved in planting seedling vegetables directly in the mix of soils. Even when mixed with topsoil again, the health threat is reduced further as the composting process continues.

Thus in any discussion of health in relation to the promotion of ecological sanitation, it is important to see the overall picture. Every step should be taken to make the compost as safe as possible, and every step taken to ensure that hand washing facilities are available and used. In this process of enlightenment, a good educational component is vital. The process of "passing on the message" not only about how to build and maintain eco-toilet, but also about health and hygiene in relation to the provision of improved sanitation is a vital one. This is the subject of the next chapter.

19. Training methods to support ecological sanitation programs

Passing on the message!

Most people in this sub-region of Africa will be accustomed to the pit latrine, which is the most common of all excreta disposal systems in the world. Whilst poorly built pit latrines often develop reputations for collapsing during the rains, and of smelling or producing large numbers of flies or mosquitoes, improved pit latrines can provide an excellent means of excreta disposal being both safe and pleasant to use. Improved pit latrines like the VIP, can offer a simple method of disposing of human excreta which is almost free of odour and fly problems. And VIP's do not necessarily need to be expense - some of the best are the simplest and cheapest. Whilst pit latrines can contaminate underground water in areas of high water table in areas where the population density is high and wells are used for supplying domestic water, the great majority of improved pit latrines do not pose a serious threat of contamination to ground water supplies. Improved pit latrines are safe and easy to use and require the minimum of maintenance. A latrine pit, 3 metres deep, will last a family for a decade and the only requirement in terms of maintenance is to keep the toilet clean, and to keep the vent pipe (if fitted) in good working condition. For these reasons the pit latrine is often the logical first choice for families living in both peri-urban and rural areas in this part of Africa. Indeed, the pit latrine has served the continent well and will continue to do so for many generations to come.

Thus, in introducing ecological sanitation to areas where the pit latrine is common, good reasons must be sought for introducing something new, which although relatively low in cost, requires a higher degree of management than the common deep pit latrine. Its practical advantages must be proven beyond doubt in the minds of the new potential future users. What are the selling points of low cost ecological sanitation?

The first point of interest is that the concept of recycling human excreta is not new at all in this part of the world. Whilst the great majority of pit latrines are abandoned after the pit is full, a small but important proportion are used for planting trees in countries like Mozambique, Malawi, Kenya and Uganda. Indeed, the traditional practice of planting trees on filled latrine pits has been used for generations in the sub-region. This method is perhaps the simplest and most elegant way of recycling the nutrients held in human excreta, although until recently, it was not recognised as such. The fact remains that huge volumes of humus formed in pit latrines from human excreta have been lost to agriculture – an estimated 1.5 million cubic metres formed in the 500 000 VIP latrines built in Zimbabwe alone! Had this potential loss been recognised 30 years ago, the course of low-cost sanitation may have taken a different route. Fortunately the methods of tapping this underground resource have now been improved and officially recognised as part of a range of ecological sanitation options.

In fact two of the three toilet systems described in this work (the ***Arborloo*** and ***Fossa alterna***) are themselves variants of the pit latrine. If they are fitted with ventilation pipes, they are also variants of the VIP latrine. Such technical developments were undertaken deliberately in Zimbabwe to form strong links between existing sanitation practice (pit latrines) and the newer concept of ecological sanitation (the ***Arborloo*** and ***Fossa alterna***). By bridging the obvious technical gap that lies been a pit latrine and a urine diverting system with these pit latrine upgrades, there is hope that the transition from a disposal system to a recycling system can more easily be made.

Thus in introducing ecological sanitation to new recruits, it make sense to offer a range of technical options of varying complexity and cost into any programme of eco-san promotion in this part of Africa. In Mozambique under a programme undertaken by WaterAid and ESTAMOS, a choice of latrine types is offered to people living in both rural and urban communities in Niassa Province (Ned Breslin et al., 2001),. The range included traditional and improved pit latrines fitted with a sanplat, VIP latrine's as well as ecological toilets like the ***Arborloo***, ***Fossa alterna*** and urine diversion systems. The ***Fossa alterna*** was found to be most popular, because, unlike earlier pit toilets introduced into the programme, they did not smell or produce flies (due to regular addition of soil and wood ash). Also the new eco toilets were considered to be permanent facilities unlike earlier toilets which often collapsed or filled up quickly. There was also the added perceived benefit of a yearly supply of compost, useful to restore the fertility of worn out soils. In Malawi, where the ***Arborloo*** is most popular eco-san option, intensive community mobilisation has been undertaken in Embangweni (CCAP Report by T. Munkhondia, 2003). The ***Arborloo*** is the simplest and lowest in cost within the Eco-san range, and planting trees on filled latrine pits is common in Malawi. Clearly it makes sense to build on tradition.

New recruits to the world of ecological sanitation are unlikely to be convinced by word of mouth alone. They must be given the opportunity to view working examples of the various toilet options and talk to the users who can inform them of any practical advantage they have experienced. This means that demonstration units, which have been in use for some time, must be available for inspection locally. Thus forward planning is required. Enthusiastic individuals or key community leaders must be selected and encouraged to participate in the construction of new eco-toilets in their own back yards - well ahead of more extensive implementation programmes. At this stage an element of faith is required. For most people, travel excursions to see examples in other provinces or countries may not be possible. Thus the first stage of passing on the message about eco-san is to set up a range of technical options to willing participants, within the proposed area of future implementation.

Many of the benefits of ecological sanitation are not immediately apparent. For instance, improved crop and vegetable production, by the use of humus derived from the toilets, can only be seen in the third year after an eco-toilet such as the ***Fossa alterna*** is first put to use. One year is required to fill a shallow pit, another year of composting and then, during the third year, the humus can be put to use. Also fruit trees grown on ***Arborloo*** pits may only produce fruit after a few years of growth. So even demonstrating the usefulness of the humus may take years to fulfil. Time is required and forward planning.

Intensely practical aspects of promoting eco-san are of thus of supreme important. Trainees must participate in constructing slabs, rings beams, superstructures, hand washing devices, pedestals etc. Ideally they will also plant trees if that is practical at the time and tour sites where trees are growing on ***Arborloo*** pits or where vegetables have grown well on mixes of eco humus from toilets and top soil. They will handle processed humus and be told how it was formed. Every aspect of ecological sanitation should de described in training and extension courses, and that means not just building toilets but also demonstrating how eco-san fits into the broader field of agriculture and forestry. How back yard gardens, small orchards and wood lots can benefit from the introduction of the concept of eco-san. The widespread and successful uptake of ecological sanitation will depend on skilled and dedicated people passing on the message in a meaningful and practical way which makes sense to the potential users. The theory alone is simply not good enough.

Eco-San training in the East and South Eastern Africa Region

Passing on the message of “closing the loop” on a flip chart at Kafunda Village, Ruwa, Zimbabwe.

Practical training exercises in construction at Ruwa, Zimbabwe (left) and in Kusa, Kenya

Lining the upper end of a pit in Malawi (left) and explaining the value of humus in Mozambique (right).

Passing on a practical message - about ecological sanitation.

Ecological Sanitation is a system that makes use of human excreta and turns it into something useful and valuable with minimum pollution of the environment and in away which is no threat to health. The basic concept is to take something which is a waste and most unpleasant and turn it into something which is pleasant to handle and useful in agriculture as well. Special toilets are used for this process. The aim is This is then followed by demonstrations of how the resulting products, both urine and humus can be used in agriculture to grow more vegetables and trees etc.

Ecological sanitation may not be an easy subject to get "converts." Toilets are often a "non subject" in local conversation and as for human excreta - well it is just very nauseating and unmentionable. People simply do not talk about these things and have no wish to. For most, it is something to be avoided. And most families have many other priorities. So training in this subject is very challenging. The overall aim of the training is to somehow make people interested in the subject, to demonstrate how easily the toilets can be made and how the conversion from excreta to valuable products can be achieved. And most importantly, how the use of this "eco-humus," together with urine, can have a real value for the family by enhancing food production in the back yard. And food will be found on every family's list of priorities. Very often in a community there may be a small number of enterprising people who are very keen and willing to take up the new methods in their homes. Nothing is so infectious as success.

There are certain "trump cards" available to the trainer of Eco-san. He or she can make use of these "needs." We can list these advantages as follows:

1. Every family needs a toilet
2. The ecological toilets described are relatively simple and cheap to construct and can be made at home by the users themselves or by relatives.
3. The toilets are almost free of flies and odours and therefore pleasant to use
3. The toilet system can last for many years. Small investments in making concrete slabs can last for generations. Local materials can be used for the structures.
4. Valuable products in the form of humus for the garden are produced. The humus can be mixed with a poor local top-soil to make a new soil in which vegetables grow well.
5. Urine can be collected in several ways and when diluted with water makes a good plant food, especially for vegetables.
6. Once the system has been set up – these plant foods cost nothing and can increase food production significantly. There is a never ending supply at no cost!!!

Simply put:

The new eco-toilets are simple, and cheap to make and they are easy and pleasant to use. As toilets, they also provide humus for improving backyard soils and help to grow better vegetables. Thus they have special value.

TRAINING TOOLS

But people will need to be convinced. And that means practical demonstration. This is done by showing people working toilets in the field and also describing in the class room by means of flip charts and models. But the most important part is getting things going in the field and reaping the local knowledge gained and transplanting this knowledge elsewhere. There is nothing so infectious as example and enthusiasm for passing on a knowledge about something that is quite simple and intensely practical. That is the message contained in this work.

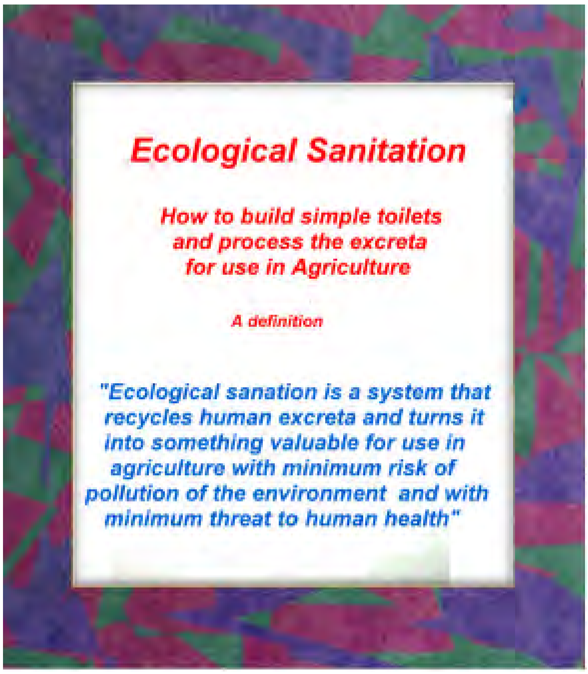
Moving a *Fossa alterna* structure

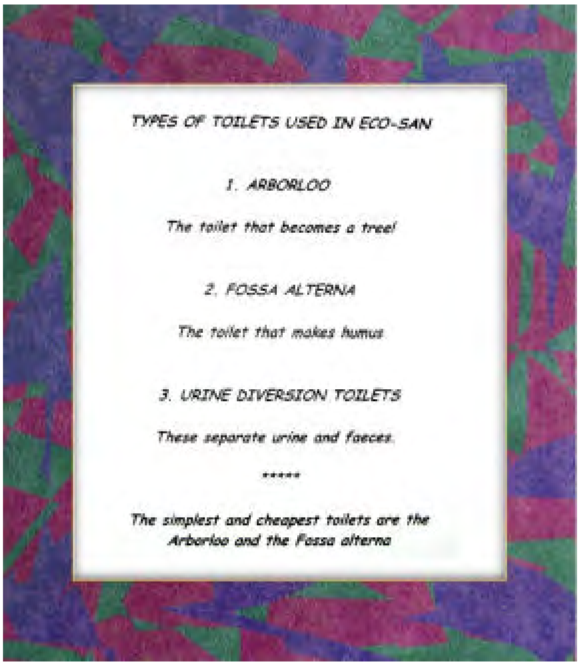
During the training sessions there are certain "tools" which the trainer/educator can use to help him or her to get the message across more easily. These "tools" include:

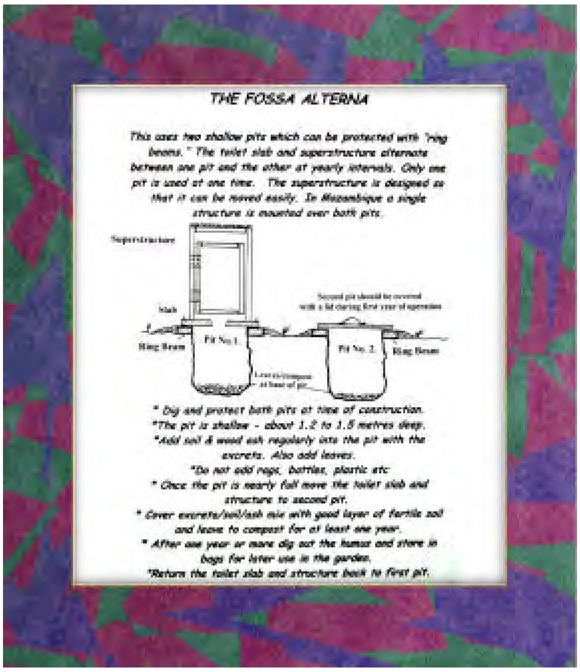
1. Prepared Flip charts

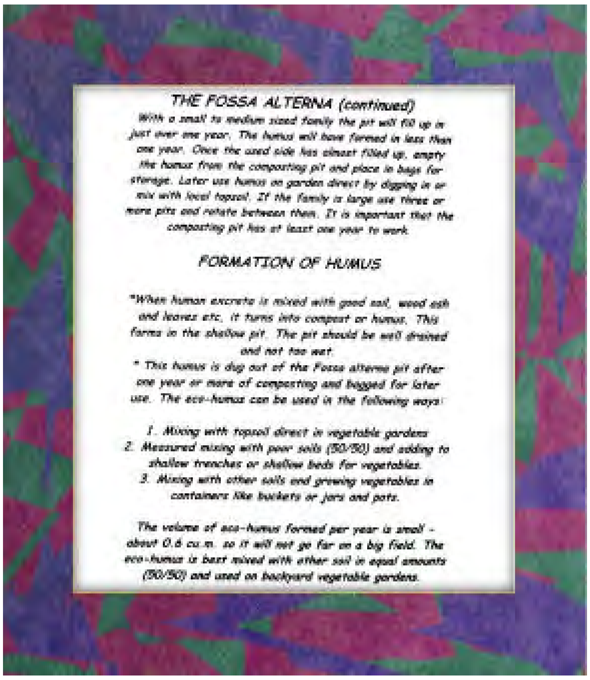
Small flip charts which describe the basics can be distributed & copied

Actual pages of the flip chart, which can be copied and enlarged






THE FOSSA ALTERNA
This uses two shallow pits which can be protected with "ring beams." The toilet slab and superstructure alternate between one pit and the other at yearly intervals. Only one pit is used at one time. The superstructure is designed so that it can be moved easily. In Mozambique a single structure is mounted over both pits.
Superstructure
Slab
Ring Beam
Pit No. 1
Pit No. 2
Ring Beam
* Dig and protect both pits at time of construction.
*The pit is shallow - about 1.2 to 1.5 metres deep.
*Add soil & wood ash regularly into the pit with the excreta. Also add leaves.
*Do not add rags, bottles, plastic etc
* Once the pit is nearly full move the toilet slab and structure to second pit.
* Cover excreta/soil/ash mix with good layer of fertile soil and leave to compost for at least one year.
* After one year or more dig out the humus and store in bags for later use in the garden.
*Return the toilet slab and structure back to first pit.


THE FOSSA ALTERNA (continued)
With a small to medium sized family the pit will fill up in just over one year. The humus will have formed in less than one year. Once the used side has almost filled up, empty the humus from the composting pit and place in bags for storage. Later use humus on garden direct by digging in or mix with local topsoil. If the family is large use three or more pits and rotate between them. It is important that the composting pit has at least one year to work.
FORMATION OF HUMUS
*When human excreta is mixed with good soil, wood ash and leaves etc, it turns into compost or humus. This forms in the shallow pit. The pit should be well drained and not too wet.
* This humus is dug out of the Fossa alterna pit after one year or more of composting and bagged for later use. The eco-humus can be used in the following ways:
1. Mixing with topsoil direct in vegetable gardens
2. Measured mixing with poor soils (50/50) and adding to shallow trenches or shallow beds for vegetables.
3. Mixing with other soils and growing vegetables in containers like buckets or jars and pots.
The volume of eco-humus formed per year is small - about 0.6 cu.m. so it will not go far on a big field. The eco-humus is best mixed with other soil in equal amounts (50/50) and used on backyard vegetable gardens.


SOIL IMPROVEMENT WITH
"FOSSA" HUMUS
The eco-humus formed in the Fossa alterna pit is very rich in nutrients. If we compare the NITROGEN (N - ppm), PHOSPHORUS (P - ppm) and POTASSIUM (K - ME/100g) we find big improvements over natural topsoil.
Source of soil
N P K
1. Natural topsoil (9 samples) 38 44 0.49
2. Fossa alterna soil (10 samples) 275 292 4.51
* If the Fossa soil is mixed with poor topsoil in equal proportions, the poor topsoil becomes much enriched and vegetables can grow on it very well. The weight of vegetables grown on the mix of soils is many times the weight of vegetables grown on the poor soil alone. It behaves like a good compost or fertiliser. The addition of Fossa humus also improves soil texture.
* So we see that the mixture of converted excreta and poor soil (50/50 mix) makes a "new soil" which is very valuable to the family because vegetables will grow in it very well.
* We can also add liquid food like a mix of water and urine to enhance the growth of vegetables and maize even more.
The combination of eco-humus mixed with poor soils and a water-urine liquid feed is best.


MIXING FOSSA HUMUS & SOIL HELPS
If we mix fully composted Fossa humus from the toilet with poor topsoil, in equal proportions vegetables will grow far better
In some experiments it was shown that by adding the Fossa humus to local soil:
Spinach growth was increased up to 7 times
Covo growth was increased 4 - 8 times
Lettuce growth was increased up to 7 times
Onion growth was increased up to 2.7 times
Green pepper growth was increased 4.6 times
Tomato growth was increased up to 10 times
These are very good increases in vegetable production!
Why?
Because the Fossa humus improves the soil nutrients and also soil texture.

URINE DIVERSION

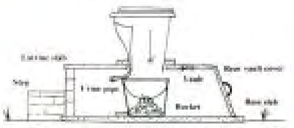
Urine diversion is a system where the urine and faeces are separated from each other. This is usually done with a special pedestal or squat plate where the urine passes into a pipe which leads to a reservoir and the faeces fall directly down into a vault or bucket beneath. Soil and ash are added to the faeces to help them dry out or compost. The faeces are then composted separately.

*The urine is diluted with water and used as plant food.

* The faeces, soil and ash are either allowed to dry out or are combined with more soil and moistened to make humus.

*The humus can be made in shallow pits or cement jars. Like the Fossa alterna humus it is very rich in nutrients.

Urine diverting pedestal



More care is required to look after the urine diversion system, and it is also more costly than the Arborloo or Fossa alterna systems, but it is very effective.

THE USEFULNESS OF URINE

Urine is rich in nutrients and has many uses in the family garden. It can be used in the following ways:

1. Used as a liquid plant food mixed with water. The best are 3:1 (water to urine) and 5:1 (water and urine). These dilutions of urine can be added to the soil where vegetables (and plants like maize) are growing - once a week or even twice or three times a week provided that the plants are also watered frequently at other times. This addition of urine makes a very big difference to the growth of plants and adds much nitrogen, and also some phosphorus and potassium.

2. The urine can also be added to soil beds before planting. The urine can be added neat but it is best also to dilute. Bacteria in the soil change the nitrogen in urea into nitrate which can be used by the plants. Best to leave stronger urine added to the soil for a month before planting.

3. The urine has much nitrogen in it and can be used as an "activator" for compost heaps - it helps the process.

Collecting urine:

* Urine can be collected in several ways:

1. Urine diverting toilet
2. In plastic bottles (for men)
3. In 20 litre containers fitted with funnels (for men)
4. In special "potty pedestals" (for women)
5. In "potties" placed in the flush toilet (for women).

THE FERTILIZING EFFECT OF URINE

If neat urine is diluted with water it makes an excellent liquid feed for plants. 3 parts water to 1 part urine is a good mix. This mix can be applied once or twice a week to vegetables with additional watering.

In some experiments it was shown that by adding the 3:1 water urine mix to vegetables:

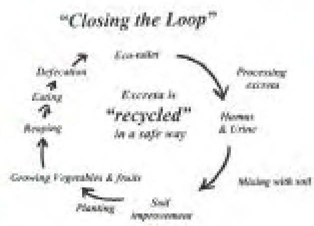
Spinach growth was increased up to 6 times
Covo growth was increased 1.5 - 4 times
Lettuce growth was increased up to 2 times
Tomato growth was increased up to 3.6 times

Also the weight of maize cobs grown in fields was increased from 28% to 39% over maize cobs grown without any fertilizer.

This was done by adding 100mls neat urine per plant every week and allowing the rains to dilute wash into the soil.

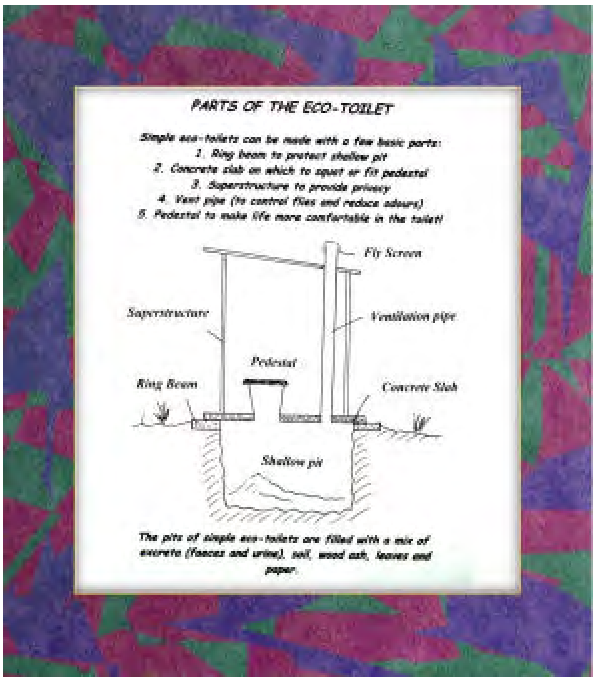
"CLOSING THE LOOP"

The "loop" is closed when what we excrete (urine and faeces) is processed to make eco-humus and plant food (diluted urine) which helps improve the soil which helps plants grow better - which we eat and then excrete again in the eco-toilet.



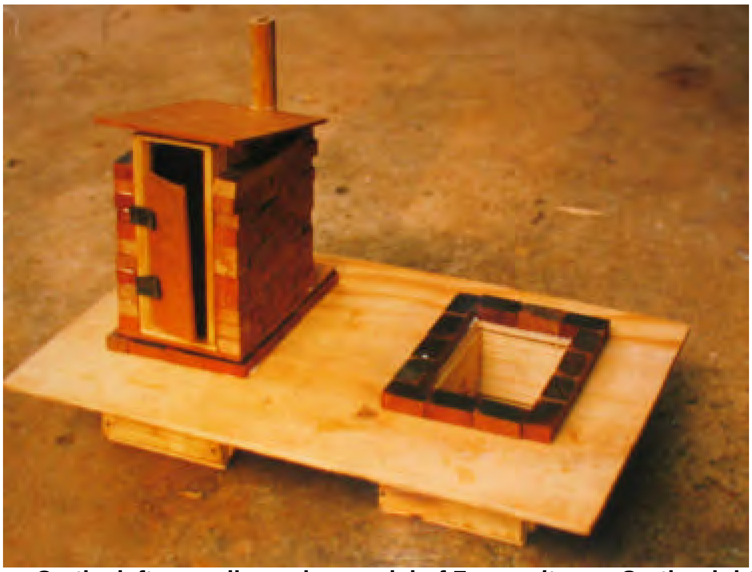
Normally we do not close the loop at all!

We waste all the nutrients in the excreta which goes to waste into the latrine pit or down the flush toilet. There is no re-use, no recycling, no closing the loop - all is wastes and lost.



Flip charts and models help a lot in training

2. Models




On the left a small wooden model of *Fossa alterna*. On the right a one third scale model of the *Fossa alterna* with concrete ring beams and slab, and wooden from a vent pipe.

3. Photo displays

It is also possible to place photo prints on a board to demonstrate toilets used in different places and also the effect of humus and urine on vegetable growth.

4. Samples of the soils and humus


Humus from *Fossa alterna* **pits varies a great deal in texture depending on the amount and type of soil added. On the left a sandy almost humus free soil has been added. On the upper right of the left hand photo some dried out fly cocoons have seen separated off – proof that once this material was excreta. On the right photo a more humus like soil has been extracted, a mix of excreta and more fertile soil. This sample has also been sieved making at an excellent potting soil for planting seedlings. The demonstration that human excreta can change into these soils and humus can be an important step in convincing people that something good can come out of practicing ecological sanitation.**

5. Samples of hardware that can be home made


Hand made examples of urine diverting devises. On the left, a urine diverting squat plate and on the right a urine diverting pedestal. Both use plastic buckets as part of the construction.


A home made hand washing devise makes a popular demonstration. Also home made non urine diverting pedestal in use on a working *Fossa alterna* impresses people.


On the left chicken wire baskets used to make leaf compost. On the right two small worm farms with drip feed water dispensers. Eco-san is made more valuable and interesting by making part of developing the organic garden

6. Demonstrations of the toilet range

Demonstration of various ecological toilets in Harare

6. Handouts - small booklets on basic information to be handed out.

The are also other ways of passing on the message, and that is to distribute information in what ever format is suitable, in the written word, by email, on Websites, on CD’s and disks.

Pamphlets, booklets or manuals can help to pass on the message, although they may be expensive. There is a need for simple low cost booklets or pamphlets which people can take away, read and understand.

The training sessions

Suggested notes

These notes form the basis of training programmes undertaken At Kufunda Village, Ruwa. They have also been used in Mombasa, Kenya. The material in them is extracted and condensed from earlier written works placed on this CD. The manual on "Passing on the Message" can be used as a separate manuscript.

SECTION 1. LECTURES

PART 1. Introduction

PART 2. The toilets

PART 3. The use of eco-humus and urine in vegetable and tree production

SECTION 2. PRACTICAL DEMONSTRATION

Part 4. How to make the parts of the eco-toilets

Part 5. Inspection of used latrines & movement of latrines.

Part 6. The practical demonstration of using eco -humus and urine in eco-agriculture.

SECTION 1. LECTURES

PART 1. Introduction

The world in which we live is not always in balance. People often lack food because their soil is poor and barren. Often it cannot support the growth of food in the form of vegetables or maize without the addition of expensive fertilizers and compost. Extra fertility and nutrients are required. Trees can help preserve the soil and reduce erosion, but in many areas there are few trees for shade or ground cover. These are serious problems facing millions of people living in Africa. Thus promoting the growth of new trees serves many useful purposes.

The safe disposal of human excreta is also another problem faced by millions of people living in Africa. Human excreta is offensive and when not disposed of properly can contaminate the places where people live. Disease can be spread from human waste. This can also pose a huge problem. So we have the twin problems of disposing of human waste properly and trying to improve poor soils which cannot grow food properly.

Both of these problems can be solved by dealing with both of them at the same time and by using the human excreta to improve the soil. Toilets are specially designed so that the waste products can be converted into a safe and valuable resource in the form of humus which can be used to help raise the fertility of the soil. In fact human excreta, both faeces and urine, contain many nutrients which are valuable to plants and can increase the level of production of food considerably. The ways and means in which this is done come under a subject called *Ecological Sanitation.*

***Ecological sanitation* is *a system that makes use of human excreta and turns it into something useful. Both the urine and humus derived from human excreta can be used to increase the fertility the soil and enhance the growth of food with minimal risk of pollution of the environment and with minimal threat to human health*.**

The aim of ecological sanitation is to recycle the nutrients available in human excreta. Thus human excreta can be converted by a process of composting into a safe product (humus) which can be used in agriculture and forestry. The urine can also be recycled by itself and can be diluted with water to make a plant food. The overall aim is to "close the loop." This means that one eats food (say fruit or vegetables) that have grown better by using nutrients available in processed human wastes. These foods are digested and pass out of the body as urine and faeces. These "waste products" are then processed by the toilet and turned into something useful (humus) which the new plants can grow in. The new plants, grown in part from the converted excreta, are then eaten again and the cycle is repeated. That is "closing the loop.

***Flip Chart of closing the loop and the cycle which includes the toilet, the humus, food production and food consumption and back to the toilet*.**

A series of simple toilets have been designed specially for the purpose of recycling human wastes. We may call these eco-toilets. There are three basic types.

1. The *Arborloo* (toilet which becomes a tree)
2. The *Fossa alterna* (the alternating pit toilet which makes humus)
3. The urine diverting toilet. These separated the faeces and the urine and processes each separately. Some urine diverting toilets process the faeces by dessicating them and others by composting them into humus. Methods of collecting urine separately in containers may be included in this category.

Flip chart of basic types of eco-toilets

PART 2. The toilets

We shall discuss the two simplest and cheapest latrines, the ***Arborloo*** and the ***Fossa alterna*** which compost human excreta in shallow pits. Also we shall talk about single vault and double vault urine diverting toilets. These use urine diverting pedestals or squat pans.

The Arborloo

The simplest toilets used in ecological sanitation are simple pit latrines, but they are built over shallow pits and the parts of the latrine are designed to be portable. The simplest, called the ***Arborloo,*** is made up of a concrete slab and a superstructure. The slab sits on top of a shallow hole dug in the ground - the pit is dug about one metre deep. The pit is built up around the top so that rain water cannot flow into it during the rains. It is normally surrounded by a square "ring" of concrete or plastered bricks called a "ring beam." This helps to hold up the top of the pit and also elevates the pit head above ground level. In other words it makes the structure on top of it more stable. A concrete latrine slab with a squat hole or sitting pedestal is mounted over the ring beam. Since the slab will be moved, this has steel handles fitted in it.

The superstructure is placed on top of the slab. This provides the privacy and protection from rain. It is light enough to move so is normally made of wood, bamboo, reeds or frames made of wood or steel and covered with grass or reeds.

FLIP Chart - diagram of parts of the Arborloo

The ***Arborloo*** is used like a pit latrine with two important differences. First soil and wood ash are added frequently down the squat hole and even vegetables scraps from the kitchen or leaves. Second, things which will not compost are not thrown down the hole like rags, plastic, bottles etc. The pit must fill up with materials which will compost. It is the addition of soil and these other materials to the pit which helps to change the excreta in to humus or compost.

These additions will also cut down on the smells and fly breeding commonly seen in pit latrines. The smells and odours can also be reduced by using a vent pipe which has a screen on the top.

The ***Arborloo*** is used for about one year or for however long it takes to almost fill the pit. For a family the pit may become almost full in a year, but the actual filling rate depends on the size of the pit and the number of users. When the pit is nearly full, the structure is taken off and the slab and ring beam are also removed. A new site is chosen and the ring beam is laid down flat and a new hole dug inside the ring beam. The slab is laid on top and the structure on top of this. The new site is now used. The contents of the old pit are now filled with topsoil. It is best to use good soil if this is available. The pit can then be left to settle to left until the rains arrive if water is short. However if water is available a young tree can be planted straight away. A hole is made near to the centre of the pit and a young tree planted there. The roots of the young tree must not come any where near the waste matter. The tree is watered and the soil covered with a mulch. It is very important to also protect the tree against animal attack like goats and chickens.

Thus with the ***Arborloo,*** the latrine slab and superstructure move on a never ending journey from one pit to the next. Once the used pit is nearly full, it is topped up with a good layer of fertile soil and planted with a suitable young tree, time and time again. Guava, paw paw, mango and mulberry are examples. But almost any tree will survive and grow well if planted properly. The end result is a "sanitary orchard" or woodlot. The tree grows in the humus formed from the composted human excreta. With this method there is no handling of excreta so it is very safe. Because the pits are shallow and the excreta changes into humus quite quickly, the risk of ground water contamination is reduced. Because space is required for this concept - it is used mainly in rural areas or peri-urban areas where there is space. The nutrients in the human excreta are used because they are taken up by the tree and help tree growth considerably.

FLIP CHART - show how the Arborloo works and moves from one site to the next. Also to show how the trees are planted.

MODEL DEMONSTRATION *- If possible small models could be prepared beforehand to show the effect. These can be made in cardboard or wood etc. A small model can be made with ring beam, slab and structure to show how the* ***Arborloo*** *works. The miniature ring beam is laid down and a small hole dug within it. Some of the soil is laid around the beam to hold it in place. The slab is placed over the beam and any spaces between the beam and the slab are filled with some soil. A weak mixture of cement will normally be used to make this seal. The* *model vent can be fitted and the action of the vent pipe can be described. How it draws air and how it traps flies when a structure with a roof is fitted. Different coloured soils can be used to show different types of materials added. When the pit is almost full the model structure and slab and ring beam are moved to another site and the hole is filled up and a small miniature tree planted. Methods of mulching and protecting against animals can be described.*

The range of trees which has been used with the ***Arborloo*** is described. These include banana, mulberry, gum trees, avocado, orange, lemon, guava, paw paw. Trees with nitrogen fixing properties like *Leucaena* also grow well and indigenous trees *Brachystegia, Acacia* and *Swartzia* etc.

In several countries like Mozambique, Malawi, Kenya, Uganda and Rwanda people plant trees on old pit latrines in their traditional way of life. However the pits filled with only excreta take much longer to convert to humus which the tree can tolerate.

On the left, *Arborloo* built by Mvuramanzi Trust in Mashonland East, Zimbabwe. On the right, *Arborloo* built in Kusa village, Kenya.

On the left, *Arborloo* built by Eco-Ed Trust in, Zimbabwe. On the right, *Arborloo* builtby Partners in Development, Maputaland, Natal, South Africa.

WE NOW MOVE TO THE SECOND LATRINE TYPE

The Fossa alterna

The second type of toilet built over a shallow pit is called the ***Fossa alterna***. This is similar to the ***Arborloo*** in so far that the toilet structure (including slab and pedestal) is portable. However two shallow pits are dug close to one another and the slab and structure alternate between the two pits - they move from one to the other and then back to the first pit at yearly intervals. In Mozambique a single permanent structure is built over both pits. These pits are often dug within a "ring beam" made of cement mortared bricks or concrete which elevates the slab above ground level and protects the head of the pit. The two ring beams also stop rainwater flowing into the pit. The single toilet slab, which is made of concrete, is fitted over one of the ring beams. As with the ***Arborloo,*** regular additions of soil and wood ash are made to the pit as well as excreta. If possible leaves should also be added. Things like rags, plastic, bottles and other wastes which cannot compost should not be added to the pit. These various materials added to the pit help to convert the human wastes into "humus" which is rich in nutrients and good for the garden. During the first year the second pit within the second ring beam, which has also been dug, is best left empty and covered with a wooden lid.

Each pit is used for one year by the family. This will allow for the pit which is dug between 1.2 to 1.5 metres deep to be nearly full of the mixed materials. At 12 monthly intervals or more the superstructure changes pits and the contents of the used pit are topped up with good layer (150mm thick) of fertile soil and left for a year to compost. This soil, which contains micro organisms (bacteria and fungi) and small animal life, also helps to convert the waste products into humus. To get better mixing it is possible to ram the new soil in with a pole. This filled pit is usually covered with a wooden lid or can be covered with grass like a mulch. The contents should be kept moist, but not flooded, by occasional watering during the year.

During that year when the first pit of excreta and soil is composting the second pit is used. After the second year, the first pit will be filled with humus and the second (used) pit will be 3/4 full of mixed materials. Then the humus or compost is dug out of the first pit and placed in bags for later use on gardens and in beds and containers.

The structure and slab are then removed from the second pit and placed over the first pit which has now been emptied. Now it is time to cover the contents of the second pit and allow this one to make compost while the original pit fills up again.

So every year it is possible to excavate some rich compost from the pit. Normally a one year cycle is used. The humus is rich in nutrients and can be mixed with less fertile soils to make plants grow better.

This concept has a value for use in peri-urban areas since the area required is relatively small - about 2.5m X 1.5m and makes available a source of excellent humus every year, which serves as a soil conditioner, which can enhance the production of vegetables on small family plots. If there is no immediate use by the householder, the humus can be stored in bags and may even generate an income.

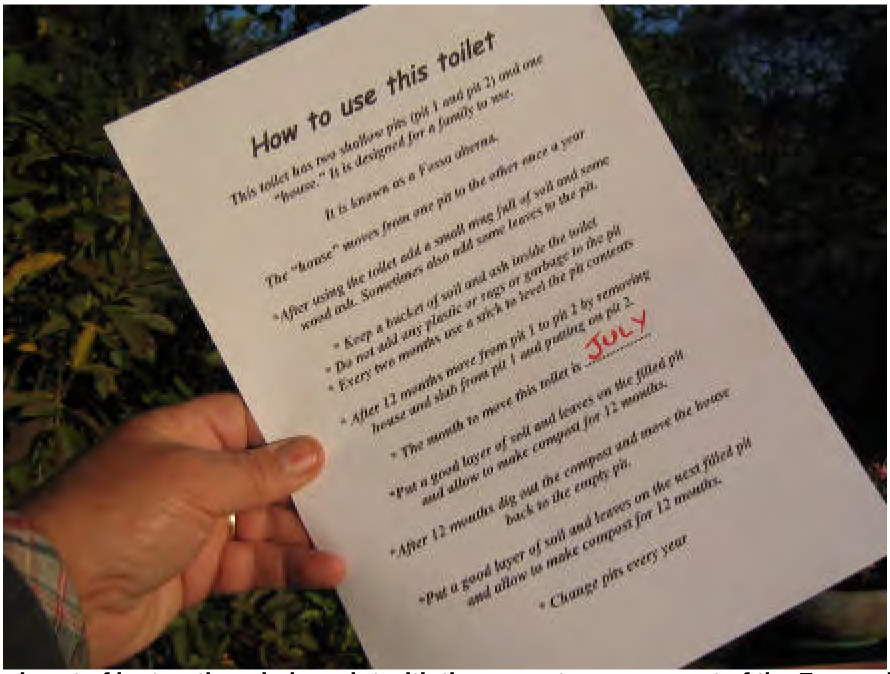
FLIP Chart *- showing diagram of parts of the* ***Fossa alterna***

FLIP CHART - show how the Fossa alterna works and how the slab and structure alternates between the two pits. The cycle of use and excavation is shown.

MODEL DEMONSTRATION *- As with the* ***Arborloo*** *it is good to have a small model available for demonstration with two ring beams, a slab and structure to show how the* ***Fossa alterna*** *works. The miniature ring beams are laid down and a small hole dug within each. Some of the soil is laid around the beams to hold them in place. The slab is placed over one of the ring beams and any spaces between the beam and the slab are filled with some soil. A weak mixture of cement will normally be used to make this seal. Different coloured soils can be used to show different types of materials added. When the pit is almost full the model structure and slab and ring beam are moved to the other ring beam. The used pit is topped up with soil. The contents can be rammed with a miniature pole to mix.*

The model can be used to show how the slab and structure move from one pit to the other at yearly intervals.

INSTRUCTION NOTICE PLACED IN TOILET



A simple set of instructions helps a lot with the correct management of the Fossa alterna

Also to have seen and participated in a "change of pits" helps the memory.

NOW WE MOVE TO THE THIRD TYPE OF ECOLOGICAL TOILET SYSTEM

Urine diversion toilets

In a third range of latrine designs, the concept of **urine diversion** is used. These use a special pedestal or squat platform (or squat plate) in which the urine enters the front part of The pedestal or plate and is then diverted through a pipe and is thus separated from the faeces. The faeces fall down directly into a brick lined va ult or container beneath. Some soil and wood ash are added to cover the faeces after every visit. This partly dries out the faeces and makes them easier to transfer. This is the most widely used ecological toilet system in the world.

There are several types of urine diverting system that can be used. Most will use a double vault system in which the urine diverting pedestal or squat plate is placed above one vault whilst the second vault is closed off. Dry soil, wood ash (or in some cases lime) is added on a regular basis to the faeces after they have been deposited in the vault. The aim is to dehydrate the faeces and then store them for a year and then remove them and use as a soil cond itioner. The urine is taken off through a pipe and collected in a container or allowed to drain into a subsurface irrigation system with a tree nearby. In the double vault urine diverting system the urine diverting pedestal or squat plate is moved every year and placed over the vault which has been just emptied of its dried fa eces.

The *Skyloo*

In a latrine called the "***skyloo***" faeces are also collected in a vault built above the ground, but they enter a bucket or basin and not the vault itself. Urine can be taken to a seepage area but is best collected in containers for use as a plant food. A mix of soil (4 parts) and wood ash (1 part) are added to the faeces once they are in the held in the bucket and are then transferred from time to time to another site called a secondary processing site, where the excreta turns into humus. Thus the raw excreta is not held in the toilet system itself for long. The bucket contents may be introduced into shallow pits or trenches, or placed into jars or other containers together with fertile soil, and leaf mould. In each case the mixture of soil and faeces is converted into a pleasant and nutrient rich humus like soil within a few months. It is then used in agriculture, preferably in combination with the urine.

MODEL DEMONSTRATION - *As with the **Arborloo** and **Fossa alterna** it is good to have a small model available for demonstrating the **Skyloo**.*

Small model of theSkyloo

Models are useful as they can be taken apart to show the various parts

FLIP Chart - *showing diagram of parts of the urine diverting system and how the faeces, soil and ash are composted in a secondary composting site, by the addition of further soil which is kept moist.*

Site visit

The best demonstration of all is to show people the actual working ***Skyloo*** *and how the mix of faeces, soil and ash so readily converts into humus in a secondary composter like a cement jar. This can be a memorable experience for the observer. The conversion of excreta into humus is remarkable.*

Visitors inspecting a Skyloo in Harare.

PART 3. The use of eco-humus and urine in vegetable and tree production

Fossa alterna humus

The humus is formed in the ***Fossa alterna*** pit because the micro-organisms (bacteria and fungi) and miniature animal like in the soil (insects and worms) digest or otherwise convert the waste matter and turn it into humus. The process appears to be more effective if the pits are lined with soil rather than bricks and the process is also more efficient the more soil, ash and leaves are present. Pits filled just with excreta alone change very slowly indeed - years. The humus dug out of the ***Fossa alterna*** is very rich in nutrients and when mixed with poor soil can enrich it enough to make plants grow well.

At this point samples of the humus should be shown and handled by the students. Next follows a brief description of the nutrients in the humus and this is compared to the natural levels of nutrients in some soil samples taken from Ruwa, Epworth and several locations in Harare. Samples of the mixed soils can also be shown.

SOIL SAMPLE ANALYSIS

These show figures for Nitrogen, Phosphorus and Potassium in various soils and the humus taken from *Fossa alterna*

Location	Nitrogen(ppm)	Phosphorus(ppm)	Potassium (ME/100g)
Natural soils (Mean of 9 samples)	**38**	**44**	**0.49**
Fossa alterna soils (Mean of 10 samples)	**275**	**292**	**4.51**
Samples of humus from Skyloo jars (Mean of 8 samples)	**232**	**297**	**3.06**

When the ***Fossa alterna*** soil is mixed (50/50) with poor soil, the levels of Nitrogen, phosphorus and potassium are all raised

Examples of mixing Fossa and ordinary topsoil

Location	Nitrogen(ppm)	Phosphorus(ppm)	Potassium (ME/100g)
Sample 1.	**91**	**337**	**1.45**
Sample 2.	**91**	**247**	**0.88**
Sample 3	**78**	**356**	**1.01**

These results show that by mixing the humus from the ***Fossa alterna*** and poor soil, a much richer soil can be produced on which vegetables will grow well. The major nutrients found in soil are nitrogen, phosphorus and potassium.

The **Nitrogen (N)** is the leaf builder of plants, Nitrogen promotes leaf growth and increases the final yield of crops.

The **Phosphorus (P)** helps the fruits of plants to build up and ripen. It gives a good start in life to crops and assists in strong root and shoot growth and encourages early maturing.

The **Potassium (K)** builds up fibre in the plant and gives healthy growth. It also helps the plants resistance to disease, drought etc and improves the quality of the crops.

Ways of using the humus in vegetable gardens.

A brief description of how to apply this humus to small vegetable gardens is now given. Remember the volume of humus is not large - about 500 to 600 litres (half a cubic metre) per year per family.

This humus is best mixed with other soils.

1. It can be dug into vegetable beds
2. It can be mixed by volume with the same volume of sandy soil from Kafunda, for instance. This doubles the working volume of the fertile soil but reduces nutrient levels, but there is still plenty of nutrients left for good plant growth.
3. The diluted humus can be used in small vegetable gardens like the one in Woodhall Road or the trench type in Woodhall Road.
4. The diluted humus can also be placed in containers to grow a variety of vegetables. Rape, tomato, pepper, spinach and other vegetables can be grown in containers very successfully. Buckets or basins can be used as containers or cement replicas of the buckets and basins.

Cement basins

One way of making cheaper containers is to use a 10 litre plastic basin as a mould. River sand and cement is mixed in the ratio 3:1 (6 pea tins sand to 2 tins cement). Apply the cement to inside of basin. Leave overnight to set. Cover with plastic sheet. Water following morning and leave. The following, day place upside down in sun. Sun will heat the plastic basin and it can be separated from the concrete basin. Water and cover for a day. Then transfer into water to cure. Keep wet for several days. Once cured drill three 12mm holes in base for drainage. 40 - 50 basins of this type can be made with a single bag of cement. We can grow about 2 tomato, 5 rape or up to 10 onion in each container.


Nice crops of onion and tomato growing on in 10 litre cement jars,

Evidence of enhanced vegetable growth.

In a series of simple experiments vegetables like spinach, covo, lettuce, green pepper, tomato and onion were grown in 10 litre buckets or basins of Epworth or Ruwa soil and their growth was compared with plants grown in similar containers filled with a 50/50 mix of Epworth (or Ruwa) soil and ***Fossa alterna*** soil. In each case the growth of the vegetables was monitored and the crop weighed after a certain number of days growth. The following chart showed the results of these trials. FA* denotes soil taken from ***Fossa alterna*** pit. The extra growth is due entirely to nutrient enhancement by ***Fossa alterna*** soil.

Plant. Top soil type. Growth period.	**Weight at cropping Top soil only**	**Weight at cropping 50/50 mix topsoil/FA*soil**
Spinach on Epworth 30 days.	72 grams	546 grams (7 fold increase)
Covo on Epworth 30 days.	20 grams	161 grams (8 fold increase)
Covo 2. on Epworth 30 days.	81 grams	357 grams (4 fold increase)
Lettuce on Epworth. 30 days	122 grams	912 grams (7 fold increase)
Onion on Ruwa 4 months	141 grams	391 grams (2.7 fold increase)
Green pepper on Ruwa 4 months	19 grams	89 grams (4.6 fold increase)
Tomato on Ruwa 3 months	73 grams	735 grams (10 fold increase)

All these results clearly show a dramatic and meaningful increase in vegetable yield resulting from the enhancement of poor spoil (Epworth and Ruwa) with the ***Fossa alterna*** humus.

The usefulness of urine as a plant food

The urine is also valuable as it contains a lot of nitrogen and some phosphorus and potassium which are useful for plant growth. It can be diluted with water - about 3 parts of water to one of urine and applied to the soil in which plants grow. It is especially good for leafy vegetables like rape and spinach, turning them very green and leafy.

There are several ways of making use of human urine - it is a valuable product with much nitrogen and other nutrients contained in it. The huge potential of urine as a plant food is wasted every day by most of the world's population.

There are several ways of collecting and using the urine.

For collection the urine diverting latrine can be used. This is where the urine and faeces are separated (demonstrate one of these if available). Also for men a urinal or a urine collector such as a desert lily can be used. The "desert lily" is a name given to a funnel sitting on a plastic container (normally 20 lire) which holds the urine. This can be mounted in a small structure for privacy. Men can also urinate in smaller 2 litre containers and collect and contain the urine that way.

Plant trials with urine for various vegetables & tomatoes

In these trials plants were grown in 10 litre cement basins and some were fed with 0.5 litres of a 3:1 water/urine mix, three times per week, whilst others were irrigate with water only.

Plant and growth period	Weight at cropping (water application only)	Weight at cropping (with a 3:1 water/urine application 3X per week)
Lettuce. 30 days	230 grams	500 grams (X2)
Lettuce. 33 days	120 grams	345 grams (X 2.8)
Spinach. 30 days	52 grams.	350 grams (X 6)
Covo. 8 weeks	135 grams	545 grams (X 4)
Tomato. 4 months.	1680 grams	6084 grams (X 3.6)

The increase in production is very significant. Even the application of a 3:1 water urine mix once a week can have a significant effect on plant growth. The onions and tomatoes held in cement basins shown on the photo earlier were fed a 3:1 water/urine mix once a week.

In further experiments on maize in the field, 100mls of neat urine was placed on each plant with rain soaking it in to the soil. This increased the maize cob size 28% in one area and 39% in another area, but both were less than the 61% increase from conventional fertilisers. However the fertilisers were expensive while the urine cost nothing. Where fertilisers are too expensive, which is often the case, urine acts as a fine substitute and costs nothing and is always available where people live.

Urine is easily collected by men in plastic bottles.

Leaf Compost (leaf mould)

This is wonderful material and is made by composting leaves in chicken wire baskets and keeping moist. Different leaves compost in different amounts of time. The composted leaf mould can be mixed with other compost or topsoil or ***Fossa alterna*** humus to make an excellent medium for growing vegetables. Urine application works much better if the soil is humus life and has a living content.

SECTION 2. PRACTICAL DEMONSTRATIONS

Part 4. How to build the latrines

Now we have talked about the latrines and how they work we must now look at how they are built. This is a very practical part of the training exercise. We shall now look at the parts of the latrine and how they are made. However it is important first to allow participants to see for themselves the various toilet options that are available before the actual construction exercise begins.

Preliminary site tour of toilets and other facilities before practical work begins

The parts of the latrine.

The construction of the following parts of the latrine will now be demonstrated. The ring beams, slabs, structure and pedestal and pipe are common to both ***Arborloo*** and ***Fossa alterna***. The ***Arborloo*** has one ring beam, the ***Fossa alterna*** two ring beams. The same slab can be used on the urine diverting ***Skyloo.***

The latrine parts are:

- **The ring beam/s (or pit linings)**
- **The above ground vaults**
- **The concrete slab**
- **The superstructure**
- **The pedestal**
- **The vent pipe (with fly screen)**
- **The hand washing facility**

For the constructions an area is set aside to make the parts. This requires a flat piece of land, cement, river sand, wire for reinforcing, wire for handles (for slab), moulds for squat hole or pedestal hole, mould for vent pipe hole, vent pipe (normally 2 - 3m of 110mm PVC). The pedestal requires a plastic seat cover and a 20 litre bucket. Bricks can be used to make the mould for the ring beams and slab. For the hand washing facility there are various options, using plastic containers. It is also important to show how the superstructures can be made. A carpenter can help with this part of the demonstration.

THE CONSTRUCTIONS

Ring beams and simple slabs are used on the simpler toilets like the ***Arborloo*** and the ***Fossa alterna.*** If the soil is soft and sandy and may collapse a full pit lining is required for the ***Fossa alterna.*** Where above the ground vaults are used, these are built on an area of concrete laid on the ground.

The construction of demonstration ring beams and slabs now follows. This can be followed by construction of a working ***Arborloo*** and ***Fossa alterna*** and also simple pedestals (in two stages a day or two apart). Also the construction of the hand washing facility can be made. The carpenter can show the various ways of making the superstructure from various materials (gum poles, bamboo, grass, reeds etc).

For the urine diverting systems, a single or double vault will be built and also either a commercial urine diverting pedestal or squat plate or even a home made unit constructed from cement and a plastic bucket.

Follow instruction material in field manual if available.

Shallow pits can successfully be protected by a concrete "ring beam" where the soil is moderately firm. This is laid on slightly raised level ground and the hole is dug down inside it to about one metre depth. The soil from the hole is laid around the beam and rammed in place. This method is being tested in a wide variety of sites. Since the superstructure is portable and therefore light in weight, there may be little need to fully line the pit with bricks. In any case the ***Arborloo*** moves to a new site every year - it would be a waste of money to line the pit with bricks. Humus formation takes place more efficiently in pits with an earth lining. Ring beams and slabs made of concrete last a very long time and are a very good investment in time, money and materials.

The concrete ring beam

This is made of a mix of 3 parts river sand to one part cement or 3 parts river sand, 2 parts small stone and 1 pat cement. A 5 litre bucket can be used as a measure. Thus where stone is used 6 X 5 litre buckets of sand are mixed with 4 buckets stone and 2 buckets cement. In practice 3 X 5 litre buckets sand are mixed with 2 buckets stone and 1 of sand first. This mix is added to the mould. Wire reinforcing is added and the same mix is made up and added again.

The mould can be of bricks or wooden planks. The outer dimensions of the ring beam are 1m X 1.3m. The inner dimensions are 0.7m X 1m. 3mm wire is used as reinforcing - two lengths along each side. The concrete is cast in the late afternoon, covered with plastic, watered the following morning and kept wet for a week before moving.

Casting ring beams at a primary school in Mombasa, Kenya

The concrete slab.

This is made with the same mix as each ring beam and takes the same amount of materials. The slab is 1.2m long and 0.9m wide. The same amount of steel reinforcing wire is also used. It has hole made in it for the squat hole (about 250mm X 150mm) or the pedestal hole (300mm round) and also for a vent pipe. The curing instructions are the same. The squat hole is made about 35cm from the rear and if a vent pipe is required a hole is made about 150mm in from the rear side.

Recruits building a concrete slab at Kafunda, Ruwa

Above ground vaults

These are used with urine diverting systems (e.g. double vault or single vault such as the ***Skyloo***). There is some variation in design. Most are built in brick over a base made of concrete. The vault is between 0.5 to 1m deep (often 0.75m) and has a rear entrance door, which permits the vault contents (whether in a bucket or vault itself) to be extracted. The vault door should be near airtight. The capacity of these vaults varies but is about 1 cu.m. In the ***Skyloo*** the vault is only 0.5m deep, and 1.5m long and 0.9m wide allowing for a sloped back door.

Building a single vault for the *Skyloo* in Mombasa, Kenya.

Skyloo **built in Mombasa, Kenya, with external secondary composting pit chambers.**
This unit is fitted with a commercially made urine diverting squat plate made of tough plastic.

The home made pedestal (non urine diverting)

Pedestals are becoming more popular in Zimbabwe. Commercial pedestals are expensive and they can be made at home more cheaply. A neat pedestal can be made with a home made seat of concrete or using a mass produced plastic seat with lid. This seat together with a 20 litre bucket is required together with cement, river sand and reinforcing wire.

First small holes are made with the heated wire in the plastic reinforcing struts under the seat and a loop of wire is passed through these. The bottom is cut out of a 20 litre plastic bucket. The mix of cement one part and river sand 3 parts is used. A small amount is mixed up and laid under the toilet seat through the wire and levelled off. Next the plastic bucket is laid centrally over the seat. About 8 small wire bend in an L shape are inserted in the concrete so far laid around the bucket. This can be left to set for some hours. Then the side walls of the pedestal are built up with the same mix of sand and cement up the side walls of the bucket. This can be done in stages. Thin wire is wrapped around the bucket within the cement for reinforcing. The cement is built up to the top of the upturned bucket and left to cure. It is kept wet and covered once hardened.

After a few days the seat, bucket and cement side walls of the pedestal are turned over and placed on a plastic sheet. A mould of bricks or wooden planks is made about 40cm X 40xm. A further mix of the cement/sand is lais in this together with some more reinforcing wires. This forms the base of the pedestal. This is kept wet and covered after hardening for some days. It can then be used on the latrine.

Making a low cost pedestal at Kafunda

Home made urine diverting squat plate and pedestal

Most urine diverting pedestals and squat plates are made commercially. However it is possible to make them at home using plastic buckets and concrete. People who weld plastic (plastic surgeons) can do this job if shown how. A smaller bucket is cut to shape and fitted inside the larger bucket to make a urine diverter. The urine drains down the area contained by the cut smaller bucket into an outlet pipe. The outer shell of the pedestal is formed in concrete. The seat itself can be made in concrete or by using a commercially made toilet seat.

The superstructure.

There are many ways of making this part of the latrine. The best is to make a frame of some convenient material - steel, gum poles, bamboo, wooden planks etc. These are made up into a frame. A door is added connected to the frame through hinges which can be made of car tyres. A roof is made in the same frame materials, chicken wire is laid over this and then a plastic sheet. This can be lid over with grass first and then upgraded later with thin corrugated roofing sheet.

The frame, in what ever material it had been made, can be covered with any suitable material - plastic sheet, tin sheet, shade cloth, grass, reeds, thin wooden planks etc. Handles can be added if necessary to make lifting easier. Very often a carpenter is hired to assist in the construction of the superstructures during training. Traditional methods of using locally available materials can be used very effectively in making the "toilet house."

Vent pipes.

The vent pipe serves a very useful purpose. It draws out odours from the latrine pit and also traps flies if fitted with a fly screen. Air passing over the top of the pipe draws air up the pipe, and if this is fitted though a concrete slab which is sealed over the pit, any air that goes up the pipe is replaced in the pit by air drawn down the squat or pedestal hole. This means that odour from the pit cannot pass into the structure. Also if a roof is fitted and the pipe is fitted with a fly screen, the vent can act as a fly trap as well. Flies are attracted to the latrine by odour and are attracted by light when they leave it.

Whilst vent pipes fitted to ecological toilets are less vital as a means of controlling flies and odours (because liberal quantities of wood ash and soil added to the pit will also do this), they do serve an important function by removing excess moisture from the pit or vault.

FLIP CHART DIAGRAM - how the vent works.

Hand washing facilities

Hand washing is very important if the health aspects of sanitation are to be achieved. There are various ways of making a hand washing facility from discarded plastic containers. A simple end effective hand washing devise can be made from a discarded plastic oil container and a discarded plastic pill bottle. The construction of this useful hand washer can be shown. It is hung next to each toilet and is economical in its use of water. The water runs for a short while and stops itself. A small bar of soap can be attached with a short piece of string from the hand washer.

An even simpler hand washing device can be made from a plastic bottle with a screw cap and a section cut from a discarded ball point ink cartridge. Cut a part of the old ink cartridge about 30mm long with one end cut at an angle. Using a hot wire, make a small hole near the base of the bottle on one side. Then push the section of ink cartridge through the hole, fill up the bottle with water and close of the cap. Water will flow out of the "spout" when the cap top is opened up and will stop flowing when the cap is closed. Very little water is required for hand washing. A piece of soap can be hung from near the bottle on a string.

A simple hand washing device should always form a part of any improved toilet.

Part 5. Site visits - inspection of used latrine. Movement of *arborloo* and *Fossa alterna*

A tour of sites where people are using ecological toilets forms an important part of any training course in ecological sanitation, so this must have been set up some time before. After some time it will be possible to demonstrate, not only the planting of young trees on filled ***Arborloo*** pits but also the alternating nature of pit use in the ***Fossa alterna***.

Garden tours


Garden tour of eco-san demonstrations at Woodhall Road, Harare. Sniffing the humus formed in a 30 litre jar from converted faeces taken from the *Skyloo*. On the right trainees are told about changing pits in the *Fossa alterna*. The structure and two pits can be seen in this photo.


First, the structure and slab are removed from the pit which has been in use for one year. The pit contents are then covered with a good later of soil and leaves (right).


Next a thick layer of leaves is added to the base of the new pit. A layer of very weak cement mortar is added to the ring beam and the slab (in this case fitted with a plush pedestal) is lowered on to the ring beam. Finally the structure is fitted back over the slab. Good for another year.

Part 6. Inspection of gardens, orchards other facilities linked with ecological sanitation.

Demonstrations of food growing on eco-humus or soil fertilised with human excreta including urine is always convincing. These covo and tomatoes are fertilised with urine diluted with water.

"Sanitary Orchard" at the Friend Foundation, Harare. On the left a fine gum tree grows on a pit of organic waste (in this case dog manure) and soil. On the right an *Arborloo* with banana growing on pit of human excreta and soil. Below, a variety of tree species grow well on the mix of "manure" and soil. These include a variety of citrus, avocado, mulberry, paw paw, Leucaena, Acacia, and other indigenous trees.

Good implementation practice

Once the initial training has been completed and a number of facilities have been installed, there needs to be a period when the various facilities can be used, examined and tested by the users. If the outcome of this period is satisfactory, in other words the sanitary facilities are found acceptable, it is possible a demand may be created for more units. This manual does not intend to go into detail about the various tried and tested methods of implementing programmes, as these will vary from one organisation to another and from one country and area to another, Whilst there may be several examples in the sub-region of successful methods of implementing eco-san programmes, two deserve a brief mention here. These are examples of work being carried out in Mozambique and Malawi, mainly under the support of WaterAid, UK.

The Mozambique programme

This implementation programme is being performed in Niassa Province, Mozambique, by a local NGO, ESTAMOS and the English NGO WaterAid. Ecosan was originally introduced into Niassa during a workshop held in March 2002 (Edward Breslin (2001), Introducing Ecological Sanitation: Some lessons from a small town pilot project in Mozambique. Paper presented at Stockholm Water Symposium, 2001). Many participants found the concepts interesting, but wondered how to actually initiate a programme that offered households EcoSan options. Initially a series of meetings was held with key leaders and activist residing in various bairros in Lichinga. Leaders were asked if they would be willing to test EcoSan in their homes, and to identify others in their bairros who may also be interested. The response was considerable, because at that time the state of existing sanitation was poor. ESTAMOS constructed the first 35 ***Fossa alterna's*** and 6 ***Arborloo's*** in these bairros, after which considerable interest grew. Households with new latrines spoke with their neighbours about these odourless, shallow latrines. The latrines were aesthetically pleasing as well, as the two shallow pits (in the ***Fossa alterna***) were housed in one superstructure linked to a washing area. Walls were made of traditional materials and a roof covering to prevent rainwater from entering the latrine. In this case the slab was the only part of the system that needed to be moved (from one pit to the other at yearly intervals).

Interest in EcoSan was further enhanced through a series of radio interviews with a woman who has received a ***Fossa alterna*** and who spoke eloquently about the numerous advantages of the system over her previous "Improved Latrine." She spoke about her toilet no longer smelling and was fly less. She spoke with pride about how her neighbours admired her new latrine, and how she was able to transform her yard with the compost produced by the latrine.

In addition some ***Arborloo's*** were constructed at a weekend festival that drew hundreds of people. This system also drew interest and currently trees planted in used ***Arborloo*** pits in Niassa include guava, mango, orange, avocado as well as a range of local fruit trees.

ESTAMOS responded by initiating pilot projects in other areas using a range of participatory methods and social marketing techniques with communities involved in water and sanitation initiatives. Communities are taken through a Participatory Hygiene and Sanitation Transformation (PHAST) process that helps communities decide what key water and sanitation problems they would like to address.

ESTAMOS has made great use of demonstration latrines. Model ***Fossa alternas*** have been built throughout Lichinga and Mandimba and also Arborloo's. Communities interested in solving sanitation problems send representatives to these demonstrations and are given the opportunity to talk to owners about their new systems. This has led to considerable demand for EcoSan latrines in both Lichinga and Mandimba. ESTAMOS also made use of an agricultural demonstration plot by planting a guava in an ***Arborloo*** pit. The results were impressive as the guava outgrew older guava plants on the farm within a period of six months. Interest in EcoSan has also increased considerably in Maua and Nipepe in Niassa, where local teams of community activists support by DAS (Provincial Department of Water and sanitation) and DDOPH (District Directorate of Public Works and Housing) with the support of ESTAMOS and WATERAID are introducing sanitation through the PHAST methodology (*Introducing Ecological Sanitation in Northern Mozambique*. Field report of WaterAid. Edward D. Breslin and Feliciano dos Santos, 2002). Sanitation ladders covering health and hygiene issues are also used. Families are given a range of technical choices to consider (improved traditional latrine, SanPlat, VIP, ***Arborloo, Fossa alterna***, Urine diversion etc). The advantages and disadvantages of each system are explored with residents listing which are best and worst. Local drama has also been used as a promotional tool.

By December 2002 over 330 ***Fossa alterna*** had been built, 11 improved latrines and 6 traditional improved latrines, reflecting the choice. In addition, formal applications for latrines in Maua, as of December 2002 were 432 ***Fossa alterna***, 179 Improved latrines and 121 improved traditional latrines, once again reflecting preferences.

Why EcoSan over other alternatives?

The high interest in eco-sanitation options is of great interest and this aspect is discussed by Breslin and dos Santos in their papers. Monitoring and Evaluation (M&E) exercises reveal that families using the ***Fossa alterna*** consistently suggest that the absence of flies and odour are considerable advantages of EcoSan systems over improved latrines (SanPlat) and improved traditional latrines. Most conventional pit latrines in Niassa have offensive odours, are full of flies, and, because there is moisture evident in many improved latrines, they can also house mosquitoes in the superstructure. This according to surveys, has not been the case with the ***Fossa alterna***, even during the rains when management of EcoSan becomes more important and somewhat more complicated. (*Introducing Ecological Sanitation in Northern Mozambique.* Field report of WaterAid. Edward D. Breslin and Feliciano dos Santos, 2002).

Second, families do not have a great deal of space in their yards for toilets. But Ecosan provides people with an alternative that addresses this problem too. People see the ***Fossa alterna*** as a permanent solution, in sharp contrast to pit latrines that eventually fill up and need to be relocated. New sites for latrines inside small yards will not have to be found with the ***Fossa alterna***. It is this incentive which has made most people choose the ***Fossa alterna*** system (Edward D. Breslin and Feliciano dos Santos, 2002).

Third, EcoSan offers people the potential for added economic value, as compost from the eco-toilets can be used for small vegetable plots within a family's yard and some also use the ***Arborloo*** in their fields. Staff of the Department of Agriculture have shown interest in this compost which comes from pit excavation. Interest in EcoSan has grown more as more people have seen for themselves that the contents of the pit do transform into humus and fears about excavating unprocessed faeces have diminished.

Fourth, the basic concepts behind EcoSan make sense to people as they are simple and easy to understand, especially with demonstration models in place. Over time, as people see the value of introducing the soil/ash mix, when their toilets do not smell, do not attract flies and lack the humidity to entice mosquitoes, the management practices continue to improve. Moreover, few have said they think the use of excreta is culturally unacceptable – instead many families insist that it is simply logical.

Fifth, there is a growing sense that the shallower pit depths of EcoSan latrines will ensure that groundwater is not contaminated. This is an important issue among residents of Lichinga and Maua Sede, especially as people link poor health with poor drinking water from their household wells.

Sixth, latrines in general and EcoSan latrines in particular, are proving to be a source of some status and prestige in project sites. Invariably, families are not primarily interested in sanitation for health reasons, but rather for reasons of status and convenience. Also many traditional latrines have a reputation for collapsing during the rains. Latrine stability is an important issue – ***Fossa alterna*** have shallower pits and the first 30 cms are lined with brick and thus are far more stable than 3 – 5 metre deep conventional pit latrines which may be unlined.

Material assistance to householders

The programme uses the concept of a material incentive in the form of a single latrine slab, a small extra contribution of cement to help make the upper pit lining and a plastic sheet to line the roof. The family contributes by excavating the pits, buying the bricks and providing the materials for making the superstructure, sand, and labour for construction and also proving a cover for the second pit. The total cost of the ***Fossa alterna*** lies between US$18 – 27.

Lessons learned

The monitoring and Evaluation (M&E) programme has proved to be most valuable and information of relevance can be reintroduced back in to the programme. At first a considerable number of households had odour problems because they were afraid to fill their pits too quickly and therefore were not including enough soil/ash after each use. This never properly covered the excreta. This was overcome by the realisation larger quantities of soil and ash overcame the fly and odour problem and did not necessarily fill the pits at a fast rate. Also to allay fears that the pit will fill up more quickly, pits are being dug between 1.3 and 1.5 metres deep. Pits do fill up more quickly if overloaded, and used by large families or more than a single family.

EcoSan latrines are more difficult to manage in the wet season, partly because it is difficult to find dry soil and ash. However some forward planning by collecting dry soil and ash ands storing in bags under cover can over come this problem. In using soil and ash to add to the pit, often with the hands, it has been found that hand washing is more frequently undertaken and simple hand washing facilities are normally built as part of the latrine/bathing complex. As time passes it will be easier to assess the acceptance of excavating the pits once they are full of humus. Will people excavate the full depth of the pit or just part of it? These questions remain unanswered at the present time. Our knowledge of the use and acceptance of the ***Fossa alterna*** and other eco-san systems increases with time. Only time will tell.

A nice example of the Mozambican *Fossa alterna* in Niassa Province

On the left - building an *Arborloo* near Lichinga. An *Arborloo* **pit is just been topped up with soil and a tree planted near the foreground. On the right – the two pits of the *Fossa alterna*, one is partly excavated.**

The Malawi Programme

WateraAid and the CCAP have also been active in Malawi, promoting EcoSan. WaterAid has an excellent programme in Salima, and another programme conducted by the CCAP in the catchment area of Embangweni hospital in Northern Malawi, has strong sanitation promoters network. Here a sanitation team has an ambitious goal of constructing at least 500 latrines by the end of 2003. In this programme masons are trained to build the various eco-latrine types, the emphasis being on the *Arborloo***,** although more recently there has been a shift towards the *Fossa alterna* **.** Planting trees on filled latrine pits has been practiced in Malawi for generations, and thus is not a new concept in Malawi. Embangweni's sanitation co-ordinator is involved in intensive community mobilisation, involving promoters, agents and masons. Sanitation clubs also promote the concept of ecological sanitation. Meetings with local leaders and households are considered very important to this programme and demonstration latrines are built in the areas intended for local promotion.

This programme is paralleled by the propagation of young fruit trees for use in the programme, particularly mango, oranges and tangerines. Grafting techniques are also used. Paw paw and banana are also widely promoted as being suitable for use on Arborloo pits as they grow very fast. Schools are being used as distribution points for cement.

As of November 2003 nearly 400 eco toilets had been built. In July 2003, a total of 303 eco-latrines had been built in this project (183 ***Arborloo***, 15 ***Fossa alterna***, 57 children's latrine (a type of small ***Arborloo*** for children), 7 ***Skyloo*** and 41 improved traditional latrines. The number of trees planted is as follows: orange 68, Paw paw 51, guava 23, tangerine 15, bananas 13, granadillas 8, pears 3, mangoes 2, sweet apple 1 (Report of the CCAP Eco-sanitation Project at Embangweni, Malawi by Twitty Munkhondia).

More recently a programme initiated by COMWASH in the districts of Phalombe and Thyolo has started, using the methods developed in Salima and Embangweni. Here again local masons become skilled in making slabs and there are distribution centres for cement. Strong links are being made with the Ministry of Health and other government departments. All these projects show great promise for future expansion of eco-san in Malawi. They have been described by Morgan 2003a and 2003b).

Portable structures designed for use with the *Arborloo* in Malawi

Trainees lining *Fossa alterna* pits in Malawi

Summary of training and extension

In ecological sanitation the recycling of human excreta is made as simple and convenient as possible. Natural processes are involved in a way that retains a simplicity of method and flexibility of design. Health issues have always been considered. For instance the ***arborloo*** is designed to minimise human contact with faecal matter, and urine diversion systems attempt to sanitise faecal material more quickly and make it easier to handle. These aspects of design help to reduce the health risks associated with the practice of ecological sanitation. Also the provision of a reliable hand washing facility is essential if a latrine system is to be associated with an improvement in health.

The need for improved soils in a world which lacks food and where soils are often leached out and infertile is also an important consideration. Ecological sanitation attends to this matter. The humus resulting from composted human faeces makes an excellent soil conditioner. The aim is to mix it with infertile and worked out soil together with garden compost and leaf litters which are also produced in the garden. Thus those practising ecological sanitation should also be familiar with the methods of making garden compost and leaf mould so that all these fertile soils can be mixed to form a living and fertile humus. Such humus when properly used in agriculture helps to improve food yields and also food quality and hence provides more food security and improves the nutritional status of the beneficiaries. The fact that excreta can change into a nice smelling soil is one of Nature's marvels. Without this natural process of "building up" and "breaking down" no animal or plant life could exist on Earth.

Practical hands on training is vital – making a slab in Kenya

20. Summing up

This book has described the fundamental principles of ecological sanitation and provided a detailed description of how to build and manage a small range of lower cost eco-toilets where the recycled products can be put to good use. Ample evidence has been provided for the value of both humus derived from human excreta and also the urine for enhancing the production of a range of food crops. The greatest effect is normally achieved by combining the use of both humus and urine. Methods of growing vegetables using recycled human excreta have also been described. The importance of combining the use of recycled human excreta and other recycled organic materials like garden compost has also been emphasised. A number of gardening and constructional techniques which assist eco-san based projects have also been described. The health implications of using processed human excreta, has also been summarised.

The techniques described here cover only a very small, and as yet little known range of on-site options for lower cost sanitation. Many large scale projects based on ecological sanitation are being undertaken around the world and these are receiving much attention. The techniques and methods described here are less well known and intended for use by poorer members of the community, who may in the past have used only the pit toilet or no toilet at all. However it is this proportion of the world's population which is perhaps the largest, the least served and the most in need of improved facilities. It is hoped that this extended range of lower cost options will help to increase the coverage of this underprivileged segment of the population.

Ecological sanitation can also assist where people have used conventional water born systems like the flush toilet before, but where these systems are failing due to a lack of water or lack of maintenance of sewage processing systems. Overburdened or poorly maintained conventional sanitation systems can also pollute the environment considerably. These conditions apply mostly in the cities and peri-urban areas surrounding these cities. Where there is space, the systems described in this book may be useful. There are many projects currently being undertaken all over the world, where these same basic problems are being addressed by the application of ecological sanitation. GTZ and Sida/EcoSanRes are at the forefront of such work internationally.

There are a few central themes on which this particular approach to low cost sanitation, described in this book, has been built.

* The toilet system itself must be thought of, not so much as a disposal system, but as a processing unit.

* Soil can provide the all-important link between the toilet system and agriculture. In the toilet systems described in this book, soil is added to the toilet in quantity – approximately equal to the volume of solid excreta added. And for best results, the added soil should be combined with wood ash and leaves.

* The added soil, together with its companion ash and leaves, converts, purifies and otherwise hastens the conversion of the foul and dangerous mass of excreta into humus, which becomes pleasant to handle, relatively safe and is rich in nutrients. The process is entirely biological, with beneficial organisms of all kinds tending to thrive and pathogenic organisms tending to die out. The inventor of the process is Nature itself.

*The end result of this natural process is a valuable humus-like soil, which can be used to enhance the growth of both trees and vegetables. Excreta, soil, ash and leaves are abundant and cost nothing. In combination and when processed they have great value.

* The processing of human excreta (both humus and urine) is best integrated into a broader scheme of recycling all organic products in both the home and the garden.

Ironically this method of using soil to process excreta was first used in the form of the “earth closet” over 100 years ago. This technique preceded the use of water born sanitation as we know it today. The concept of using earth, rather than water, quickly went out of fashion however, after the invention of the flush toilet. As we have seen the “earth closet” and its variants still have considerable merit and greatly deserve revival.

All organic material can be composted. Thus leaves are recycled by making leaf compost. Organic vegetable matter, derived from both kitchen and garden are recycled to make garden compost. Manure derived from animals is recycled to enter the compost heap. The composted materials from all sources, of both animal and plant origin, are applied back into the soil, which becomes enriched. Thus it is the combination of recycled leaves, manure, vegetable matter, kitchen scraps together with recycled human excreta which are used to form a medium which is mixed with topsoil to enhance the growth of food crops.

Put simply, eco-toilets form part of an ecological approach to managing the garden and home in a holistic way. Even used water (grey water) can be recycled in such a way that it can enhance the production of food. The home and garden becomes part of an eco-home and eco-garden. Recycling in all its forms is encouraged. That is how Nature works!

The question then remains, what if I am not a gardener and have no interest or time to produce my own vegetables? Many may have no garden, but this will rarely apply to those for whom this book has been written. If this is the case, these eco–toilets will at least save water if the alternative is a flush toilet. If the alternative is a deep pit toilet, this new approach will provide an alternative facility which is safe, relatively cheap and pleasant to use. The fact remains that all pit toilets will eventually fill up and must be replaced sooner or later. For those millions who use pit toilets, low cost eco-toilets may provide a good answer for the future. For many, it will be the low cost of the simpler toilet systems described in this book which will have the greatest appeal. For others, it will be the ease of construction and the possibility of self sufficiency which will appeal. For others, the selling point may be that for the first time a toilet can do more than just dispose of excreta.

There is also the possibility that once put to use, the production of humus from the eco- toilet, together with the re-use of urine, may encourage the home owner to consider growing vegetables or enriching flower beds or growing more fruit trees. My own interest in gardening and the organic approach was much encouraged when I started to use an ecological toilet and reused the humus formed and the urine.

In this study I have been constantly amazed by the conversion process - how all these materials which in their prime state could never be classified as soil, easily turn into a product which can only be described as soil. Thus leaves turn into soil, organic wastes from the kitchen turn into soil, vegetable and manure turns into soil and even human excreta turns into soil. Soil is surely the beginning and the end of it all. In this discipline, the answer does indeed lie in the soil.

But even the richest soils need rejuvenation when they have yielded their nutrients up to the growing plants and a method of constantly re-introducing the nutrients derived from urine and humus into the soil is required. Thus compost or processed manure should constantly be introduced into the vegetable garden. Where jars, basins or other containers are used, once the vegetables have been harvested, the used soil can be tipped out into a pile, sieved and introduced into a fresh pile of soil to which fresh compost or eco-humus is added. So there is constant rejuvenation of the soil which is used.

I subscribe to the view held by Louis Bromfield, that there is nothing wrong with carefully combining different techniques in the garden, provided that the soil is enriched, biologically, and plant life is helped to flourish. And careful use of organic and even inorganic plant foods, even those available on the market can also be used carefully in combination with the methods described.

Conclusions

This book attempts to provide practical information which will allow those living in rural, peri-urban and even some urban areas of Africa to build and practice the art of recycling nutrients from their own excreta in order to gain better crops and vegetables in their own back gardens. The work is primarily intended for use in East and Southern Africa, where there is space, where back yard gardening is practiced and where the climate is warm and wet seasons are interspersed with dry.

The basic principles outlined in this book are the most important. These principles can be adapted to suit local conditions in various countries in the sub-region. The method chosen will depend on several factors, not least the amount of money available to build a facility and the willingness of the user to engage in the practice of recycling.

Eco-toilet in an African setting. Ruwa, Zimbabwe

It should be remembered that all these eco-toilet systems require a degree of management which is far more demanding than required by users of the normal deep pit latrine or even the flush toilet. This may not always be clearly understood at first. Thus practical hands-on training and demonstration are vitally important. Often judgements about final design and processing methods may be taken only on-site where soil type, ground stability and drainage have been assessed.

The methods described in this work represent new ventures into the world of low cost sanitation, and there is still much to learn. This work has been written by a researcher, who dabbles at the fringe of understanding. There is an ocean more still to learn. The methods described are intended to add on to the sanitary range of options already available and not compete with them. The pit latrine, currently the commonly used excreta disposal system in the world, has survived over the centuries because, along side its potential deficiencies, it has great merit. It is simple and easily managed. A pit dug 3m deep may take 10 years to fill and thus requires limited management. When full however, the pit is usually difficult to empty and a new toilet must be built. The pit toilet can also be upgraded with a screened vent pipe to make it almost odourless and fly free. In the great majority of cases pit toilets do not seriously pollute ground water, especially if the toilets are well placed in relation to the water source (30m distant). However in high density settlements where pit toilets are built close together and shallow wells provide a source of domestic water, contamination of the water source is possible. This is where shallower pit or urine diversion eco-toilets can play a useful role.

The flush toilet and related waterborne systems have brought with them the possibility of people living together in cities, and of greatly reduced incidents of disease which has made modern life possible. Thus the application of waterborne systems made possible a huge rise in living standards for countless millions of people around the world. And this continues to be the case. All sanitary systems have their place. Both the pit and flush toilet systems will remain as major excreta processing systems for as long as we live. They will be joined by urine diverting systems and variants of both the flush and pit toilets which make recycling possible. There is room for all these systems to be used in the most appropriate setting.

This new ecological approach to sanitation has come just in time to add a new perspective and dimension to sanitation itself. The low cost alternatives described in this work, offer really practical solutions for providing acceptable sanitation on a small budget. Very often it is the simplicity, low cost and ease of construction which may appeal at first to the beneficiary. And upgrading from one system to another is always possible over time. The direct link to agriculture and forestry is also an important element in this new initiative. The additional benefits of recycling the compost and urine to enhance food production and tree growth are clear to see. These various practical benefits may convince the householders to take up the eco-san route.

ONLY TIME WILL TELL!

Peter Morgan
Harare

June 2006.

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