

2. The answer lies in the soil

The theme which is central to this book about ecological sanitation is its link to the soil. Soil with its complex makeup of living organisms and nutrients is essential for the formation of humus. Even the recycling of urine is linked to the soil, for soil bacteria are essential for the conversion of urea and ammonia contained in urine to the nitrate - a salt of nitrogen which can easily be taken up by plants. When a mix of soil and excreta are combined, the organisms in the soil help to break down the excreta to form humus. The excreta in return offers additional nutrients to the soil and also improves the soil's texture. Adding urine increases the nutrient content further. So the living soil is central to the process.

The various toilet systems and recycling methods described in this book have been so designed that the excreta which accumulates is converted into humus in a form which can readily be used by a great variety of plants – whether they be vegetables, cereal crops, flowers or trees. In the case of the *Arborloo*, a shallow pit toilet where a tree is later planted in the composting pit contents, humus formation is encouraged by the regular addition, not only of excreta but also of soil, wood ash and leaves into the pit. Once the pit is almost full, the structure and slab are removed and placed on top of another shallow pit nearby. The used pit is topped up with a generous layer of leaves and more fertile soil and a young tree is planted in this soil, watered and protected. It is planted in the soil – not the excreta – plants do not survive when planted in fresh excreta. If the fates are kind, the young tree grows, at first in the topsoil, whilst the excreta below is being transformed into humus as it would in Nature. In this way the nutrients held within the pit contents are utilised by the growing tree, and when the tree matures, can be recycled to produce fruit (fuel or building materials). Much of the urine is absorbed into the mass of humus or leaves held within the pit, and the excess will be drawn into the surrounding soil and converted into usable nutrients – which the tree can also use later in its life. The *Arborloo* thus travels on a “never ending journey” through the “lands” followed by a series of trees which may eventually form a woodlot or an orchard – or just simply shade or ornamental trees scattered here and there. Sometimes a young tree will hesitate as it starts to grow. A few may die, but most grow strongly right from the start if well cared for.



The *Arborloo* is the simplest ecological toilet. Photo at Eco-Ed Trust.

In the case of the *Fossa alterna*, the second simple eco-toilet described in this book, a similar process takes place in the shallow pit, with soil, wood ash and leaves being added as well as excreta. The difference is that the *Fossa alterna* is built with two permanently sited shallow

pits which are used alternately. Both pits can be housed within a single more permanent structure or a portable structure can be built and moved from one pit to the other at yearly intervals. Once the first pit is nearly full, the structure is moved to the second pit which then begins to fill. The first pit is topped up with a good layer of leaves and topsoil. After one year the contents of the first pit will have changed their form into humus which can then be dug out and used on the garden. The structure is then moved back on to the emptied pit. It moves from one pit to the other once a year, every year – a process which is fully described in this book.



A Fossa alterna in Epworth, Zimbabwe. The twin pit system makes humus

In the case of urine diverting toilets where the urine and faeces are separated, the faeces normally accumulate in one of two vaults beneath the pedestal and the urine collects in an offset plastic container. There are many descriptions of urine diverting toilets in the international literature (see bibliography at the end of this book, notably *Ecological Sanitation* by Esrey et al. 1998 – a revised edition of this book will be available in 2004).

In the example described in this book, the faeces accumulate together with soil and wood ash in a **bucket** held within a small **single vault**. The soil and wood ash are added after every visit made to deposit excreta. This mix of faeces, toilet paper, soil and wood ash is removed within the bucket and deposited into a “**secondary composting site**” where more soil is added. This site can be a container, such as a cement jar or twin shallow pits etc. Here the composting process continues and the mixture changes its form into humus for onward passage to the garden at a later date. The writer has called this system the “*Skyloo*.”

Human faeces readily turn into humus if they are in close contact with a fertile soil – and are kept moist and are well drained and aerated. The aim is to allow the soil to form layers within the accumulation of faeces to effect the change. The mix of faeces, soil, ash and paper, once removed from the toilet in the bucket, and added to the shallow pits, trenches or containers and covered with layers of fertile soil changes quite quickly from a most obnoxious, foul smelling mass into a pleasant humus. This is quite remarkable. It takes place in nature all the time, on the forest or woodland floor, for instance, where the “wastes” produced by animals turn into humus on the rich organic forest floor together with leaf compost formed from the fallen leaves. All the nutrients formed are recycled back into the forest floor and then back into the soil and taken up by the trees again. That is Nature’s way.

The importance of humus

Humus is the dark crumbly material formed from decayed matter formed in Nature from a constant supply of residues from both animal and plant life. These residues are constantly converted in Nature by the organisms present in the soil and also in the residues themselves. Moisture is required during the whole period during which the humus is being formed and also abundant aeration is essential. The presence of leaves will help to improve aeration. Even in Nature, if too much water is present, the aeration of the forming humus is impeded and the process slows down or stops. If too little water is present, the activity of the micro organisms slows down and then may cease altogether if the mass becomes desiccated. Desiccated leaves can remain unchanged for decades or even centuries – but when they are moistened they decompose readily. Rainfall is an excellent method of watering since it is a saturated solution of oxygen. The conversion of the various natural products into humus is a result of activity by beneficial bacteria and fungi and also by a myriad of other micro organisms and small animals and insects. Bacteria are essential to this process. Most bacteria present in Nature are beneficial to life and present no health threat. In fact by far the majority of bacteria are essential to the natural process of breakdown. Without this process of breakdown, followed by re-growth, life on this planet could not exist. The soil is the home of millions of beneficial bacteria.

Humus is essential to soil fertility and adds an important physical condition to the soil, making it more crumbly, more moisture retaining and physically capable of greater oxidation, which is essential for the growth of all living organisms including plants. In ecological sanitation, the best humus is derived by mixing the soil formed from excreta with other humus like soils and leaf compost. Thus excellent humus can be built up, in a series of generations, by adding and mixing. The earth worm, the bacteria, the fungi, and a myriad of other micro-organisms of a benevolent character whose habitat is the soil are important actors in this process. The only way to farm or to manage a successful garden is to maintain the fertility of the land by adding humus – thereby preserving the living content of the soil. That living content of the soil is best maintained by the constant refreshment of further supplies of life in the form of humus. Everything we see in Nature shows the greatest use of every type of “waste.” In fact nothing anywhere in Nature is allowed to go to waste. Recycling is a central theme in Nature. Ecological sanitation also promotes this ideal.

These views, well expressed by Friend Sykes in his book *“Humus and the Farmer”* and other promoters of the humus theory (Howard, 1943 and Balfour, 1943) make a lot of sense (see bibliography). Others promote the use of chemical fertilisers as the best means of obtaining adequate crop yields on the land. The probable truth lies somewhere in between, in striking a balance between using natural and artificial fertilisation (Hopkins (1945)). This wise concept is also discussed by Louis Bromfield in his book *“Malabar Farm”*. In his studies of the land, Bromfield found that chemical fertilisers were of very little use on soils devoid of organic material and of great immediate value upon soils high in organic content. Studies revealed in this book also show that the same holds true for the application of urine to the soil. Urine adds only chemical nutrients to the soil and no living material or humus. Bacteria in the soil are essential for the conversion of the urea present in urine into forms of nitrogen (nitrate) which can easily be absorbed by plants. So the use of urine as a plant food, depends very much on the soil and its living content to be effective. Soil containing humus is far more effective at processing urine than soil deficient in humus, such as very sandy soil. So once again, the soil plays a central role, even in the use of urine.

The capacity of chemicals to burn out crops or to destroy bacteria, earthworms and other living organisms in the soil, Bromfield found, was largely determined by the amount of

organic material present and of the moisture content which accompanies its presence in the soil. Nothing was so effective in trapping and holding rainfall and moisture as organic materials in every stage of decay. Thus it would appear that the value of humus holds true, whether or not artificial fertilisers are added, in whatever form they are used. This must also hold true even where diluted urine is the source of liquid feed. Plants will respond better to urine if the soil is more humus-like and has water-holding properties. Thus the recycling of both solids and the liquids of human excreta must depend on the presence of humus - the living soil.

One major difference between the process taking place in the garden compost heap and that seen in our shallow pit eco-toilets or the production of humus from excreta in bags, buckets and jars, is the relatively larger proportion of “manure” (human faeces) and the smaller proportion of vegetable matter. Vegetable matter in abundance is vital to the “Indore Process” of composting promoted by Sir Albert Howard. With less vegetable matter being present in the humus formed in shallow pits and jars containing human excreta, there is little rise of temperature – as compared to the compost heap where significant rises of temperature occur. The conversion of excreta into humus in this case does not depend on the activity of heat loving (thermophilic) micro-organisms (bacteria and fungi) but rather those bacteria and fungi which thrive at ambient temperature (mesophilic), that is close to the temperature of the surroundings. All manner of other beneficial organisms, including insects, worms, and many other life forms also thrive best at ambient temperatures. Not only do these animalcules and microbes digest the excreta but also inhibit, compete with, consume or otherwise antagonise those pathogenic organisms, such as bacteria that carry disease. The process is an entirely natural one leading to the formation of humus. The addition of fertile soils and leaves to excreta also help to absorb much of the moisture content of the excreta itself – a process which is associated with a reduction of the volume of the mass. The end result of this process is a crumbly, darkened humus, which when mixed with topsoil makes an excellent soil conditioner and nutrient enhancer.

The conversion of raw excreta into humus, in the presence of adequate volumes of soil, leaves and ash, reveals a change of colour, odour and texture of the original faecal matter, which darkens, becomes pleasant to smell and handle and also become more friable. The activity of insects and their larvae may also be important in breaking up the faeces as well as bacteria, fungi and earthworms where they are present. Roots from trees and other plants also invade the highly organic layers in the eco-pits or containers where excreta is converting, and are very visible when the pit is being excavated or the jar is opened. Where plants grow into the organic materials held in pits or containers, their roots also convey oxygen into the body of the material, which greatly assists the decomposition process. In Nature, all living organisms and their products eventually end up in the soil and become part of it, only to be recycled again and again within a never ending process of building up and breaking down.

The top-soils of many parts of Southern Africa are worn out and almost devoid of humus or nutrients. In Zimbabwe 70% of rural farmers work on a soil which is labelled as poor or very poor, and unable to sustain a good crop without the use of manure or fertiliser. Nitrogen is being lost at a greater rate than it is supplied. Even when nitrogen is applied, heavy rain can leach out the nitrogen and drive it down to deeper layers where it is not available to plants. Most naturally occurring soils where people live are not only deficient in nitrogen but also in phosphorus and potassium and also many trace elements. Nitrogen, phosphorus and zinc, amongst other minerals are seen as limiting to meaningful agriculture in 70% of samples collected around Zimbabwe. Most soils are sandy and have a low pH. Few soils in the rural and even peri-urban and urban areas can sustain any form of healthy crop production without meaningful inputs of both humus and nutrients. These issues are discussed in

“Ecoagriculture: Initiatives in Eastern and Southern Africa”, edited by Devlin and Zettel, 1999 (see bibliography).

Since the soils of Africa are so depleted in nutrients there is an overwhelming case for using all methods available to restore both nutrients and fertility. The use of animal manure is widely used in those areas where cattle are kept and this technique forms part of a longstanding traditional practice. But huge numbers of people, particularly those living in the peri-urban fringes do not own cattle. In a world where commercial fertilisers are becoming increasingly unaffordable, there is an even greater need to harness any other form of humus or nutrient suitable for crop growth. It is in this context that processed human excreta must be considered. Whilst the volume of excreta produced by a family is not large, it is certainly enough, once processed, to contribute significantly to the fertility of a family vegetable garden and that should be the initial aim. This means taking full advantage of whatever humus can be processed, including leaf and garden compost and also urine and combining their best properties to increase the food crop.

The successful use of the specialised toilets used in eco-san depends to a large extent on the users’ understanding of the processes involved, and the potential benefits to be gained. Compared to pit latrines, which can provide an almost maintenance free service for a decade, ecological toilets require more attention and the advantages may not be immediately obvious.

A tree planted in an *Arborloo* pit may take a few years to bear fruit. Two years are required before the first humus can be dug out and used from the *Fossa alterna* pit. Thus sound educational programmes and novel forms of demonstration must therefore precede programmes of construction – with ample evidence of the benefits to be gained. Most people simply do not believe that excreta can turn into “soil.” And this “soil” together with their own urine can save them money that would otherwise have been spent on buying fertiliser. One needs evidence to believe and that means individuals seeing the proof with their own eyes. **Seeing is believing!**



Group of eco-san trainees at Kufunda Village, Ruwa, Zimbabwe, planting a mulberry tree on an *Arborloo* pit (mid 2002). The same mulberry tree (on the right) has grown. Banana trees too. The *Arborloo* is in the background. Photo taken early 2004.