Teaching Ecological Sanitation in Schools

A compilation of manuals and fact sheets
(March 2010 edition)

Peter Morgan and Annie Shangwa

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AUTHORS NOTES – March 2010

These manuals were originally written as chapters for a book which is still being researched and compiled. In order to make the valuable information available for others to use and adapt, the chapters have been converted into manuals which can be used separately if required.

The technologies so far described do not represent the full range of options available and additional toilets designs and plant trials will be added as time proceeds.

This range of toilet options is designed to suit conditions currently suitable for Zimbabwe. Where toilet designs are taught in other countries, clearly they must also suit local conditions.

An ideal range to start may include simple toilets which most suit conditions at the school and also surrounding homesteads. Also simple methods of making hand washing devices should be taught together with simple garden experiments which best demonstrate the effectiveness of compost and urine as plant food.

ACKNOWLEDGEMENTS

Support for this schools work has been generously given by Mr John Mutisi (Headmaster) and Mrs Hove (Headmistress) and supporting teachers of the Chisungu Primary School, Epworth, Zimbabwe, particularly Mr Maduma and Mr Kano. The enthusiasm and skills of the pupils have also helped enormously to make this work a success. In particular the very special talents and enthusiasm of Dhiriza Moreblessing are much appreciated. We also thank Madeleine Fogde, Arno Rosemarin, and supporting staff of the EcoSanRes Project at the Stockholm Environment Institute, Sweden for their encouragement and support. We also offer thanks to Sida for their support which has made this work possible.

Peter Morgan and Annie Shangwa
Harare, March 2010

An Introduction

Education of young people is an integral part the development of all nations around the world and literacy and knowledge levels are ever on the increase. It is very clear that the school environment offers the best possible platform to become the centre of all learning and information dissemination for a wide range of disciplines, including health, hygiene and sanitation.

Firstly, the school provides a great audience platform in the sense that most families of a community are represented and the information is provided in a formalised way. The infrastructure is also quiet appropriate with chalk boards, class rooms and school gardens which are always available. In addition the pupils are always in a mode of learning and motivated. Teachers too are amongst the most motivated of all professionals. Co-operation and discipline makes the learning and dissemination process quiet efficient and effective for it provides a two way communication which enables feedback and evaluation.

The school thus offers the best possible environment for teaching pupils about sanitation in all its aspects. Toilets are needed in all schools and homes. But the practical knowledge about how to build toilets and how they work may be little known. In the world of developing Africa such a practical knowledge is all important. The new sanitation which brings with it a more ecological approach offers even greater benefits than providing just toilets alone. The possibility of using compost made from toilets and using urine to grow greater quantities of vegetables and maize and also grow a variety of trees has huge practical application within the school itself. The methods taught within the school can be replicated in surrounding communities.

We have found that children take great pride in showing their ability to build simple yet effective toilets. The pupils also take great pride in being able to show and practice how they can grow vegetables and maize in greater quantities. These personal achievements make their parents proud and involved. This pride of achievement is important to all of us. But its importance has no greater impact than in the development of the child itself.

The work which is described in this book is still being undertaken. It is not finished and there is still much to do. But the amount of information we have built up is large and useful. All these things are important in our lives and can improve the way we live. We wish to pass on what we have learned and have arranged the material in a series of manuals and fact sheets. These are preceded by a few chapters which introduce the subject. We wish to share our rich experience with others.

Above all it's the passion and love to learn you see in the pupils, which speaks lots about our hopes for the future.

Annie Shangwa
Harare
March 2010

Schools eco-sanitation in a wider context.

The ecological sanitation programme for schools described in these manuals and fact sheets reveals the early findings of a pilot study – which hopefully will lead to greater things in the future. It certainly has all the ingredients of an exciting and positive future.

Whilst this work describes how children can build toilets and how they can learn to recycle human excreta to make more food that forms just a small part of the whole story. What is important is that strong links are made between the sanitation component and many other areas of practical development and ecology.

We see direct links being made to the world of agriculture, where the use of toilet compost can enhance the quality of the soil and where the use of urine can produce spectacular increases in the yield of valuable vegetable crops and maize. These methods can be used with similar effect, not only in the school but also in homesteads in rural, peri-urban and even urban environments. The evidence for this is clear to see. The great challenge is to pass on that message so that people can understand and use the valuable technique in their own back yards. Such messages become ever more important as food becomes short and top soils deteriorate in their quality,

We can also see direct links to the tree – nature's provider of fruit, vitamins, fuel, building material, medicine, shade and beauty. The range of trees that can grow on toilet compost is endless. Exotic and indigenous alike, it will almost certainly grow and grow well if cared for. And trees have a very positive effect on our climate and environment.

Once a programme has started, planting trees of all sorts can only have a positive effect. Gum trees, bamboo, or even reeds on compost pits, will provide the timber for future toilets. As a supplier of vitamins, fruit trees can provide in abundance and once well established need little care. Think of all the mangoes that just keep providing fruit year after year. And the paw paw, mulberry, banana, guava, avocado and all the others. Then the special trees like *Moringa, Neem and Leucaena*. Nothing quite like sitting under a shade tree to see nature in all its glory. And trees help the environment and our world climate – they help to reduce erosion and desertification. Trees are indeed a treasure of Nature. They are part of our future on this precious planet of ours.

Improving diets, even in small ways like providing more vegetables and crops like tomato, pepper, onion, garlic, covo and rape together with the fruits and herbs can help people fight off infections and disease. And in this world, that's important.

Then there is the important concept of recycling, whether it be human excreta, bottles, tins or even old car tyres and sacks. The use of articles which may have been put in the garbage bin before and discarded are now being put to good use. That is an important concept. In this new world we need to recycle.

Then there is the benefit of sanitation itself –of providing a safe and effective way of isolating excreta from the open environment and containing it in such a way that the environment is protected. And as a special bonus, to turn that "waste" into something valuable and useful in the real world. In this programme, the pupils at the school have built the toilets themselves, no mean achievement and something which has developed with it a great pride in those that participated.

This programme also touches on the important subject of providing sanitation for the "girl child" at the school, where personal problems are encountered and where specialised toilets, which are private and convenient for use are urgently required.

And the benefits of personal hygiene form an important part of this story. Where the children are able and proud to make and use their own hand washing devices and show others how to make and use them in the home. That counts for much. A hand washing device made from a discarded can with three holes punched in it and fitted with a wire handle when used properly can offer immense improvements in personal hygiene. This simplest of devices can provide far reaching and most beneficial effects on health.

The concept of economy of effort and of cost is also embraced here. The imported costs of cement, for instance are low. Locally available materials and methods are used if possible to increase the indigenous ingredient and rely less on imported items. If things are relatively easy and low in cost, they save the pocket money. If there is a good return for the small investment made, then a good deal has been made.

In this programme some of the concrete toilet slabs are small yet equally effective. In one version, the children's toilet, used in the homestead, as many as ten can be made from a single 50kg bag of Portland cement. That is less than a US dollar per slab in cement. Young children can learn how to use a toilet and this can help to clean up the environment of the homestead. Such toilets can later be planted with trees or provide toilet compost. If the return is more fruit or vegetable, then that's a good deal! If Millennium Development Goals are ever to be reached in the rural areas, only low cost and effective methods can work in practice. When toilets become affordable and eagerly sought by families then we have achieved the goal of sustainability.

And there is the element of science thrown into the programme too! Special techniques are acquired and scientific principles learned. The role of different nutrients in the growth of plants and how one type of nitrogen needs to be converted into another before it can be used by plants. Vegetables and maize are weighed and measured and recorded. That is science! All these methods can later be absorbed into future curricular.

Also special skills are being taught – not least how to make and cure concrete, how to build in bricks and mortar, how to shape wood, how to use bottles, tins and plastic buckets to make useful things. These skills will always be valuable for every pupil or teacher who has been in contact with this programme.

But there is far more than that. The important roles of the “girl child” and women of all ages in this sector is vital and this programme reveals this very clearly. This programme has been based on a passing on important messages and skills from a young and talented educator to young people and their teachers who will play important roles in the future. As other studies in this area of development have revealed, the role of women in Africa is not only important but essential. This type of programme empowers women and highlights how important they are in the development of the continent as a whole.

New ideas and concepts are being learned all the time, and this project has given birth to new thoughts and developments. The school offers the best learning centre of all. What better place to form most important links between sanitation, health, hygiene, water, agriculture, the world of trees, ecology and a better Earth on which we are all privileged to live. All our lives can be improved by learning and the practical application of this knowledge. Let us see where this important project will take us!

Peter Morgan
Harare,
March 2010

Basic principles of ecological toilets

Most of the toilets described in this book can turn human excreta into compost which can either be used in the vegetable garden or can be tapped by trees growing nearby. Most are shallow pit toilets. The regular addition of soil, ash and leaves to excreta in a shallow pit helps the composting process considerably and also reduces smells and flies. The more soil and ash are added to the pit, the greater the rate of composting and greater the control of flies and odours.

The single pit composting toilet (*Arborloo*)

In this concept the pit is shallow (1m deep) and the toilet site temporary. A ring beam of bricks or concrete is made and the pit dug down inside this. A concrete slab is mounted on the ring beam and a movable or portable "house" is built around the slab or ring beam. Soil and ash are added to the pit daily and ideally after every visit to defecate. Once the pit is nearly full, the toilet (ring beam, slab and structure) are moved to a new site nearby. This movement takes place at between 6 and 12 months intervals or even longer depending on the family and pit size. The used pit is topped up with a layer of top soil about 15cm deep and left to compost. A young tree is then planted in the topsoil. Trees are best planted at the onset of the rains, but if water is available the tree can be planted in the topsoil immediately. It should be protected against goats and other animals. If a tree or vegetables are not planted, the contents of the compost pit can be dug out after 12 months and the pit used again for a toilet.

It is possible to alternate between two permanently sited pits in a toilet known as the *Fossa alterna*. It works the same as the *Arborloo*, in that soil and ash are added regularly and the pit contents turn into compost and can be dug out later. That is an alternative to planting a tree. In some programmes people start with the *Arborloo* principle and then turn towards using the compost from their pits on the garden. Pit compost is easier to dig out than soil from a new pit.

The best of both worlds

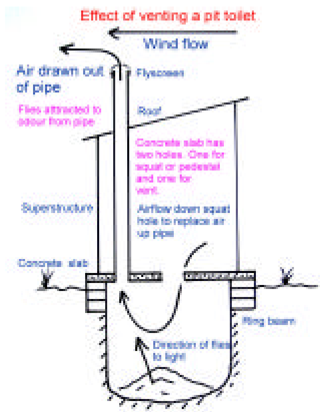
In another method for use with shallow pit toilets, a young tree is planted close to the *Arborloo* at the same time as the toilet is built. The main pit is dug down to the required depth (0.8m – 1.0m) within the ring beam. The slab and house are built and the toilet put to use. But at the same time a second pit is dug or drilled near to the toilet – about half a metre away. This pit is dug down and filled with a mix of soil and compost. A young tree is planted immediately in this “tree pit” next to the *Arborloo* pit. As the tree roots grow and penetrate the soil deeper they will search for and find the richer compost in the toilet pit and start to feed on the nutrients provided. The growth of the tree will be accelerated.

Once the pit has been filled, the parts of the toilet can be moved elsewhere and a new pit dug. The original pit is topped up with soil. Now food crops like tomato, pumpkin or squash etc can be planted in the soil over the pit. Growth can be accelerated by the addition of diluted urine (3:1 with additional watering) once the plants are established. Adding more ash (potash) helps many plants like tomato. The fertile pit can form an “organic plug” which can provide nutrients for both trees and crops. Extra food can be dug in to the soil over the pit in the form of compost or animal manure as well as urine. You see – we get the best of both worlds!


Mulberry trees planted next to toilet pits.

Ventilated improved pit toilets which compost excreta

The VIP toilet uses a screened ventilation pipe and a structure with a semi-dark interior to control both flies and odours. The concrete slab has two holes made in it, one for the vent pipe and one for the squat or pedestal hole. As soon as the pipe is fitted air will start to move up the pipe and this escaping air draws fresh air down the squat or pedestal hole. So the toilet smells much less. The air flow is caused by air flowing across the top of the pipe. The pipe, if fitted with a fly screen also acts like a fly trap and this reduced the fly problem.



Pits of intermediate depth

Pit composting can also be made to work in pits of intermediate depth – say 2 metres if the pit contents are a mix of ingredients (excreta, soil, ash and leaves). The pits of this depth should be lined with bricks. Using a brick laying technique known as "corbelling" (see later) it is possible to construct a brick lined pit with a wider diameter but reduced in depth compared to a normal deep pit. If a pit of this type is used in an ecological way (ie no garbage, little water and plenty of ash, soil and leaves) it becomes easier to excavate than a normal pit toilet. Since the pit is lined, a house made of brisk can be built on top. Remarkably, brick superstructures can be dismantled and rebuilt if the bricks are of moderately high quality and the cement mortar used to bond them together is weak. Also by planting trees with soft wood, like paw paw, in the filled pit (planted in a layer of soil), the tree itself can be removed later when the time for pit excavation comes. The roots will have taken up nutrients and the paw paw provided fruit. But after a few years the tree can be dug out. This would not be possible with trees which establish themselves more permanently. The pit compost can then be dug out to gain access to the original pit and the compost used on the garden. Thus toilets can become a long lasting asset and not just a useful facility with a limited life span.

In fact the various parts of the toilet can be made in such a way that they are also recyclable. Using weak cement mortar in brickwork, fired brick walls can remain stable, but can be taken apart easily. The bricks can be cleaned and used again. Roofs, vents, slabs, pedestals etc can be taken away and reassembled to make new toilets. So every part of the toilet structure above ground can be recycled. If the pit contents turn into compost, then even that part can be used again.

Urine diverting toilets

The urine diverting toilet uses a special pedestal or squat plate which separates the urine from the faeces. The urine is fed through a pipe to a plastic container to direct to a tree like a banana. The faeces fall into either a pit below ground or into a vault or even a plastic bucket or sack held in a brick vault above ground. Soil and ash are added to the pit, vault or bucket/sack after every deposit is made. The solids can be removed from time to time and mixed with more soil to compost. This material can be added to shallow pits or into compost heaps. Many urine diverting toilets use two vaults where the faeces are drying out in one whilst the other is filling up. Most urine diverting toilets are built above ground level and therefore are useful if the ground water is high or if the ground is rocky.

An introductory lecture

What is ecological sanitation?

Ecological sanitation can be defined as a system (usually a toilet) which makes use of human “waste” (faeces and urine) and turns it into something useful and valuable, with minimum pollution of the environment. It consists of using toilets which are safe and designed in such a way that the end products can be easily used in agriculture and forestry. Thus the worlds of sanitation and agriculture become partners. In ecological sanitation the so called waste products (both faeces and urine) are not thought of as a waste, but rather as a valuable resource. Human excreta can turn into valuable compost for instance and urine is rich in nitrogen which many plants can benefit from greatly. Urine treatment on green vegetables can increase the yield by many times. Because excreta (faeces) contain bacteria and other organisms that can cause disease, some care is required in the design and use of the toilets. And also some care is required in the methods of transferring the products into agriculture. The aim is to improve the health of the users and also provide simple systems where the products can be used with great benefit for growing fruit, trees and vegetables. Faeces when mixed with soil and completely decomposed come to look like and smell like humus, a pleasant soil which plants like to grow in.

Thus ecological sanitation involves at least three basic parts.

1. The toilets themselves which are ecologically sound and make the collection of the products (compost and urine) possible.
2. A good method of transferring the products (compost and urine) into agriculture in an easy and hygienic way.
3. Methods which best allow the compost and urine to be absorbed by the plants in a safe and effective way that leads to increased yields of the trees, vegetables and other food products.

Initial approaches with the school

After an agreement has been made at the school with the headmaster and staff to introduce the extra curricular training course in ecological sanitation, plans are drawn up to start off the course with an introductory lecture. This is followed by practical toilet demonstrations and building and garden experiments. Selected pupils are chosen from the upper classes of the Primary school (grades 6 and 7). Those pupils in the top class will move on to a secondary school, so there is some continuity in choosing pupils from at least two senior classes. In this early pilot course 16 pupils were chosen from two classes.

The introductory lecture

An introductory lecture was given by Mrs Annie Shangwa using the **flip chart** and **models** (attached to this chapter) and other teaching aids. Various methods of making simple hand washing devices were also taught during the introductory lecture to add practical interest. These methods and many others, including gardens trials and classroom experiments are also described in this book.

Introducing the concept of ecological sanitation and eco-toilets to the pupils

The Ecological Sanitation FLIP CHART

"Eco-san" in brief – an introduction

How to build simple toilets and use the toilet compost and urine formed to grow healthy vegetables and trees

Peter Morgan and Annie Shangwa

How we can benefit from ecological sanitation

1. We get a family toilet!

2. The toilets are simple and relatively cheap

3. The simple "eco-toilets" are almost fly and odour free

4. The parts of the toilet can last for many years

5. It is possible to upgrade and improved the simple toilet over time

6. Valuable products come from the toilets such as toilet compost and urine

7. Toilet compost is rich in nutrients and can enrich poor soils

8. Urine is very rich in nutrients especially nitrogen and can be mixed with water to make a good plant food

Types of toilets used in Eco-san

1. Arborloo

The toilet that becomes a tree

2. Fossa alterna

The toilet that makes compost

3. The ecological Blair VIP toilet

The Blair toilet that makes compost

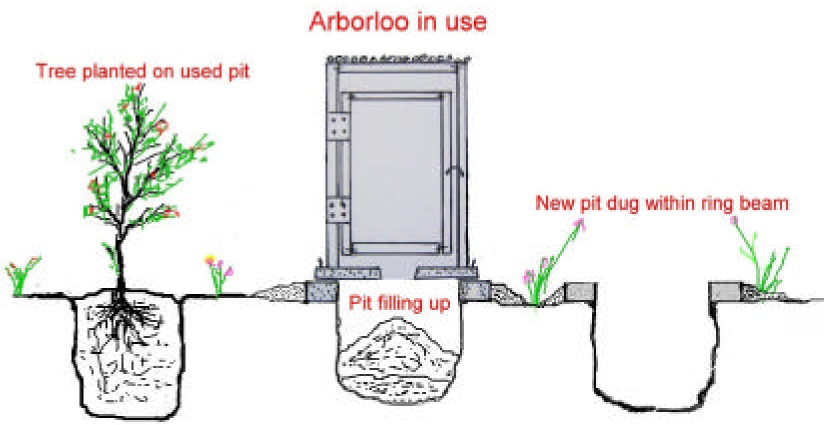
4. Urine diversion toilets

These separate urine and faeces

The simplest and cheapest are the Arborloo and the Fossa alterna. Both can be made into Blair VIP toilets by upgrading.

The Arborloo

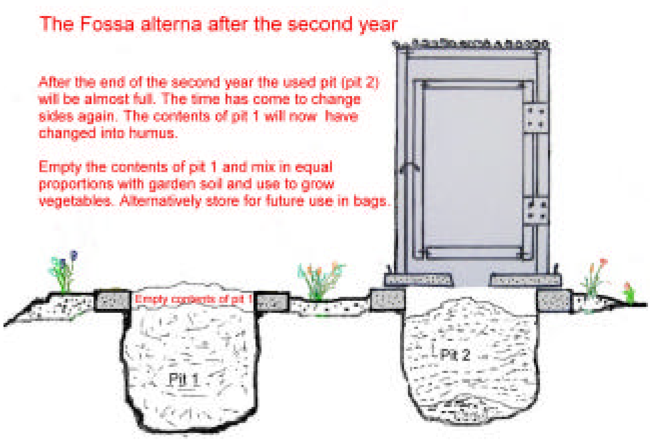
This toilet moves from one shallow pit to the next on a never ending journey. A young tree is planted in each shallow pit filled up and topped up with soil



**** The pit is shallow – about one metre deep***
**** Soil and ash are added to the pit with the excreta. This helps to make compost and helps to control flies and odours***
**** Once the toilet is nearly full move the parts of the toilet (structure, ring beam and slab) too the next site.***
**** Cover the pit contents with a thick layer of good soil and plant a tree***

The Fossa alterna

This uses two shallow pits which can be protected with "ring beams" or lined with bricks. The toilet slab and "house" alternate between one pit and the other at yearly intervals. Only one pit is used at one time. The toilet house is designed so it can be moved easily.



****Dig and protect two pits at time of construction. Pit 1 is dug about 1.2m deep. Pit 2 is dug shallow***
**** As the pit is used add soil, wood ash and leaves.***
**** do not add rubbish into the pit***
**** Once Pit 1 is nearly full, dig down the second pit to 1.2m deep and move the toilet slab and house to the empty pit.***
**** Cover the contents of Pit 1 with soil and leave to compost for one year.***

Use of the toilet compost

The compost from the Fossa alterna can be dug out after a year. There are several ways of using it.

1. Dig and new pit for a tree ("tree pit") and move toilet compost into this pit and plant a tree.

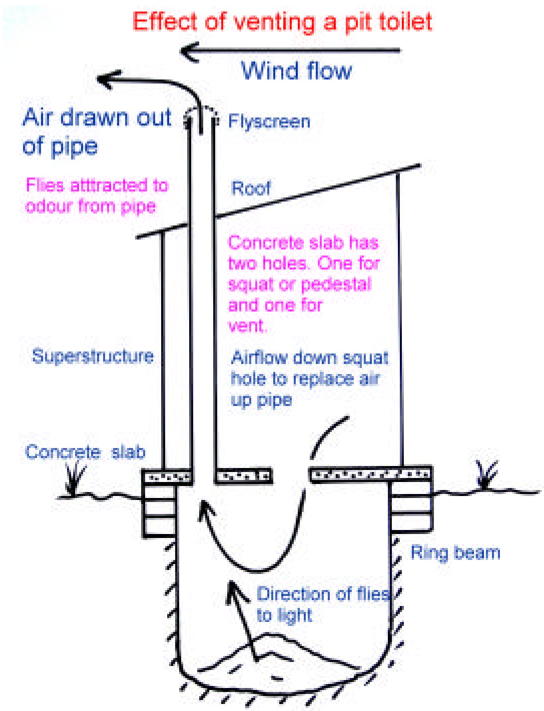
2. Mix the toilet compost with equal volume of poor soil in a container and plant vegetables

3. Mix the toilet compost with the topsoil of vegetable and flower beds

4. Place the toilet compost in sacks ready for use. It can be dug into maize plantations during the rainy season.

The Ecological Blair VIP Toilet

A Blair VIP (Ventilated improved pit) toilet is a pit toilet fitted with a ventilation pipe. The pipe is fitted with a fly - screen to trap flies. This is how it works. Ecological VIP toilets have pits 2m deep and a tree is planted close by.



Both the Arborloo and Fossa alterna can be upgraded to a Blair VIP.

What is important for the Blair VIP

1. The toilet house should have a roof and the inside should not be too light. If a door is fitted it should be self closing. Or a spiral (door-less) structure should be used.

2. A vent pipe should be used and fitted into a hole in the toilet slab. There are several ways of making low cost vent pipes.

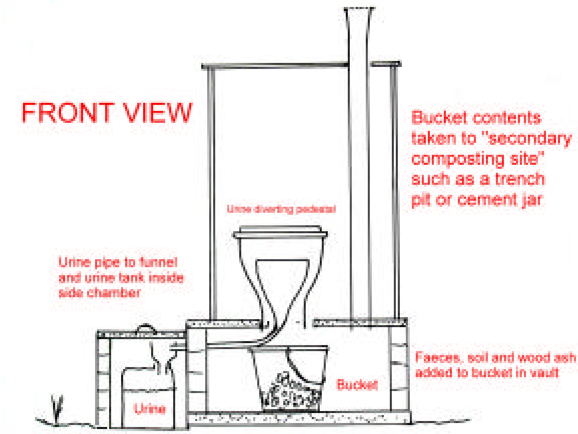
3. The vent pipe should have a screen to trap flies. This is best made of aluminium which does not corrode.

4. The ecological Blair VIP toilet can be used in the same way as the Arborloo and Fossa alterna.

5. If a long life is required the pit can be made much larger and lined with bricks. Then a brick house can be fitted. There are economical ways of lining pits with bricks and fitting the same concrete slab as used on the Arborloo.

Urine diversion toilets

These are special toilets where the urine and faeces are separated from each other. The faeces fall into a bucket or vault together with soil and ash which are added. The urine is led off through a pipe into a plastic container.



The container of feaces and soil and ash is removed when full and placed in a composter with more soil. It turns into good compost.

Urine which contains a lot of nitrogen can also be collected in plastic bottles or "eco-lilies" a plastic container with a funnel at the top. The boys can pass urine into the funnel (Lily) and the urine is collected in that way.

How to use urine as plant food

There are several ways of using urine to make plants grow faster and larger. Normally the urine is diluted 3 parts of water to 1 part urine for use on vegetables. Ways of using urine:

****Add diluted urine to young green vegetables planted in buckets, basins, ring beam gardens or vegetables gardens.***

****For a 10 litre bucket add about 400mls urine + 1200mls water once or twice a week. Also water at other times.***

**** For a ring beam garden add about one litre urine with 3 litres of water once or twice a week. Water at other times.***

**** For maize add diluted or neat urine to each plant in hole nearby. About 100mls urine per plant per week during the growing season.***

Parts of the ecological toilet

Simple eco-toilets can be made with a few basic parts:

1. The concrete slab made from cement, river sand and wire.
2. The "ring beam" made from cement, river sand and wire
3. The "toilet house" made from many materials. Simple structures made from poles and grass or reeds can be very neat.
4. Vent pipe for the Blair VIP toilet. There are several ways of making these pipes.
5. Pedestal for sitting can be made for more comfort.
6. Brick lining of pit. For large pits which last for many years the pits are best lined with bricks. A method known as "corbelling" where a wide pit can be fitted with a small slab is a useful technique.
7. Hand washing devices. These are essential parts of any toilet. Improvement of personal hygiene is very important for health.

Making the parts of the eco-toilet

1. The concrete slab

The amount of cement used depends on the size of the slab For a larger slab 1.1m in diameter 10 litres of cement (Portland) is mixed with 50 litres of river sand. This is added to a round mould made of bricks 1.1metres in diameter. Holes are made for the squat hole and ventilation pipe hole. Half the mix is added first, then some reinforcing wires (3mm thick) is added. Then the remainder of the concrete is added, smoothed off and left to cure and get strong by keeping wet for 7 days. Smaller slabs use less cement.

2. The Ring beam

This is a ring of concrete which is used to protect the shallow pit and raise the slab above ground level. Two circles of bricks are made for the mould. For the larger 1.1m diameter slab, the inside diameter is 1 metre and the outside diameter 1.3metres. The concrete is made by mixing 10 litres of cement with 50 litres of river sand. Half of this is added to the mould first and levelled off. A circle of wire is placed on the cement and the rest of the concrete is added and levelled off. This is left to cure for 7 days. Smaller slabs use smaller ring beams and use less cement.

3. The "toilet house"

There are many ways of making a toilet house from many materials. The simplest are made from poles, reeds and grass. These structures can be improved over time.

4. The “pedestal”

Pedestals are useful for elderly people and also for those who are used to sitting when they go to a toilet. Simple pedestals can be made using cement and a plastic bucket. They make going to the toilet more comfortable. Pedestals can be made in several ways. Some pedestals can separate the urine from the faeces.

5. The “hand washing device”

The washing of hands is so important and essential if we are to be healthy A hand washing device should be fitted to every toilet and also in the kitchen. There are many ways of making a hand washing device from bottles, tins and cups.

6. The “vent pipe”

If a vent pipe is fitted to a toilet (like the Blair VIP toilet) it can carry away smells and make the toilet more pleasant to use. With a little bit of training it is possible to make a good vent pipe in the home using simple materials and some cement and sand.

7. Container of soil and ash

All these eco-toilets need soil and ash added to the pit. It is best to dry out soil taken out from the pit and mix it with wood ash and keep in a dry place in a sack. Then it can be placed inside the toilet in a bucket or container together with a small cup which can be used to put some of the soil and ash down into the pit after the toilet has been used.

Conclusions

During this course we will learn how to make simple compost making toilets (eco-toilets).

These include the Arborloo, the Fossa alterna and the ecological Blair VIP toilet.

We will learn how to make concrete ring beams, concrete toilet slabs, simple "toilet houses," hand washing devices, simple vent pipes, and simple pedestal seats.

We will also learn how to use "toilet" compost and urine to increase the growth of vegetables in our gardens.

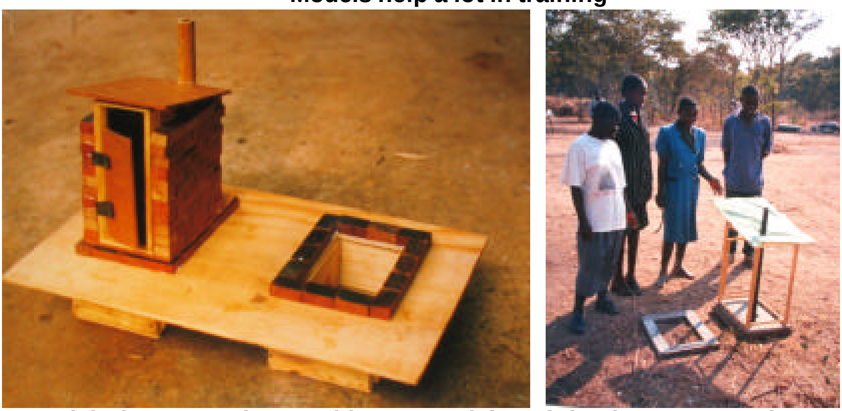
We will also learn how to plant and raise important trees in our gardens using toilet compost.

All these things are important in our lives and can improve the way we live.

Training methods – using models

Many of the ideas relating to ecological sanitation (and many other things) can best be explained by the use of models – small replicas of the real thing. By using models one can explain the sequence of building and upgrading easily and repeat it time and time again and not necessarily at the site where the real live technology is being put to use. This section explains the sequence of upgrading the sanitation technology using a series of models.

Models help a lot in training



A model of a *Fossa alterna* with square slab and ring beam – 2 versions!

The challenge is to explain the sequence of upgrading in a simple and understandable way using visual stimuli and where people can touch and experiment with the models. The models shown in these photos are made of high strength concrete (usually a mix of one part PC 15 cement and 2 parts clean river sand), wooden bricks, wood, grass and wire.

The basic elements – slab and ring beam and house.

The slab and ring beam are cast in high strength concrete as miniature replicas of the full size components

Slab and 1 ring beam, slab and 2 ring beams. These are the basic elements of the series together with a suitable superstructure (toilet house) and vent pipe.

House without vent and with a vent. When a vent is fitted without a roof, flyscreen and semo darkened structure, odours will be removed but there will be no fly control. Many types of model superstructure can be made.

Sequence describing the *Arborloo*

The ring beam is placed on the ground and a hole dug inside it. The slab is mounted on top on a bed of termite mortar or weak cement mortar to make a seal and cope with any uneven surfaces. A suitable structure is placed on top. Ideally this should have a roof. Small leaves are then added to the base of the pit. A mix of excreta (eg pellets) is added followed by some soil and ash and some leaves occasionally. The pit is filled up in this way (quickly). When nearly full the structure, slab and ring beam are removed. The ring beam is moved to another site. The near full pit is filled up with soil, a hollow made and a tree planted (this is a miniature tree).

The ring beam has been caste on ground allowed to cure and a hole dug down inside. The slab has been fitted.

The simple structure is now fitted and the *Arborloo* put to use


The hole has been nearly filled and topped up with soil. a young tree is prepared.

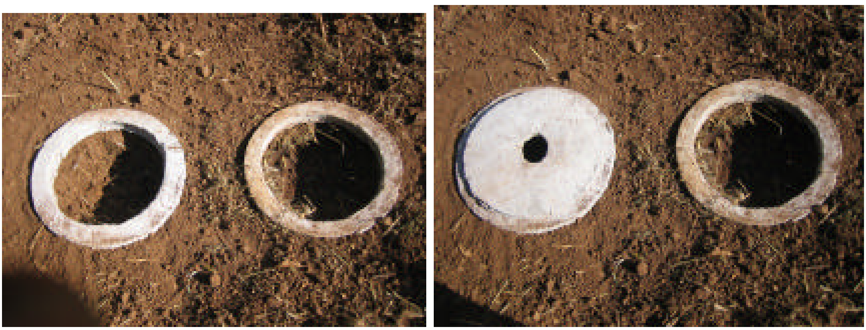

The tree is watered and protected. The ring beam is moved to a new position.


The hole is dug down, leaves added and the slab added. The structure is fitted and the *Arborloo* put to use.

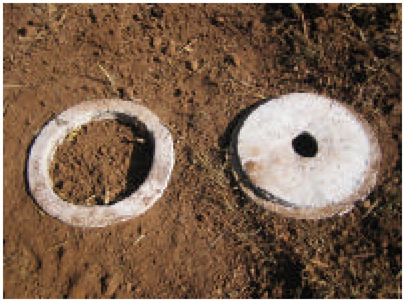
Sequence describing the *Fossa alterna*

Here the same applies with 2 ring beams and one slab. The first sequence should show using unlined pits with ring beams. This is effective in many cases where the soil is moderately firm. Later also a model showing the brick lined pit with corbelled upper brickwork should be shown. Also the method of alternating between two pits of the same size and two pits of different sizes. One of these may be brick lined and the second unlined (The Earth and Moon Principle).

In this case model structures can be shown with and without a roof and pipe. In all cases a roof is preferred and a vent pipe helps to reduce odours. In all ecological toilets the generous addition of both soil and ash helps to reduce odours and encourages composting in the pit. Adding leaves improved the quality of the compost. A combination of adding soil, ash and leaves and using a vent is best.



Two ring beams used in the *Fossa alterna.* Caste ring beams in place and when hard dig inside both down to 1.2 to 1.5m. Add a sack of leaves to the pit which be used. Fit the slab on one ring beam and cover the second for safety. The second can be filled with leaves and soil to make compost.

Add structure to the slab and use the toilet, filling the first pit with a mix of excreta, soil ash and leaves. When the first pit is nearly full (after 12 months) remove the structure and move the slab to the second pit (after removing any compost). Fill up the first pit with soil.

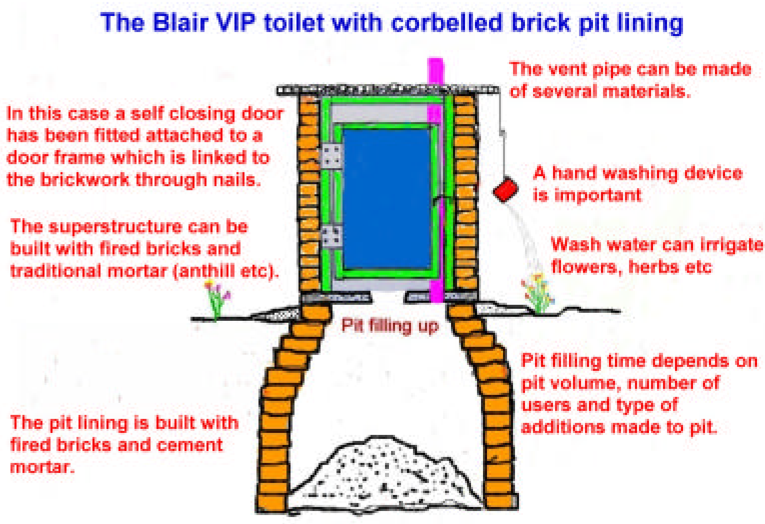
Fit the portable structure back on the slab and use the second pit, adding excreta, soil, ash and leaves. When the second pit is nearly full dig out the compost from the first pit and move the slab and structure back on to the first pit. Repeat this process once a year. The model shows the process clearly. The pit compost can be bagged for storage or used in gardens.

Upgrading to lined pit

These models show how the pit can be lined with bricks and the brickwork **corbelled** at the top to reduce the pit diameter. This allows the same ring beam and slab (1.1m) to be fitted on the top. This technique can be used with the *Fossa alterna* technique (using two lined pits) or with the Blair VIP. Pit capacity can be increased significantly by using this technique.

The model was made in this case with wooden bricks bonded together the cement mortar on a firm base. A miniature concrete ring beam was placed on top of the brickwork as it would be at real size. The miniature concrete slab (with vent hole) was then fitted on the ring beam.

The superstructure if then fitted to over the slab on the ring beam. The wooden door has self closing rubber hinges. The vent pipe (made of plastic pipe) is then fitted together with a miniature roof made of cardboard and reeds. This technique can be used with a single deeper pit (2m – 3m deep) to make a Blair VIP or with 2 shallower pits 1.5+m to make an alternating shallow pit system like the *Fossa alterna*.



The single pit VIP system

Making a urine diverting toilet with the same building blocks

In this case two ring beams are used. One is mounted in the ground and a brick wall of 3 courses (on edge) are built up on the ring beam and the second ring beam mounted on top. A gap in the brickwork is left for the vault access panel. The slab is fitted with a squat or pedestal hole enlarged to suit the type of urine device fitted. A miniature urine diverting pedestal or squat plate can also be made as shown below. A structure is fitted on top, with or without a vent pipe. A bucket or bag can be placed in the vault for collection of solids.


The low brick vault wall has been built on a ring beam. A second ring beam has been fitted on the brickwork and vault access door added.


The slab has been added and hole enlarged to suit the urine diverting device used. A miniature urine diverting pedestal is shown.


Photo showing interior of the model after the roof and pipe have been fitted. The rear of the model showing structure and vault access panel.

Models are excellent tools for showing how toilets and other struc ture are built. They can also be used to show how ecological and other toilets can be used and maintained. Once made well and solidly they can be used many times over to train many people.

Demonstration of venting in VIP toilet

Models can also be used to show how the VIP pipe works. A slab with a vent hole and squat hole is placed over the brick lining model and the interface between the slab and the ring beam sealed with sand or soil. Some grass or dried leaves are placed down the squat hole and followed by some small pieces of newspaper lit with a match. Soon smoke will appear at the head of the pipe and not from the squat hole. It is a memorable demonstration and helps to show how the VIP toilet works.

This remarkable demonstrations shows how the vent of a VIP toilet works. A small smoky fire is lit in the miniature pit structure. The pipe draws up air and fresh air passes down the squat hole.

Teaching Ecological Sanitation in Schools

How to build an Arborloo with a spiral superstructure which can be upgraded to a VIP toilet

Peter Morgan and Annie Shangwa

How to build an *Arborloo* which can be upgraded to a VIP toilet.

In this chapter we describe how to make an *Arborloo* which has both vent and squat hole. Thus it can be upgraded later to a VIP toilet. The pit is shallow, about one metre deep and fills up with a mix of excreta, soil and ash. Leaves can also be added. These help composting in the pit and also reduce flies and smells. The simplest *Arborloo's* which cannot be upgraded with vent pipe were described in the last chapter. These are easier to make, but it is essential that soil and ash are added regularly to the pit to reduce odours and smells. If the slab is made with a vent hole as well as a squat hole, the option is open to fit a vent pipe later which will control odours. The *Arborloo* made up of 4 parts

1. The pit
2. The "ring beam" to protect the pit
3. The concrete slab which sits on the ring beam
4. The toilet house which provides privacy.

Locating the site for construction

A suitable site must be found for the toilet which is convenient for use and the ground should be levelled. Then a ring beam is constructed on the ground in concrete or bricks and also a slab is made nearby. These are left to cure for at least a week. The pit is dug down within the ring beam to a metre depth. The slab is then carefully placed over the ring beam and should be placed on top of some weak cement mortar or traditional mortar (anthill) so the support for the slab is equal all round. If this is not done the slab may crack when people stand on it. Once the slab is fitted with the squat hole facing in the correct direction, then the toilet house can be made. There are many ways of making a toilet house. It is mainly for privacy and is best made with a roof. It can be made in the shape of a spiral without door or a round shape fitted with a door.

Stages of construction

1. Concrete slabs

Concrete slabs can be made of many sizes. The smaller slabs of 0.7 and 0.8m in diameter cannot be fitted with vent hole, but the slightly larger 0.9m diameter slab can be fitted with both a squat (or pedestal) and vent pipe hole. With the smaller slab the interior is a bit small, and the resulting pit is smaller, but they can work well and suit small children best. In this manual we describe how to make both the larger and smaller slabs which have both a vent and squat hole.

1a Making a 1.1m diameter concrete slab

The larger slab is 1.1m diameter slab fitted with squat hole and vent hole (110mm). The concrete slab is made with a cement and good quality river sand (sharp feel and clean) with some wire reinforcing (3mm wire or barbed wire). The best cement is called Portland cement which is intended to making concrete. But this is often not available. In that case the weaker masonry cement must be used but with a higher proportion of cement to sand. If Portland cement is available a mix of 5 parts river sand (50 litres) to 1 part cement (10 litres

The mould for the concrete slab is made from a ring of bricks laid on levelled ground. The bricks are laid around a circle 1.1 metres in diameter (radius 55cm). If plastic sheet is not available a layer of river sand laid down and levelled off. Using a centre mark, bricks are laid around in a circle. The circle can be marked with a stick 55cm in length or a string radiating from a nail placed in the ground. The bricks are laid on the sand around the marked circle. The sand is wetted and made flat

A suitable mould for the squat hole can be made using bricks, wood or a shaped plastic bucket. This should measure about 30cm long and 15cm wide at the rear, and should taper down towards the front. This squat hole mould is then laid 30cm from the rear end of the slab. The vent hole is 110mm in diameter and is made by using a 75mm length of 110mm PVC pipe. This is laid to one side of the squat hole, 10cm in from the edge.

The concrete mix can be made in two halves using 5 litres of Portland cement mixed with 25 litres river sand. Mix thoroughly in the dry state and then add water to make a thick slurry and mix again. Add this mix to the mould and level off. Add carefully around the squat and vent hole to ensure the moulds do not move. After the first half of the mix has been added, place the 3mm wire or barbed wire in a grid formation 20cm apart. Add wire also between vent and squat hole and in between the slab edge and the two holes. Then make another mix of 5 litres cement and 25 litres river sand and add on top of the reinforcing wires. Smooth flat with a wooden float. After two hours carefully remove the squat hole and vent hole moulds and smooth off edges of the squat hole. Cover with plastic sheet or plastic bags leave overnight. Once the concrete is hard add water and cover again with plastic sheet. If a ventilation pipe is not going to be used immediately the vent hole can be filled with a small weak mix of sand and cement (15:1). This forms a plug which can be knocked out when the pipe is fitted later.

If Portland cement is not available a higher proportion of masonry cement must be used. This will be 12 litres of cement to 50litres of sand if the masonry cement is fresh or up to 15 litres of masonry cement to 50 litres of sand if the cement is older and starting to form lumps.

The slab is left to cure for at least 7 days. It is kept wet under plastic sheet or paper all the time. It can also be covered with sand which is kept wet. The curing process (where the slab is not allowed to dry out) is very important. Slabs only develop strength when cured properly. If they are allowed to dry out once made, they never develop strength. Curing is essential for a long life concrete slab.

The slab is the most important part of the toilet and the part which can be used over the years. It is very important to use the cement provided wisely and ensure that the concrete work is made strongly, and cured correctly. Once a concrete slab has been well made and cured it will last almost indefinitely and can be used on a whole range of toilet designs from the simplest to more sophisticated models.

The concrete slab is 1.1m in diameter and made with 10 litres cement (PC15) and 50 litres clean river sand. The concrete mix is laid inside a mould of bricks on a plastic sheet or on sand. The squat hole is positioned 30cm from the rear of the slab and the vent hole 10cm from the edge at 45 degree angle.

Half of the concrete mix is added first, then the reinforcing wire. Then the second half of the concrete mix is added and levelled off with a wooden float. Remove squat hole and vent pipe moulds when the concrete is stiff after about 2 hours. Allow to harden overnight. Add water the following morning. Keep wet for at least 7 days under plastic.

How to make a brick ring beam

Get some fired bricks and mark a circle on the ground 90cm in diameter (radius 45cm). Lay the bricks around the circle. The diameter of the ring beam should match the slab. Ideally the slab should lay over half the length of the brick. Bricks are about 22.5cm long, so about 11cm of the rim off the slab should sit on the ring beam. The vent hole in the slab is normally made between 11cm and 12cm from the edge so that the vent hole will lie directly over the pit. One course of bricks can be laid in a circle to support the slab and can be bonded together with weak cement mortar. A stronger ring beam can be made with two courses of bricks as shown below. Traditional mortar can also be used. This is normally made by mixing anthill soil with river sand. Using a trowel add the anthill mortar between and above the bricks. Then add a second layer of bricks on the first layer. The upper layer of bricks should sit on the joint between bricks of the first course. Use the anthill mortar to hold all the bricks together. The pit is now dug down inside the brick ring beam. The soil from inside the pit is heaped around the ring beam and rammed hard in place. This will help to secure the ring beam and protect the beam and the pit during the rains. Brick ring beams must be taken apart when the pit is full and rebuilt in the new *Arborloo* site. The advantage of the concrete ring beam is that it can be moved as a complete unit from one site to the next as a complete unit.

The bricks are laid in a circle to make the ring beam and bonded with anthill mortar (Ivhu re pa churi) or cement mortar. The anthill mortar is made up by breaking up ant hill soil and mixing with river sand and water.

6

How to make concrete ring beam for 1.1m slab.

The ring beam is a ring of bricks or concrete which is caste on the ground at the top of the future pit. The ring beam is made first then the hole dug inside later. The concrete slab is laid on the ring beam. The ring beam helps to keep the top of the pit from falling in. It also supports the concrete slab, which is raised above the ground level. The ring beam also diverts rainwater away from toilet site. The pit is dug down inside the ring beam once it has been laid. The soil taken from the pit is rammed in place around the ring beam to make the toilet safer and raise the ground level around the toilet.

The ring beam can be made of bricks and anthill mortar or it can be made from wire reinforced concrete using a mix of cement and clean river sand. It is important to raise the toilet base above ground level to avoid flooding during the rainy season. The ring beam is made on slightly raised ground where the toilet is to be built. The ring beams works if the soil is moderately firm, but will not work on looser sandy soils.

Preparation

Locate the site for the toilet and level the ground. The site should be well away (30m) from wells. Make two circles of bricks on the ground. The concrete for the ring beam will be laid within the two circles of bricks. Lay the bricks so the inner diameter of the ring beam is 1metre and the outer diameter 1.3 metres. Thus the width of the ring beam is 15cm all round. This will take the same volume and mix of cement as the slab ie. 10 litres of cement and 50 litres of river sand (for PC 15 cement). Use a mix of 12+ litres cement and 50 litres river sand if masonry cement is used. A ring of 3mm wire is laid half way up the mix as in the slab. The procedure of mixing and adding the concrete is the same as for the slab. If ordinary bricks are used for the inner ring mould the spaces between the bricks must be filled with wet river sand to get a smooth wall all around.

In this case special bricks have been used for the inner brick mould. Lay on ground with 1 metre for internal diameter of ring beam and 1.3m for external diameter. This makes the beam 150mm wide. In these photos pupils from a primary school are making the ring beam and mixing half the mix at a time. That is 5 litres cement and 25 litres river sand mixed and added to the mould followed by a single ring of 3mm wire then a second mix is added. The concrete is levelled and hardened with a wooden float. The ring beam is covered with plastic sheet and left to harden overnight. It is then kept wet for several days to cure. The bricks can be removed after a day or two.

2. Making the smaller 0.9m diameter slab

The smaller slab and ring beam may be particularly useful for small children in the homestead garden. The slab is cast on a plastic sheet or a levelled bed of sand which has been wetted. A circle of bricks is laid so the diameter of the slab will be 0.9metres. A hole is made for the squat hole using a special mould. The hole for the vent pipe can be made of a short length of 110mm PVC pipe. The squat hole mould is laid so that it is 27cm from the back of the slab and the vent hole laid so that it is 9cm from the edge of the slab and at an angle of 45 degrees from the centre line through the middle of the slab. 10 pieces of 3mm wire are cut, 5 of 85cm, 3 of 70cm and 2 of 30cm. The smaller pieces are for the lifting handle. The concrete is made by mixing 6.5 litres Portland cement with 32.5litres of quality river sand. Half is added to the mould first, then the wires are added. Then the second half of the mix is added and smoothed down. If masonry cement is available the concrete is made by mixing 10 litres of cement with 30 litres of quality river sand. It is often easier to mix these as half measures. A one litre tin can be used for measuring.


Arrangement of bricks, wire, squat hole & vent pipe moulds to make the 0.9m slab. On the right a half mix of 15 litres river sand and 5 litres masonry cement (3:1). If Portland cement is used the mix can be 5:1


Half the concrete mix has been laid and the wires added. The second half of the mix is then prepared and laid on top and smoothed down. Wire handles are added on either side to assist lifting.


The vent and squat moulds should be removed after a few hours before the concrete has set. The slab is covered with a plastic sheet and left overnight. The following morning it is watered down and kept wet for at least 7 days before lifting. The small handles help a great deal in the first lift.

3. How to make concrete ring beam for 0.9m slab.

In this example the ring beam is not caste on site, but prepared for moving to a site after curing. The ring beam is cast on a plastic sheet or a levelled bed of sand which has been wetted. Two circles of bricks are laid so the internal diameter of the ring beam is 75cm and the external diameter 105cm. Thus the ring beam is 15cm thick all round. Special bricks may be required to make the inner brick mould. The same mixes of cement and sand are used as for the slab. If Portland cement is available the concrete is made by mixing 6.5 litres cement with 32.5litres of quality river sand. Half the mix is added first to the mould. A loop of 3mm wore is then laid half way across the beam. Then the second half of the mix is added and smoothed down. If masonry cement is available the concrete is made by mixing 10 litres of cement with 30 litres of quality river sand. Two handles can also be fitted to make lifting easier.

When the ring beam is caste off site, it is rolled on to the site and the soil must be loosened first a little to ensure the ring beam lays level and is held firmly all round. Once the ring beam is firm and level then the digging of the pit can proceed.

Method of making the concrete ring beam. This is left to harden overnight, watered the following morning and then kept wet under plastic for at least 7 days to cure.

4. Dig the pit

After the ring beam has hardened the pit can be dug down inside it with some of the soil placed around the ring beam and rammed hard in place. The pit rim is thus raised above ground level. The pit is dug down one metre deep. But is can be dug deeper if the soil is firm. It is a good idea to add leaves to the base of the pit help composting. Ring beams are suitable only for light weight structures.

Pit being dug down to one metre depth and soil rammed around the ring beam

4. Building the toilet house (superstructure)

There are many ways of making simple low cost toilet houses from locally available materials. A roof provides shade and keeps the rain out. It also helps to control flies. Where ring beams are used the "house" is made of light materials and built around or on top of the ring beam. Some structures may be fitted with simple doors and others built in a spiral (round or square) shape so that a door is not required. Wooden poles or bamboo can be used as the frame of the structure. Wood ash or engine oil can be placed in the holes made for the poles to reduce attack by ants and termites.

The main purpose of the toilet house is to provide privacy. If the unit is to be upgraded to a simple VIP toilet, then the house should not only provide privacy but should also be semi dark inside. An important feature of superstructures made for Arborloos is that they are either portable or can easily be dismantled and rebuilt on a new site.

Making a traditional square spiral structure

The photos below show one method built at the Chisungu School Epworth by School children. Nine upright poles 2.1m long are found and a roofing frame made. The roofing frame measures 2.2m long and 1.4m deep. The roofing frame is laid over the slab/ring beam and holes drilled around the ring beam in such a way to form a structure with opening at one end. There is no door in this version.


Nine poles 2.1m in length are used. The hole locations are determined from the roof frame. The poles are dug in at certain depths so the roof slopes backwards slightly. Wires are used to attach uprights to roofing poles. Holes have been drilled at the top of each upright. A wire is passed through each hole and around the roof frame. Reeds are laid across the top of the roof frame and secured in position with string.


Plastic sheets can be laid over the roof frame and covered with grass. These can be secured by adding more reeds on top.


The square spiral unit has no moving parts which is an advantage. At this stage no vent has been fitted. A hand washing device has been fitted.


A home made vent pipe can be fitted to make it a low cost VIP toilet. The inside of the house fitted with a vent pipe.

The final structure fitted with hand washing facility and vent pipe. This is a low cost Blair VIP. These can be very effective units.

How to use the single pit compost toilet

If the toilet is not fitted with a vent pipe it will smell and breed flies unless soil and ash are added regularly. So in those *Arborloo's* which are not fitted with pipes, it is very important to add soil and ash to the pit very often. The ideal is to add a small cupful of dry soil and ash to the pit after every defecation. This will ensure the faces are covered and does help a lot to reduce the smells and flies. It also helps to add dry leaves to the pit from time to time. The ash, soil and leaves all help to make the excreta in the pit compost more quickly and prepare it for tree planting later. A bucket of ash and soil should be placed in each toilet and a small dispenser (cup) placed nearby so the soil and ash can be added regularly. Keep the inside of the toilet clean as this will also help to stop flies getting in the pit. The pit is used until it is nearly full. The length of time this takes depends on the size of the pit and the number of users. Small pits may last for only 6 months, larger pits much longer.

What to do with the filled pit

When the pit is nearly full it is time to move the toilet to a new site. The house must be moved or taken apart and the slab and ring beam removed and plenty of soil added on top of the pit contents. This should come up to the level of the ground. Then leave the pit to settle for a while. The ring beam should now be moved to a new site, the pit dug down inside it and the slab and "house" added to make a new toilet. Add a sack of leaves to the bottom of the pit.

1. Leave this pit to settle. Add more soil and compost and wait for the rains before planting a new young tree. OR
2. Plant a young tree immediately in the added soil and look after it. It will require protection from animals and frequent watering. OR
3. Allow the pit contents to turn into compost and dig the compost out later (after 6 – 12 months) for use on the garden or for trees.

A later chapter describes how to plant and look after trees.

Teaching Ecological Sanitation in Schools

Building an Arborloo with door and surrounding ring of trees

Peter Morgan and Annie Shangwa

Introduction

This *Arborloo* was built on ring beam over a shallow pit. In this case the superstructure was built with treated gum poles and grass with a roof made of cement impregnated hessian laid on a wooden frame. A variant in this case was that the slab was a newly designed unit made of fibreglass. This unit is expensive and has been designed in Zimbabwe to serve emergency areas where cholera is a serious health problem. The toilet was constructed using the same basic principles as other *Arborloo's* – that is make the ring beam, dig the pit, place the slab, build the structure and fit a roof. In this particular case the unit was also surrounded by a ring of gum trees – a variant on the concept of planting a tree after the toilet is full, as is the standard practice with *Arborloos.*

The ring beam shuttering diameter in this case was 0.9m inside and 1.3m outside.10 litres of PC15 cement was mixed with 60 litres river sand. 3mm wire was placed inside the concrete as reinforcing.

The shuttering was removed and ring beam levelled off and allowed to cure for a few days being kept wet

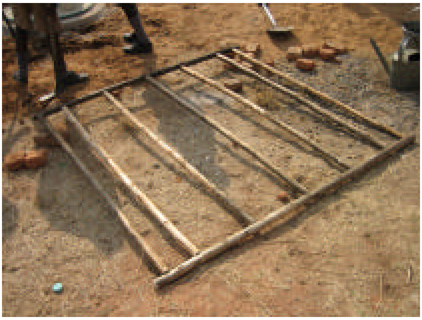

Once the ring beam was cured the pit was dug down inside the ring beam to one metre depth. The ring beam was covered with weak cement mortar and the special fibreglass slab fitted and made level.


The area around the toilet was cleaned and a series of 8 holes drilled with an earth auger. The treated poles were placed in these holes.

MAKING THE DOOR FRAME


The door frame was made next on site to match the distance between the two gum poles placed at the front of the toilet. Rubber hinges were fitted.

Making the roof frame

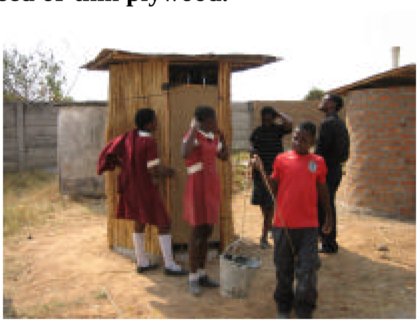



The roof frame was also made from thin gum poles to match the size of the structure. In this case the poles were nailed together. A roof sheet of cement impregnated hessian was made separately at the school see other manual) and allowed to cure for several days.


The two front poles (king posts) were placed in the holes drilled for them and made level. Soil and stones were placed in the holes to make the posts firm. The roof frame was then added on top and nailed in position.


The ring beam extended a little and made neat. Then thatching grass added all round to make the wall. This was attached to three wires wrapped around the poles and secured with thatching twine.


The grass structure being built. A hessian sheet was added as a door panel. This can be coated with cement slurry to make stronger. Also heavy duty shade cloth can be used or thin plywood.

The hessian impregnated roof panel being taken to the toilet. It is laid over the roof frame and secured with wire.


The completed toilet is surrounded by gum trees placed in holes drilled by a large earth auger (see detail in other manuals). The A hessian cement vent pipe has been added and the completed unit inspected by health officials.

Teaching Ecological Sanitation in Schools

How to build and manage a Fossa alterna

Peter Morgan and Annie Shangwa

Introduction

The *Fossa alterna* is a double pit composting toilet. There are two shallow pits about 1.5m deep each and placed about 1m apart. These are pits are protected with by two ring beams if the soil is moderately firm or by two brick lined pits if the soil is unstable. A single slab is mounted on one of the pits and a portable toilet house. The pit which is used fills up with a mix of excreta and soil and ash. The pit which is not used can first be filled with leaves to make leaf compost. The conversion of excreta into compost takes far less time if lots of soil and ash to the pit. Once the first pit is full the leaf compost from the second pit is removed and the slab and toilet house from the first pit are moved to cover the second pit. The contents of the first pit are covered with soil and left to compost for a year. By the time the second pit is full the contents of the first pit will have changed into compost and can be dug out. This compost can be used in various ways in the garden. The slab and house are then transferred back on the first pit. This alternating of pits continues for as long as the pits remain stable.

Making the *Fossa alterna* at the school.

1. Laying the two ring beams and digging the pits

In this case two ring beams were made in concrete (see other manuals) and laid on the levelled ground about one metre apart. Most times ring beams are made on site but this time they were made elsewhere and brought to the site. Once located, the pits were dug down inside both ring beams. The ideal depth for a *Fossa alterna* pit is 1.5m


Lay 2 ring beams and dig 2 pits inside

2. Adding the slab

The soil was levelled off around each ring beam. A matching concrete slab was made (see other manual) and placed over one ring beam in a bed of weak cement mortar.

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The slab is added to one of the ring beams.

Slab fitted ready for toilet house

3. Making the toilet house

In this case the toilet house was made with 6 treated gum poles (fitted with a door on rubber hinges) and a roof made of roof timbers and a sheet of cement treated (impregnated) hessian. The roof is attached to the poles with wires. In this case the walls were made of grass mounted on wires. The toilet house in this case is moved by taking it apart, removing the poles and erecting the structure again on the second pit.

Making the door

The door is made by cutting “brandering” timbers. The door is made 1.5m high and 0.5m wide with a cross piece for support. The door panel timbers are held together with triangular pieces of plywood. Rubber hinges cut from car tyres connect the door panel to the gum pole which supports it.

“Brandering” timber was used to make the door. The timber lengths were held together using triangular shaped pieces of plywood.

Attaching the door to a treated gum poles with rubber hinges

Making the roof

The roof frame is also made with “brandering” 1.4m wide and 1.5m long. It is also possible to make the roof frame with gum poles. When made with brandering, 7 timbers are cut as shown. These timbers can be wired together as shown in photos or nailed together. A cement impregnated hessian sheet (2 layers) is fitted on top of the roof frame.

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Making the roof frame

Making the roof sheet

In this case the cement impregnated roof sheet was made 1.4m wide and 1.5m long. 2 layers of hessian were used. 8 litres of Portland cement mixed with 5 litres of water to which 300mls salt had been dissolved. The salt was first dissolved in the water and then this was added to the cement and thoroughly mixed using rubber gloves. The first hessian sheet was laid on a large piece of plastic sheet and the cement paint rubbed into the hessian all over. The second sheet of hessian was then added and more cement paint rubbed in all over. For extra strength and durability a third sheet could be added. Finally the roof sheet was covered with another sheet of plastic and left to cure for several days before being lifted in position.

The cement paint is prepared and the hessian sheet laid on plastic sheet,

The cement paint is thoroughly rubbed into the first hessian sheet. Extra cement is added and the second hessian sheet is placed over the first. More cement paint is rubbed in all over. Then the sheet of covered with plastic sheet to cure.

Making the toilet house

In this case the toilet house was made by erecting 6 treated gum poles in a circle (one fitted with a door frame) and covered the walls with grass mounted on wires.

Locating the holes for the poles

The roof frame is used to mark the positions where the holes for the treated gum poles will be placed. The erected gum poles (6) will be attached to the roof frame with wires.

Locating the positions for the holes. Drilling the holes with an earth auger. Adding water to make the soil softer

The holes being drilled. The two main poles ("king posts") on either side of the door frame are placed carefully in the drilled holes so they are the correct distance apart.

The two main poles in the front of the toilet are mounted first. The door is attached about 60cm above the bottom of the pole and about 30cm below the top of the pole. The pole is 2.4m long and the door 1.5m high. The door is 0.5m wide. The roof timbers are secured to the poles with wires.

General view of *Fossa alterna* with two pits and a single structure

Adding the grass walls on wires placed around the poles

Three wires are attached around the poles in an upper, mid and lower position for attaching of the grass. Then bundles of grass are added both from the top and the bottom being attached to the wires with thatching twine. The erection of the walls is quite rapid and the appearance neat.

Bundles of grass are built up as walls for this toilet.

Adding the door panel

The frame off the door has already been made. The panel to cover the frame is now added. This can be made of hessian sheet, cement impregnated hessian, heavy duty shade cloth or other materials. In this case it was made from hessian sheet.

The hessian door panel is nailed to the door frame. This could be treated with cement paint later to make it more durable.

Adding the roof

The cement impregnated hessian roof sheet is then added to the roof frame. As can be seen from the photos it is flexible.

Carrying the roof sheet to the toilet.

The roof sheet is added to the roof frame and secured with small 25mm nails

The roof sheet must be secure otherwise the wind will bl ow it off the structure. The second pit is filled with soil and leaves to form compost whilst the pit in use is being filled with excreta, soil and ash.

 

The slab inside the toilet house. At first a pipe may not be fitted. The pipe can be fitted later. When plenty of soil and ash are added to the pit smells and flies are reduced.

Use and management of the *Fossa alterna*

The used pit is filled with a mix of excreta, soil and ash which are added regularly. When the first pit is full, the toilet slab and structure are moved on to the second pit. If the second pit is filled with compost this is dug out first. A layer of top soil 15cm deep is placed over the contents of the first pit which is then left to compost. It is best to level off the contents of the pit first. The second pit is then put to use as the toilet pit whilst the contents of the first pit are composting. The composting pit can be topped up with soil to the rim of the ring beam. It can be used as a miniature garden.

After a year or more of use (for a small to medium sized family) the second pit will become full (with excreta, soil, ash and leaves). By this time the contents of the original pit will have changed into compost and will be ready to dig out. If there is doubt about the quality or safety of this pit compost it can be placed into another pit (tree pit) nearby, and a tree can be planted in it. If it is considered safe it can be dug into the top soil of the vegetable garden. After the original pit is emptied the toilet slab and structure can be placed back again over the empty pit and the recently filled pit covered with soil and left to compost for a further year. This ritual of changing pits every 12 months can continue for many years in the same site if the soil remains firm. Otherwise the pit can be lined with bricks. Each year the family gains a rich and valuable form of compost.

Teaching Ecological Sanitation in Schools

How to build a simple VIP toilet with bricks and door

Peter Morgan and Annie Shangwa

Building a brick VIP toilet

It is possible to use the same slab we used to make the simple Arborloo described in the last chapter to build a more permanent brick toilet, which can operate like a Blair VIP. The best size of slab for this is 1.1m or 1.2m in diameter, but smaller slabs can be used, as small as 0.9m, but they provide less space inside. If a toilet is to become a VIP the slab must have a hole for the vent as well as for the squat hole or pedestal hole. When bricks are used to make the "house" it is essential that bricks are used also to line the pit. Otherwise the house will collapse into the pit as it is very heavy.

Digging and lining the pit

The pit should be dug wider than the final pit diameter because bricks will be used to line it and this will reduce the diameter. So if the final pit diameter is to be 1.3metres, then the pit must be dug at least 1.5metres in diameter. For most households the pit should be dug at least 2 metres deep. With care it is possible to line a pit down to 2mettres and also make a good concrete slab with one bag of masonry cement, providing the cement is fresh. In the example described here, built at the Chisungi school, the pit was dug only to one metre deep as an example of what could be build by the pupils themselves. But when the pit is dug in the homestead, it is best to dig to at least 2m in depth and better 3metres of a long life is required.


In this case the pit was dug 1.5m across and 1m deep. A mix of one part cement and 15 parts pit sand was used to make the cement mortar.


The bricks are laid in a circle as close to the pit wall as possible. See how the bricks are laid on top of one another. Half way up the pit, each course of bricks is stepped in a little so the diameter starts to get less. This method is known as "corbelling." This allows for a small slab to be fitted on a larger pit – so it is a useful technique.

The bricks are laid as shown in the photos, so that the joint between two bricks is made in the middle of the brick below. This method of bonding bricks together makes the structure very strong. The roundness of the structure also makes the pit lining strong. A technique known as "corbelling" is used in this technique. This means that half way up the pit lining each course of bricks is stepped in a little so that the diameter is reduced as we get nearer to the top of the pit. The uppermost course sho uld be the same as the diameter of the slab which will be placed on top of the brick lining. In this case that is 1.2metres.


The top of the brick ling comes above the ground level as shown in these photos. The outside diameter of the final layer of bricks should be the same as the diameter of the concrete slab.

 

Soil from the pit is then placed down inside the space between the bricks and the pit wall and built up to ground level. Then a layer of weak cement mortar (16:1 sand and cement) or traditional anthill mortar is laid over the bricks. The concrete slab has already been made (see earlier chapter) and laid on top of the bricks in a bed of cement mortar. It is important to get the orientation of the slab correct with the vent hole at the back of the toilet. Laying the slab in a bed of mortar helps to avoid cracking as neither the slab or the top of the brickwork is perfectly level.

Once the slab is laid solidly on the bricks some cement mortar is plastered around the slab to seal it nicely with the bricks.

Making the brick "house" (method one)

In this case the house (superstructure) will be round and made of bricks fitted with a door. The doorframe is made up first in wooden poles or other timbers. The frame is linked to the brickwork through a series of nails which are hammered into the door frame. The

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position of the nails is made by laying the doorframe on the ground and placing bricks along side it, so the nails will find their way into the cement mortar placed in between bricks.

Nails are hammered into the door frame so that they can be held by cement mortar placed between the bricks. Once the two upright frames have been fitted with the nails a wooden plank is placed between the two upright poles both at the top and the bottom. These act as spacers. The wooden frame is held in place by a long wooden timber to ensure it is straight and upright whilst the bricks are being laid.

A circle of bricks is laid on top of the slab. The lowest course of bricks is laid in cement mortar placed on the slab. the mix of mortar is about 10 parts pit sand to one part cement. Where the mortar is placed around the nail some extra cement is added to make the mortar stronger at that point.

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Most of the brickwork was carried out by two very skilled school boys, but each pupil on the course was given a chance to lay bricks. Some girls were very good as this task.

Most of the brickwork was undertaken by these two skilled pupils, who had great talent. The brickwork continued to near the top of the wooden doorframe upright.

The roof frame was then made in small poles being wired together and sheets cut from plastic sacks attached with thin wire.

The roof timbers are secured with wire which passes through the brickwork and over the roof poles.

Grass this then laid over the plastic sheeting and this is secured by laying reeds across the top of the grass. It is possible to fit other types of roof to a brick structure such as tin, asbestos or ferro-cement. A hole is made in the roof to fit the vent pipe once it has been made.

 

The timbers of the door are cut to fit inside the doorframe, now connected to the brickwork. The various timbers can be wired or nailed together. To make the door more rigid struts are made in each corner of the door to make triangles which make the unit stronger.

 

The hinges for the door are made from car tyres which are cut in the shape shown and then screwed into the door and door frame timbers. These hinges are very durable and have the additional effect of making the door self closing.

 

A sheet of stout plastic sack is cut and painted with enamel paint in this case for the door. A latch of screws and wire is made inside for privacy.

The pupils are also given lessons on how to make vent pipes from reeds and cement and other methods (see in another part of this book for details). A suitable pipe is fitted over the vent pipe hole and through the roof.

The interior of the Blair VIP toilet showing the cement pipe fitted to the vent hole in the slab and how it passes through the roof.

The proud pupils now make a garden around the toilet they have built.

The parents, teachers and members of the community can now see what can be achieved with a little help, good training and support.

Method 2: Making the brick house with door
The "*horseshoe Blair*" VIP

This is a method where two treated gum poles are placed in holes in the ground in front of the slab. The pit is lined with bricks and the slab is mounted over the lined pit as before. Then the bricks are laid in a horseshoe shape around the rim of the slab and forward to join the poles. A door can be made from wooden poles or (as in this case) with wooden "brandering." The roof is made with the same material. The door is rugged has a cross piece to make it rigid and is attached to the main treated gum pole with stout rubber hinges cut from old car tyre. These make the door self closing, which is important in the Blair VIP toilet.

The special feature of this design is that the brickwork is easy to construct and makes a good starting point for those who have no experience or little experience at brick laying. The upright poles guide the less experienced builders and the horseshoe shape provides a natural strength to the structure. Also the aim of this part of the project was to demonstrate that the more experienced brick layers could teach the less experienced pupils how to lay bricks. The roundish horseshoe shape of the structure makes this method of laying bricks much simpler than those which have a free standing wall. The following pages show the stages of construction.

Dig and line the pit

The pit is dug down to the required depth (1m – 2m) and lined with bricks as described earlier.

The pit is lined with bricks so the lining stands at least one course above ground level.

Make and fit the concrete slab

The concrete slab can be made 1m or 1.1m in diameter and is caste within a circle of bricks laid over plastic sheet or sand. 10 litres of cement is mixed with 35litres to 50 litres of river sand depending on slab size. A special mould is used to make the squat hole and a 110mm PVC pipe to make the vent hole. 3mm wire is used for reinforcing in this case 4 lengths of 0.9m and 4 lengths of 0.7m. Half the mix is added first, followed by the wire and then the second half of the mix. The moulds are removed about 2 hours after casting the concrete. The concrete is left to set overnight. It is then watered in the morning and kept wet for at least 7 days to cure and strengthen. The curing process is very important for concrete slabs. Stronger slabs can be made with Portland (PC 15) cement compared to masonry cement. The river sand should be clean and sharp to the touch. A well made concrete slab will last for generations and is a good investment in time, money and energy.

 

The slab is carried to the lined pit and mounted in a bed of very weak cement mortar. It must be laid level. Sometimes small stones are required, placed between the brickwork and the slab to make it level. The cement mortar is then packed between the slab and the brickwork.

The configuration of the horseshoe toilet

 

The name horseshoe toilet is derived from the shape of the brickwork as shown above. The two long lasting treated gum poles are mounted in holes drilled in front of the slab. The brickwork is easier to erect than toilets which have free standing walls like the standard spiral Blair VIP. This unit is fitted with a door with self closing car tyre hinges made from car tyres. The door is attached to the left hand gum pole (king post). The brickwork is mounted around the rim of the slab and then forward to connect to the posts. It is this design which has been used to train less experienced pupils how to construct the toilet in bricks. The rounded shape of the brickwork gives the unit strength and relatively few bricks are used compared to the open spiral. Also the bricks can be built on edge which reduced the number of bricks further. Whilst a Blair VIP fitted with a door has a moving part (the door) which is prone to damage, the advantage is that far fewer bricks are used in the construction of the superstructure and the roof area is much smaller.


The roof and door frames are placed above the slab to ensure they are the correct size. The door must lie between the two posts which will be mounted in front of the slab.


Two holes are drilled with an earth auger (or with a pick) in front of the slab about 0.5m apart. The door is used to check the distance between the two pole holes.


The holes are drilled down in the soil so the 2.4m long treated gum pole will stand 1.8m above the slab level. The door is used to check for distance between poles.

The second pole is placed in position. Once correctly placed the holes are filled with stones and soil which is rammed hard in place.

The bricks are then laid in a circle to form the horseshoe shape. Cement mortar is made. This can be 16 parts pit sand to 1 part cement. The bricks are laid with plenty of mortar between them.

The brickwork is then built up course by course.


Wire loops can be placed around the poles and into the cement mortar every 5 courses up. These help to bond the brickwork to the poles.


Photos showing the arrangement of the bricks and the bonding technique used.


Girl pupils built the entire structure under the tuition of the boy pupil. Higher up a chair is required to lay the bricks.

 

The arrangement of the slab and brickwork. Also the arrangement of the squat hole and the vent hole.

The roof and door

Wooden brandering is used to make the frames for door and roof. The door is 0.5m wide and 1.5m in length. The roof is 1.6m wide and 1.35m wide (the 5 wood lengths between side timbers being 1.3m each in length, The door timbers are held together with plywood triangles which are nailed to the timbers. The roof timbers are wired together.

 

The door frame is covered with heavy duty shade cloth attached with small nails or drawing pins. The roof is covered with chicken wire which is covered with black plastic sheet and then grass.

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The door covered with heavy duty shade cloth. A later design has a single diagonal wooden strut and can be covered with hessian (sacking) material painted with cement paint.

The rubber hinges

The rubber hinges are cut from the sides of a used car tyre. The rubber hinge is nailed to the door frame as shown. Since this door is heavier than the one shown earlier in this chapter, two pieces of rubber have been used. Two sets of hinges are fitted per door.

The hinges fitted to the lower part of the door frame with nails. The part of the hinge which is attached to the post is best held with screws or suitably sized bolts. This method makes it easier to remove the door if it requires repair. The door can be replaced or upgraded and will require maintenance. It is best if it can be detached by unscrewing or unbolting. Removing long nails may damage the link between bricks and pole.

Placing grass to the roof and fitting to the structure

The roof frame is covered in plastic sheet and grass and mounted on top of the two gum poles and rests on the brickwork at the rear of the toilet house.

Wiring the roof in position. In an upgrade the roofing material can be made with cement impregnated hessian.

Fitting the vent pipe

A range of possibilities exists for the vent pipe. This can be made of PVC, tubes of cement made with sacking, hessian or reeds, paper cement pipes or pipes plastered on to the walls (see school-girls toilet). However when considering the concept of re-use of the parts, it is best to fit a pipe which can later be removed and refitted to a new toilet. Lower cost pipes made of cement slurry and hessian may be best.

 

In this case a pipe made of paper and cement paint has been chosen as a trial. Cement filled hessian make stronger pipes. This has been fitted with a screen. A hole is cut in the roof material and the pipe pushed through from beneath.

 

The pipe above the roof. The base of the pipe is cement mortared in place.

The girl - builders and their teacher (the boy on right) stand proudly by the toilet they built themselves.

Teaching Ecological Sanitation in Schools

How to build a spiral brick VIP toilet

Peter Morgan and Annie Shangwa

Building a brick VIP toilet with spiral structure

We have described how to make a brick Blair VIP with a door. But the type without a door is the normal way Blair VIPs are built, because there are no moving parts and the inside never gets too light. The same concrete slab is used -1.1m or 1.2m in diameter. Once again the slab for a Blair VIP must have a vent hole as well as a pedestal hole. Brick superstructures must be supported by brick lined pits.

Digging and lining the pit

The pit should be dug down about 2 metres or more if possible. And it should be dug at least 1.5m wide, so that the inside diameter is 1.3m after the bricks are laid. Better to dig wider if possible. It is possible to make the cement mortar for the brickwork and a good concrete slab with one bag of cement, providing the cement is fresh. The photos here show a pit dug down only to one metre deep as an example of what could be build by the pupils themselves. But when the pit is dug in the homestead, it is best to dig to at least 2m in depth.


In this case the pit was dug 1.5m across and 1m deep. A mix of one part cement and 16 parts pit sand was used to make the cement mortar.

 

The bricks are laid in a circle as close to the pit wall as possible. See how the bricks are laid on top of one another. Half way up the pit, each course of bricks is stepped in a little so the diameter starts to get less. This method is known as "corbelling." This allows for a small slab to be fitted on a larger pit – so it is a useful technique.

The bricks are laid as shown in the photos, so that the joint between two bricks is made in the middle of the brick below. This method of bonding bricks together makes the structure very strong. The roundness of the structure also makes the pit lining strong. A technique known as "corbelling" is used in this technique. This means that half way up the pit lining each course of bricks is stepped in a little so that the diameter is reduced as we get nearer to the top of the pit. The uppermost course should be the same as the diameter of the slab which will be placed on top of the brick lining. In this case that is 1.2metres.

 

The top of the brick ling comes above the ground level. The outside diameter of the final layer of bricks should be the same as the diameter of the concrete slab.

 

Soil from the pit is then placed down inside the space between the bricks and the pit wall and built up to ground level. Then a layer of weak cement mortar (16:1 sand and cement) or traditional anthill mortar is laid over the bricks. The concrete slab has already been made (see earlier chapter) and laid on top of the bricks in a bed of cement mortar. It is important to get the orientation of the slab correct with the vent hole at the back of the toilet. Laying the slab in a bed of mortar helps to avoid cracking as neither the slab or the top of the brickwork is perfectly level.

Once the slab is laid solidly on the bricks some cement mortar is plastered around the slab to seal it nicely with the bricks. At this stage a very stable pit and slab structure has been formed. Many types of superstructure can be fitted on this slab as it will be very stable with a reasonable pit capacity.

Making the brick "house"

In this case the superstructure will be built in a spiral (door-less) shape. This overcomes the need to have a door, which is the preferred method with the Blair VIP. With this shape some of the brickwork for the "house" will come outside the slab area and a special brick foundation needs to be built to support the walls.

These photos show how the foundation is built. The soil is dug down a little and the brick laid in weak cement mortar. The foundation is made so the space between the outside entrance and the inner entrance is at least 45cm. Two courses of bricks have been laid for the foundation 22cm wide. The brick wall, which is 11cm wide is built in the middle of the foundation as shown. At first the bricks are laid around the outside of the slab as shown. Then the back of "house" is extended beyond the slab and onto the foundation. The space between the slab and the outer wall is filled with soil which is rammed hard.

These pictures show the first course of bricks and the third course. The bricks are built up straight using a straight piece of wood to get it straight up.

The brickwork continues upwards

At about the 15th course some glass bottles are introduced into the brickwork. These will later act as windows allowing a little more light into the toilet house. They are cement mortared in position and the brickwork then continues upwards.

Photo showing glass bottles in wall. The full height of the superstructure is about 19 courses of bricks.

A wooden roof frame is then made. Reeds can be laid within the main frame for more support to the plastic sheet which is laid on top. In this case white bags have been used. Later a black plastic sheet will be laid over this lower sheet and then grass will be laid on top.

The roof is then laid down on top of the brick structure. The front is raised slightly so that rain will tend to run off the back. It is possible to fit other types of roof to a brick structure such as tin, asbestos or ferro-cement. A hole is made in the roof to fit the vent pipe once it has been made.

The vent pipe is cement mortared in place on the slab. A sheet of black plastic is laid over the roof and a hole made in it for the vent pipe. Later grass is laid over the black plastic to protect the plastic sheet from the sun and to make the inside cooler.

Some cement mortar is then laid on the soil placed

The final structure looks smart. The pipe is fitted with a fly screen.

In this case a mulberry tree has been planted in a pit dug about half a metre away from the toilet on the entrance side. This is filled with fertile soil and the young tree is planted. Later the tree will grow and use the nutrients in the pit to make it grow faster and larger and provide more fruit.

Teaching Ecological Sanitation in Schools

How to build a school-girls VIP toilet

Peter Morgan and Annie Shangwa

Building a school-girls toilet

This facility is a very important part of any schools programme. In the past toilets have not been designed with the specific requirements of school girls and young women in mind. This has been and remains a major failure of both the Zimbabwe and also many international sanitation programmes. School girls and young women have very specific requirements in terms of privacy and the need for hygiene in relation to their menstruation. The existing multi-compartment VIP toilet never catered for this need and thousands of young lives have been adversely affected by this deficiency.

School girls require a toilet that provides safety as well as privacy. The need to be able to dispose of sanitary pads or cloths is important. The need to be private and safe is important. The door-less multi-compartment system is inadequate. Units for school girls should offer space and privacy as well as security. A door which can be closed off is important. Also there is a requirement for being able to sit rather than squat. And of no less importance, the requirement of being able to wash or cleanse using water, and preferably inside the toilet. There is also a need to have enough light within the structure to wash. So we need space, a seat, water, a door and enough light.

The method of construction of the toilet for the "girl child" can vary. Used wash water can drain away through a pipe from the washing facility within the toilet to a drainage area outside the toilet. This can be planted with a tree, so the water is used for a useful purpose. Since sanitary pads or cloths will be thrown down the pit, it is unlikely that the pit compost will be suitable for excavations. But recycling of the nutrients can still take place by placing a tree near the main pit. The structure is best made of bricks built over a brick lined pit. The roof can be upgradeable, starting off as a wooden frame covered with grass and progressing to a more permanent roof made of asbestos, tin sheet or ferro-cement. The type of vent pipe can also vary from PVC, cement/fabric pipes or as in this case pipes fabricated in cement mortar on the internal walls of the toilet house.

Building a toilet for school girls

This toilet is based on a ventilated pit toilet principle. The pit is lined with bricks, covered with a concrete slab and a brick structure is built and fitted with a door which can be latched from the inside. For convenience and comfort a pedestal fitted on the slab and this will require a slab which has a round hole made in it. The pit is lined with bricks using a corbelling technique as described in the last chapter. This photo series shows school girls and boys building a brick toilet and highlights some important aspects of the design.


Once trained and offered suitable support school children are able to build very good toilets. The pit is lined with bricks bonded together with cement mortar.


The upper course is made the same diameter as the concrete slab. The slab is fitted over the lined pit. In this case a circular hole is cast in the slab in place of the squat hole as a pedestal will be fitted.

The round slab is used in this case about one metre in diameter with hole for the vent pipe and pedestal. The space inside the toilet can be enlarged to suit the specific requirements. A brick foundation is laid on the ground outside the slab area. The brick wall will be built on top of this foundation.

The brick wall is built up layer by layer. The vent pipe hole is positioned quite close to the brick wall.

A line of bricks is laid at the entrance on the same level as the slab. The brick wall is supported by a foundation along its full length.


The brick wall is almost complete. The roof frame made of wood has been prepared in two parts to fit the structure. The hole for the pedestal and the vent pipe. The vent pipe type is optional.


The upper courses of brickwork are high and a chair is required to stand on for the primary school builders. Preparations for making a pipe plastered on the internal wall of the brick structure. In this case a 2.5m length of 90mm PVC pipe is covered with a plastic sheet. This will form the mould around which the cement mortar is applied.


The plastic sheet is wrapped around the pipe and held in place with tape.

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The plastic covered PVC pipe is taken into the toilet and its lower end placed in the vent pipe hole. If the wall has already been plastered as in this case, the plaster should be removed to reveal the brick work. It is best make this pipe against brickwork which has not yet been plastered. A strong mortar is made up to make the pipe. This is made with one part PC15 cement and 3 parts pit sand. In this case bricks are piled up around the pipe with a space between. The space is filled with mortar course by course.

The pipe is held in place by placing a wire around the pipe and hanging down outside the toilet. The strong cement mortar is applied around the pipe course by course. This was an experimental technique only.

The mortar fills the space between the bricks and pipe. On the right the pipe is almost complete.

The cement mortar is allowed to cure overnight. The pipe is then removed with a twisting motion and completely removed from the toilet. Next the plastic sheet is twisted and pulled out of the cement plaster tube.

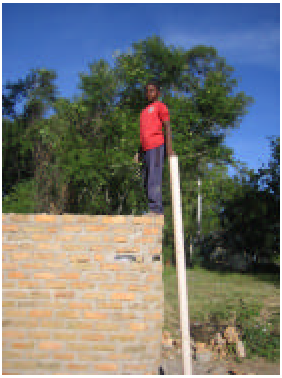
The bricks are then removed from the plaster pipe

The mortar is then scraped down to a smooth rounded shape. The pipe is then inserted again.

During the scraping process weakness or holes in the mortar tube will be revealed. These can be filled with new mortar. The pipe is then completed smoothened off with cement mortar and left to cure.

The pipe is removed again. The top of this internal mortared pipe is set at the same level as the wall. An extra length of pipe about 50cm long will be added on top later.

The hand washing device (water dispenser and basin)

Many designs of a water dispenser are possible. In this case a 5 litre plastic bottle has been cut and drilled as the photos show. In this case holes have been cut at the top of the bottle as shown and two small holes drilled near the bottom. Water is carried by the girl child into the toilet and this is poured in to the dispenser. The water can be held in bulk within the toilet in a larger plastic container. Water is added to the dispenser and then pours out slowly through the holes.

The water dispenser is held up with a stout wire which passes through the handle of the bottle and through the brick wall. Water is poured in from another bottle.

The wire holding the bottle. Two small holes have been drilled through near the bottom of the bottle. Sufficient water for washing flows out.

Making the basin support

The basin support is made of bricks as shown.

The water outlet pipe.

A hole is cut through the brick wall and a 25mm plastic pipe is inserted. The upper end is fitted to a funnel which will receive water from the basin. In this case the funnel is made from a plastic milk bottle.

Making a concrete basin

The concrete basin is made by applying a very strong mix of PC15 cement and sharp river sand (ration 1:2) to a mould covered with thin plastic sheet. In this case the mould is a metal basin. A short length of pipe is placed in the casting to act as a water outlet.


The strong concrete is added all over the metal basin mould covered with thin plastic film.


The concrete replica of the basin is removed from the mould

Fitting the basin


The basin is fitted in position on the basin holder and mortared in place.

A paint made of neat cement and water is made up and applied with a brush over the surface of the basin. This makes it smooth. The facility is then neatened up. The facility is valuable for girls when placed inside the toilet.

Drainage water to irrigate a tree outside the toilet.

The wash water passes out of the 25mm plastic pipe into a seepage area planted with a tree. In this case a 1m deep drilled hole is being made with an earth auger. The girls drill down through the soil with the auger.

The hole is then filled with a mix of garden compost and soil. The tree (in this case a mulberry) is planted in the rich soil. The soil around the tree is covered with a mulch of leaves to cover up the drainage water.

Making the short vent pipe

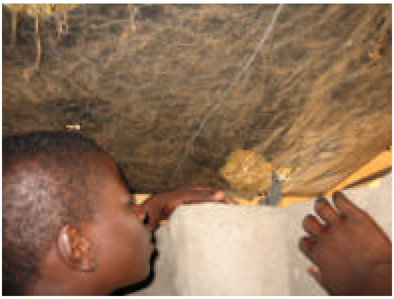
The mortar pipe made inside the toilet is fitted with an extra 0.5m length of pipe which will pass through the roof. This length can be made of PVC to match the size of the mortared tube. In this case the pipe is made with paper bonded with a paint made of PC15 cement and water. The method is described in this book.


In this case a short mould has been used about 0.6m long. The mould is made of 90mm PVC pipe which has been cut along its length into 3 pieces. These three pieces are wrapped around two tin cans (one at each end) with their bottoms removed. The 3 section of PVC pipe are held in place around the cans with pieces of rubber car inner tube.


The two cans have been removed and the 3 pieces of PVC pipe removed from within the cement pipe. A piece of fly screen (in this case PVC coated fibreglass has been cut and wrapped around one end of the pipe and held with string. This type of screen will last 5 years. The best fly screens are made of aluminium or stainless steel. Aluminium is cheaper.


The top end of the pipe is then plastered with a string 2:1 mix of sand and cement to hold the screen in place. It is kept in the shade and left to cure and harden.

Fitting the upper section of pipe on the structure




These photos show the pipe being fitted after the roof has been fitted. For details of the roof see below. A hole is made in the roof wires, plastic and grass to allow the pipe to pass through. The short length of pipe is fitted and made vertical. This may require a short length of PVC pipe to be used at the junction.


The pipe is cemented in position using strong cement mortar. The pipe emerges well above the roof level as shown.

The roof.

The roof in this case has been made with lengths of wood fitted together with wire. The timber used is called brandering – it is used in roof construction in standard housing to support tiles etc. The roof area is large and in this case the roof has been made in two sections. The timber frame is covered first with chicken wire and then with black plastic and finally with grass.

The two wooden roof frames being assembled. The measurements vary and are made to fit the specific superstructure. In this case the two frames were of different sizes. Front frame (2m X 1.2m) rear frame (2m X 1m)

The two frames have been covered with chicken wire. This is followed by a layer of black plastic sheet and then the grass is added on top.


Finishing off one roof panel. Carrying the roof panel to the toilet.


Fitting the front panel to the toilet. Additional bricks are added to the walls of the structure to support and raise the centre of the roof to give it a slope. Grass roofs can be smart, although they require more maintenance than asbestos, tin or concrete roofing sheets.

Roof in position

Making the pedestal

The construction of the simple pedestal is described in another chapter of this book. In this case a 10 litre bucket (with base cut off) has been built up with a concrete sheath. The surface of the seat is files down and made smooth. It is painted with enamel paint. A better method is to apply an additional coat of strong mortar to which red oxide has been added. This can be made very smart and even polished with wax to provide a neat and easy to maintain unit. To make the pedestal higher, the unit can be mounted on bricks or a concrete collar mounted on the slab around the pedestal hole.

Pedestals can be made very smart using a combination of a bucket and strong concrete.

Making and fitting a door

In this case the door is made about 1m high and 0.6m wide from lengths of wooden “brandering” which are nailed together with triangular supports at the corners. The door frame itself is attacked to a wooden post through car tyre rubber hinges. The post is attached to the brick walling with lengths of 3mm wire. The door frame can be covered in a variety of materials which include heavy duty shade cloth, cement filled hessian, thin plywood and sacking etc.


The door frame is made with wooden “brandering” and triangular plywood corners. A single diagonal strut supports the frame. Some form of covering is added to the frame. In this case sacking material called hessian.

The school girls toilet complete with door and its own mulberry tree fed by washing water from inside.

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Teaching Ecological Sanitation in Schools

Building a round brick VIP toilet with a steel door and frame

Peter Morgan and Annie Shangwa

Building a round brick VIP toilet with steel door and frame

This unit was built as an upgrade on the brick lined pit with seepage holes in the walls. The original superstructure was made of poles and grass, with the intention of upgrading later. The grass structure was taken down and a more permanent facility erected in its place over the same lined pit. The method of lining the pit is described in another manual. With a pit of this volume it makes sense to construct a stronger and longer lasting structure from bricks. Trees were also planted around this brick lined pit with seepage holes in the walls.

The original pit and slab

The original pole and grass structure and the upgraded brick structure

Building the brick toilet

1. Making the dished cement floor

All toilet floors should be dished or sloped so that wash water can drain into the pit. This is particularly important for Blair VIP toilets which are also used as washrooms. The cement used for plastering should be strong and finished off with a steel float. A 3:1 mix of pit sand and Portland cement is used. In this case a circle of bricks has been laid around the rim of the slab first and the floor being dished down inside these bricks.

The slab has been washed down and a layer of strong cement plaster (3:1 with pit sand and PC15 Portland cement) applied around the rim of the slab. Bricks are then laid in this mortar around the slab.

Once the brick work is finished additional cement mortar is added all round and dished towards the squat hole. This is smoothed down flat. A 75mm length of 110mm PVC pipe is fitted to the ventilation hole whilst the floor mortar is being added. This PVC pipe is withdrawn after an hour and the floor left to set and harden.

2. Add the steel door frame and brick up the walls

In this case the steel door frame and door has been made commercially. It is fitted with steel "sprags" or thin fingers welded to the door frame. These are held by the mortar in the brickwork and hold the door and door frame tight.

The door frame is fitted first. This stands directly on top of the brick rim around the slab and is held in the vertical position by two poles as shown.

The bricks are then laid with weaker mortar (about 12 parts pit sand to one part cement) in a circle above the existing brick circle. The steel sprags are inserted in between bricks in the mortar (see later photo). The walls are built up as vertical as possible. The round shape makes the structure easy to build and strong even if the walls are not perfectly vertical.

The brick work rising up. Right photo shows steel sprags welded to the frame. These are embedded in the cement mortar used to bon the bricks together.

The walls of the round structure have now been built up. After a few days The two poles can now be removed as the frame is now held up by the brickwork.

The floor is now cleaned down

 

The door is now fitted inside the frame. Rubber hinges are used to make the door self closing. A roof and vent pipe must now be fitted.

3. The roof

The roof of this structure can be made with asbestos or corrugated iron sheet. It can also be made using cement impregnated hessian mounted on a timber frame. In this case the roof is made of a timber frame made from "brandering" and two sheets of cement filled hessian.

Making the timber frame.

In this case the timber frame has a length of 1.4m and a width of 1.3m. Two lengths of 1.4m are required and 5 lengths of 1.2m. The size is made to suit the individual toilet. The individual pieces of timber are first treated with a mix of creosote and old engine oil to prevent termite attack. After a day or two of soaking the roof frame timbers are nailed together.

 

The roof timbers are cut first to suit the individual toilet. The roof should have an overlap around the structure. Roof timbers being treated with a mix of old engine oil and creosote. Then they can be nailed together.

Making the cement impregnated hessian roof sheet

The hessian is purchased in a standard width of 1.4m. Two hessian sheets are cut 1.5m long. The hessian sheets overlap the frame slightly on the sides and at the front and back. So the wooden frame is made slightly smaller than the hessian sheet.

Making up the cement paint

The cement paint is made by mixing 10 litres of PC 15 cement into 6 litres of water to which two heaped tablespoons of table salt has been dissolved. The mix is thoroughly stirred with rubber gloves and applied liberally to the first hessian sheet which is placed over a plastic sheet. The paint should soak in. In fact this mix should be able to fill 3 sheets of hessian this size.


Hessian sheet laid over plastic sheet. Stirring the cement paint mix.


The cement paint is thoroughly applied to the first sheet using rubber gloves.


The second sheet is laid over the first and rubbed into the cement. Then further cement paint is applied. For additional strength and durability a third sheet can be applied and filled with cement paint. If the cement paint is not enough a little more can be made to fill a third sheet.


It is important that the sheet is allowed to cure under a plastic sheet for several days. The hessian panel is slightly larger than the roof frame. After a few days it can be slid onto the timber frame and carried to the toilet and mounted.


The roof is carried to the toilet and small nails are used to attach the roof sheet to the roof frame.

The roof is then mounted on the toilet and wired in place.

4. Fitting a ventilation pipe

A ventilation pipe is an important part of any VIP toilet. Commercial pipes are available in PVC and resin impregnated hessian. In this case a 2.3m long 110mm resin impregnated hessian pipe fitted with an aluminium fly screen is being used.

This pipe is a new unit on the market and is being field tested. It is about half the cost of a PVC pipe. A length of PVC pipe is fitted at both ends.

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A hole is cut in the roof material and the pipe passed through from underneath. Then weak cement mortar is prepared and laid around the pipe with a trowel. This stops rainwater penetrating through the roof at this point.

 

Some cement mortar is also laid around the base of the pipe. This toilet is surrounded by a circle of gum trees which are watered regularly.

The completed toilet.

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Teaching Ecological Sanitation in School

Making a ring beam to support light-weight toilet superstructures in stable soils.

Peter Morgan and Annie Shangwa

Introduction

The ring beam is a valuable method of protecting a pit without a brick lining and works well in soils which are a moderately stable. The method is suitable for light weight superstructures. The pit is dug inside the ring beam once it has become hard and cured for a few days. Ring beams can be made with bricks, but are more durable if made from concrete.

A ring beam made from bricks. The bricks are best mounted in cement mortar. However traditional anthill mortar can also be used in mortar traditional structures. The brick ring beam supports a fibreglass slab in this photo. Most toilets slabs are made of concrete.

In this case the ring beam is cast within two steel shutters. The inner shutter is 0.9m across and the outer shutter 1.3m across.


A mix of 10 litres of Portland cement and 60 litres of river sand is prepared. The soil on the ground within the ring beams is wetted down.


Half the concrete mix is added between the shutters and levelled off. Then two rings of 3mm wire, 3.7m long are added half way between the shutters or bricks as reinforcing.


The remaining concrete is added and levelled off

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The shuttering is then removed with a turning motion. First the outer shutter is removed, then the inner shutter.

The ring beam is then neatened up and left to harden overnight. It is kept wet for several days to cure. Then the pit is dug down within the ring beam to a depth of 1m or 1.5m in firmer soils.

It is best to dig the hole so the diameter of the base is slightly less than the diameter of the top. A matching slab will have been made measuring between 1.0m and 1.2m in diameter.

Before the slab is fitted a layer of weak cement mortar is added on the top surface of the ring beam. Then the slab is added. This has two useful effects. It provides an even surface on which to mount the slab which preve nts slab cracking and also makes an airtight seal between the ring beam and slab. An airtight seal is essential if a vent pipe is fitted later and is expected to draw air efficiently from the pit.

The sealed pit is then ready for the construction of the superstructure.

Teaching Ecological Sanitation in Schools

How to make standard corbelled pit linings

Peter Morgan and Annie Shangwa

Introduction

This method of lining toilet pits has been described in several toilet construction manuals in this series. The method makes it possible to line a large capacity pit with bricks and fit a smaller low cost concrete slab on top to cap the pit. Using this method a pit with a life of at least 10 years can be lined and capped with a strong concrete slab using a single bag of PC15 cement. This includes making the slab. The best size of the slab is 1.1m in diameter (see another manual). Most of the pits dug at the school using this technique have been dug to 1m depth to make it easier for the children. Normally however the pits would be 2m deep or even 2.5m deep. The pit can be dug about half a metre deeper below the brickwork and it is normal for the upper courses of brickwork to rise above ground level. The deepest corbelled pit lined at the school was dug in a pit 1.6m deep and the final depth of the pit was 1.8m, since the lining rose 0.2m above ground level.

The internal diameter of the pit can vary between 1.3m to 1.5m and the depth should be 2m or more. When estimating the width of the pit to be dug, add an extra 30 cm to the required internal diameter. Thus a 1.3m internal diameter pit (inside brickwork) should be dug at least 1.5m in diameter. A 1.4m internal diameter pit should be dug 1.6m in diameter and so on. The pit walls should be dug straight down and the pit base should be level.


Dig hole and assemble bricks


The mix of cement and pit sand is 1 part cement and 16 parts pit sand. A ring of bricks is dug at the base of the pit. Everybody can lay some bricks as the number of courses in increased from the base of the pit. The cement mortar is laid on plastic sheet on the pit floor.


About half a metre from the ground level the courses of brickwork are stepped in. About 2cm every course. Thus the diameter of the pit starts to decrease as the pit walls get higher.

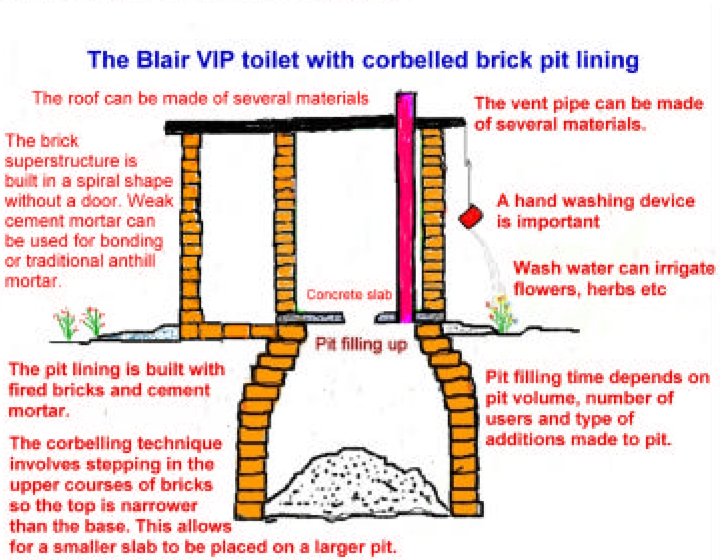

The bricks are stepped in until the external diameter is the same as the concrete slab which has already been case. The bricks should rise above ground level by at least two courses.

The external diameter of the lined pit is measured to match the concrete slab. The slab should sit on top of the bricks with just a little brickwork showing out side the slab for mortaring and making seal.

The slab is then lowered in position with the squat hole facing the correct direction. This will depend on the type of structure built. The slab is laid down in a bed of weak cement mortar to make a good seal and also to ensure that the slab is supported evenly all round. Otherwise the slab may crack.

The slab must also be level. If the slab is not level it should be propped up with stones until is becomes level and the cement mortar applied underneath the slab. The slab must be supported by cement mortar all around. Once the slab is set in position and the mortar has been allowed to harden, the construction of the superstructure can begin.

Cross sectional diagrams of a pit lined with bricks using the mortaring technique.



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Teaching Ecological Sanitation in Schools

A method of lining a pit with bricks using the corbelling technique and also making provision for seepage from the walls into the surrounding soil.

Peter Morgan

Introduction

The corbelling method used to line pits with bricks has the advantage that a small economical slab can be placed over a large capacity pit. Those pits built in trials are generally constructed so they have internal diameter (between bricks) ranging from 1.3m to 1.5m at the pit base. The internal diameter at the top is around 0.8m to 0,9m. The depth is normally 2m but can be increased to 2.5m by digging down further within the brickwork. This capacity should last for 10 or more years for an average family.

This new technique, where lateral pit seepage is encouraged by the provision of a series of holes in the side wall of the pit, is best used where the pit contents build up as liquor, and not as a solid. Ecological pit toilets are shallow and the addition of soil and ash is encouraged in larger quantities to promote composting and reduce smells and flies.

This design works on different principles. The addition of wash water is encouraged (as in a normal Blair VIP toilet), so that the pit fills with a liquor rather than a solid. Thus the use of the toilet as a bathroom is thus encouraged. Ash can be added to help reduce flies and odours. An important part of this design is the biological component – a series of trees planted around the pit. The trees are planted in a circle in a series of drilled tubes about 1m deep. The tubes are filled with a mix of compost and soil to encourage fast growth and deeper root penetration. Diluted urine can also be added to the trees to accelerate growth (see separate manual). As the trees grow they are able to tap the nutrients supplied from the pit which will accelerate their growth. Suitable trees like gum (*Eucalyptus grandis*) will also extract moisture from the surrounding soil, thus reducing liquor penetration to deeper layers.

The value of the brick lined pit is that it can be built with a large capacity and makes the pit stable. Unlike the *Arborloo*, there is no need for annual movement of the toilet. However trees planted around the pit can take advantage of pit nutrients if the pit walls are permeable to liquors.

Fully lined corbelled pits 2m deep with an internal diameter of 1.3m can be lined with bricks using mortar from a single 50kg bag of Portland cement (30 litres) with enough cement left over to make a 1m or 1.1m diameter concrete slab (which uses 10litres). A full bag of cement holds 40 litres. This is a very economical way of using a single bag of cement.

This refinement (adding seepage holes in the side walls of the pit lining) also reduces the number of bricks required in the pit lining. This is because 8 courses of the brickwork are made with holes, which reduces the number of bricks used for every course built.

This manual describes the construction of a corbelled and permeable pit lining. This is achieved by building up the brickwork in the normal fashion and leaving spaces in the brickwork. In this case discarded alloy cans have been used to make the holes in the pit wall.

Diagrammatic view of root growth formation around porous pit lining

3

The constructional technique

1. Dig the pit

The pit is dug in a suitable site 1.6m deep and 1.6m wide. The depth can be increased to 2m or more if sufficient bricks are available. The side walls are dug vertical and the pit base level.

2. Make the cement mortar for the pit brickwork.

Prepare mortar by mixing 16 parts of pit sand with 1 part of Portland cement. This can be prepared in smaller lots using 5 litres of cement mixed with 80 litres (8 X 10 litre buckets) of pit sand.

3. Make the first course of brickwork at the pit base.

A ring of bricks is laid in mortar around the base of the pit. In this case 21 bricks were used in the lowest course of bricks.

4. Start the special porous lining technique.

This is done by placing used alloy cans in spaces made between bricks in each course. Mortar is laid around the cans as well as around the bricks.

The cans are laid between the bricks and cement mortar laid around them.


About two courses are laid with the alloy can inserts. Then the cans are removed with a twisting motion and used to make holes in higher courses. The cans must be removed when the cement mortar it fresh.


The number of bricks used per course is reduced from 21 and 16.


8 courses of the special pit lining with seepage are built followed by normal brick lining. In this pit the internal diameter of the brickwork was 1.4m.

5. Carry on lining the pit using the corbelling technique

The lowest brick course and the special lining technique will raise the pit lining by about 0.9m. That is about 10cm per course. The courses above this are stepped in a small amount at every course so the diameter of the pit lining is reduced. The mix of 0.5 litres of cement with 80 litres of pit sand to make brick mortar will bond about 4 courses of bricks.

Each brick course is stepped in about 2cm so the overall diameter of the pit lining is reduced as the pit lining goes higher

The corbelling continues above ground until the external diameter of the brickwork is just slightly more than the diameter of the concrete slab. In this case it 1.03m. The base of the pit is cleaned out of all mortar which could clog the base of the pit.

The space between the pit and the brick lining is then filled with soil to ground level. The slab is then placed on the pit lining i n a bed of weak cement mortar (16:1)

It is important that the concrete slab is level. Stones may be used to prop up the slab to make it level, then cement mortar is placed below and on the sides of the slab all round to support it. Once the slab is fitted construction of the superstructure can begin. In this case the brickwork rose 20cm above ground level making the total depth of the pit 1.8m. 360 bricks were used and less than 30 litres of Portland cement leaving able to make the concrete slab.

Teaching Ecological Sanitation in Schools

How to make a 1.1m diameter concrete slab for use on the Arborloo, Fossa alterna and Blair VIP toilets

Peter Morgan

Introduction

A strong concrete slabs lies at the heart of a sound toilet structure. Slabs can be made round, square and rectangular to suit different situations. Also slabs can me made in a variety of sizes from 0.9m to 1.2m if a vent hole is to be fitted in addition to the squat hole. The ideal size is 1.1m as this is not too heavy to move and also when fitted to a brick lined pit a round brick superstructure can be built on top of the slab around the rim. The circular slab is convenient because it can be added to a ring beam on lower cost Arborloo toilets or can be added to round pits which are lined with bricks using the corbelling technique. This manual describes how to make a 1.1m diameter slab.

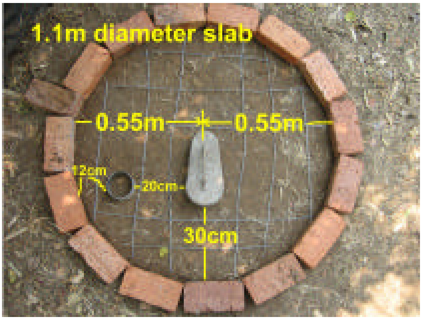
Making the slab

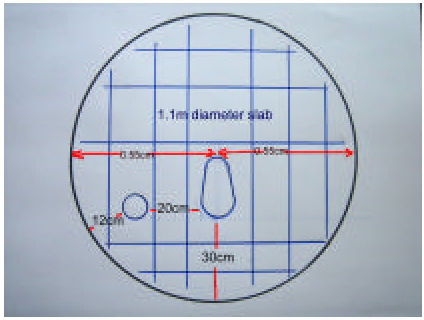
Prepare the shuttering and moulds for vent pipe and squat hole

The shuttering for the concrete slab can be made from a ring of bricks laid on levelled ground. The bricks are laid around a circle 1.1m in diameter (radius 5.5cm). The bricks can be laid on a plastic sheet placed on the ground. Alternatively the ground can be levelled off and river sand laid down and levelled off and the circle of bricks laid on the sand. The sand should be moistened with water. Using a centre mark, bricks are laid around in a circle. A string or wire radiating from a nail placed in the ground is ideal. Or a length of 3mm wire bent at both ends at a right angle to form a 1.1m circle. A mould which has been made for the squat hole is then laid 30cm from the rear end of the slab. This can be made from a 15 litre plastic bucket, with a wire to make the shape), or a commercially made squat hole mould. A durable steel squat hole mould is made by V & W Engineering (who also manufacture shuttering to make both the slab and the ring beam). The vent pipe hole is 110mm in diameter. The vent hole is made using a 75mm length of 110mm PVC pipe. This is laid to one side of the squat hole, so the lower edge of the pipe hole and the squat hole are in line (see diagram). The vent hole is caste 12cm in from the edge of the slab. The distance between the vent hole and squat hole should be about 20cm.

The wire reinforcing

3mm steel wire or barbed wire can be used for reinforcing. For the 1.1m slab 3 pieces 1.1m and 4 pieces 0.9m and 4 pieces of 0.6m are used. The wires are laid on the concrete when half has been added. The remaining half of the concrete mix covers the wire.





Figures 10 & 11: Brick mould for slab showing the dimensions for locating squat and vent pipe holes and also position of the 3mm wire reinforcing. Diagram showing layout of wire reinforcing.


1.1m diameter concrete slab being made by school children. Steel shuttering is used and a steel mould for the squat hole.

The concrete mix

The slab is made with a mix of 10 litres of Portland cement (PC 15) and 50 litres of clean river sand. The dry ingredients are thoroughly mixed and then water is added to make thick concrete. Mix thoroughly. A 50kg bag of cement contains about 40 litres of cement. The remaining 30 litres of cement is used to make mortar to line the pit with bricks.


5 X 10li buckets of clean river sand and 1 X 10li bucket of Portland cement are used to make the concrete. These are thoroughly mixed, water added and thoroughly mixed again.

Adding the concrete to the shuttering

Add half the concrete mix within the shuttering and around the squat hole and vent hole moulds and level off with a trowel. The reinforcing wires are then added in a grid formation as shown in the diagram and photos. The remaining concrete is then added and levelled off with a wooden float and then a steel trowel. After two hours the squat hole and vent hole moulds are carefully remove and the edges of the squat hole smoothed off. Lay some thin poles over the slab and cover with plastic sheet and leave overnight. Once the concrete is hard the following morning add water and cover again with plastic sheet (or sand). If a ventilation pipe is not going to be used immediately the vent hole can be filled with a small weak mix of sand and cement (15:1). Place a ring of plastic sheet in the hole first and then fill with concrete. This forms a plug which can be knocked out later when the pipe is fitted.


Start by adding the concrete mix around the vent and squat hole moulds. Then build up the concrete using half the mix. Add the wires on top of the concrete and press in.

Using the rest of the concrete mix add to the moul d and level off. After about 2 hours carefully remove the squat and vent hole moulds and the outer shuttering. Neaten up any edges with a trowel. Cover with plastic sheet and leave for a week to cure. After the first night water down thoroughly and keep wet for the whole week.

Curing

The slab is left to cure for at least 7 days. It is kept wet under plastic sheet or paper all the time. It can also be covered with sand which is kept wet. The curing process (where the slab is kept wet all the time and not allowed to dry out) is very important. Slabs only develop strength when cured properly. If they are allowed to dry out once made, they never develop strength. Curing is essential for a long life concrete slab. The longer the slab cures the stronger it will become.

Adding the slab to the ring beam or pit lining

Move the slab carefully and place on the ring beam or pit lining. It is best to add a layer of thin mortar around the ring beam or on the upper course of bricks in which to bed down the slab. It is important that the slab is bedded down evenly all round to avoid cracking.

Bedding down the slab in a ring of weak cement mortar is important.

Teaching Ecological Sanitation in School

Making a 1.2m concrete slab suitable for both brick and tubular vent pipes

Peter Morgan

Introduction

This series of manuals has described making concrete slabs which are suitable for tubular vent pipes placed within the toilet structure. This design and configuration allows for a small economic 1.1m diameter slab to be made which can be adapted to suit a wide range of substructures and superstructures. In 2010 the Government of Zimbabwe relaxed its policy of standardising on the brick Blair VIP (BVIP) toilet alone to include an additional design called an Upgradeable BVIP (uBVIP). In this version the basic requirement is for a brick lined pit and a covering concrete slab, which allows the owner to upgrade in a sequence of steps to attain the final brick built Blair VIP. The starting point is a brick lined pit of suitable capacity capped by a slab which has both squat and vent holes. The government specifies that the range of vent pipe options should include those made from bricks as well as tubes (eg PVC or asbestos etc). In fact the specified pipe in the existing technical option for Zimbabwe is made from bricks, although tubular pipes are also fitted.

This new revision of policy which is regarded as a relaxation of the earlier policy necessitates a change in the configuration of the vent and squat holes in the concrete slab and also a slight enlargement of the slab from 1.1m to 1.2m. The existing policy recommends a 1.3m diameter slab built over a pit 1.1m in diameter and 3m deep.

In order to satisfy the new revision of government policy the Chisungu schools program started to build revised slabs with the intention of building a range of substructures and superstructures which could be adapted to use both brick and tubular pipes and also superstructures fitted with doors and without doors (spiral shape).

Brick built pipes can be constructed at relatively low cost with traditional materials (locally made fired bricks) and cement mortar. That is why they have been specified in the existing policy for decades. However brick pipes are bulky and heavy and are not suitable for light weight structures built on ring beams (such as the *Arborloo*). Neither can they be built inside superstructures since they take up too much space. Brick pipes must be constructed outside the superstructure and in fact form part of the brick superstructure of current brick built BVIP designs. This necessitates that the diameter of the slab must be greater than 1.1m. In current designs a heavy 1.3m diameter slab is specified and even this is smaller than the original 1.5m diameter slabs specified in the early 1980's. However in modern Zimbabwe an era of constraint dictates that cement should be used sparingly and carefully so that the investment made is good value for money and time. Also donors are no longer willing to provide the large material subsidies offered in former times.

Consequently a smaller, lighter and more economical 1.2m diameter slab which permits the construction of both brick and tubular pipes has been designed for the schools program. This uses 12 litres of Portland cement and 50 litres of clean river sand (5:1) and 3mm wire for reinforcing. A total of 10m of 3mm wire is used per slab (4 X1.1m + 4 X 1m + 3 X 0.5m). Slabs are caste within steel shuttering as the photos show, but can also be cast within brick moulds.

Earlier 1.1m design (left) for tubular pipes placed inside structure. Later (right) 1.2m design used for wider range of pipes. The 1.1m slab uses 10 litres of cement per slab and the 1.2m slab 12 litres of cement per slab.

Sequence of slab construction

In this case steel shuttering has been used as a mould 1.2m in diameter. The hole for the brick vent has been made 140mm in diameter using a short length of PVC pipe as mould. The squat hole in this case is made using a specially designed steel mould. The brick pipe has a square cross section but a round hole has been chosen to provide extra strength at this point. The 140mm hole is placed 110mm from the edge of the slab and the vent and squat holes are 300mm apart. The squat hole is 300mm long and 150mm wide. The holes are placed down the centre line of the slab.

The slab is being cast over sand on the ground which has been wetted and smoothed down. The moulds for vent and squat holes have been laid in position down the centre line of the slab. The role of 3mm wire is cut into lengths (see above) to reinforce the slab.

A mix of 12litres of cement (one level 10litre plastic bucket) and 60 litres of clean river sand (five level 10 litre plastic buckets) is thoroughly mixed and water added to make a slurry like concrete. This is added into the shuttering around the moulds which are held in position whilst the concrete is added.


Half the concrete mix is added first and levelled off. Then the lengths of 3mm reinforcing wire are added as shown.


The remaining concrete mix is added and then levelled and compacted with a wooden float or bricks. Then it is smoothed down with steel floats.


After about 2 hours the squat hole and vent hole moulds are removed. The outer shuttering is also removed. The slab is covered with plastic sheet and left overnight to harden. The following morning it is carefully watered and covered again. To gain the proper strength before moving the slab should be kept wet and covered for at least 7 days.

Options for the substructure (lined pit)

Once the slab is cured it can be mounted over a suitable brick lined pit. The pits can be of various depths and diameters. The pits can be 2m deep and corbelled or 3m deep and straight walled. The internal diameter of the 2m deep corbelled pit can be 1.3m in diameter or the straight walled 3m deep pit can be 1.1m in diameter. If sufficient cement and bricks are available, pit size can be increased in size. In all cases the uppermost external diameter of the brick lining should be 1.2m one or two courses of bricks above ground level.

Simple early "start up" superstructures

The superstructures built on and around this slab can be spiral shaped without doors or "horseshoe" shaped with doors. Treated poles and grass can be used at first but brick built structures are much preferred, as they are much more durable.

The very simplest first step is to surround the slab with a simple grass and pole structure and cover the ventilation pipe hole with a small concrete cover. Alternatively the vent hole can be filled with a weak mix of cement and pit sand (20:1) which can later be knocked out when the pipe is built or fitted. At first odours and flies can be controlled by regularly adding wood ash to the pit to cover fresh faeces. Also a cover can be placed over the squat hole to reduce flies.

1.2m slab with vent hole filled with weak cement mortar. This can be used as a start up slab. When the upgrade takes place and a pipe is built or fitted, the weaker mortar is knocked out exposing the vent hole in the slab. The alternative (right) is to make a small concrete cover and mortar in place over the vent hole.

Demonstration of brick “horseshoe” shaped structure

In this case the area within the toilet is extended forward in front of the slab. The shape of the structure becomes horseshoe shaped. As described in earlier manuals, two treated poles are placed in holes dug in the ground in front of the slab. The distance between the squat hole and each pole is about 65cm. The photos below show a demonstration unit being built at the school.

In this demonstration the slab remains on the ground where it has been cast. The bricks are laid on the slab and in front of the slab so they join the two door posts which are 50cm apart. In this demonstration the poles are 65cm from the front of the squat hole. The arrangement of bricks which form the vent pipe is also shown. There are four bricks per course in this vent pipe which is built around the 140mm hole.

A series of bricks is then laid in front of the slab and around the door posts. This forms a temporary mould in which concrete will be laid to form the front part of the toilet floor. The concrete mix (about 8:1 with river sand) is laid down level with the slab. The toilet wall will be built on this foundation.

The finished toilet floor before mortaring the bricks in place. The arrangement of the brick pipe around the 140mm diameter hole.

Using a weak economical cement mortar mix (20 parts pit sand to 1 part PC15 cement) the bricks of the vent and walls are bonded together. If traditional anthill mortar is used for the walls, the pipe should still be mortared with cement mortar.

The bricks are laid in the mortar so they join up with the door posts in a gentle curve (horseshoe shape). A second course of bricks is laid for the vent pipe. The brick walls and pipe are then extended upwards so the final height of the wall is about 1.8m and the vent 2.3m.

Bonding the brick vent


The courses of the brick pipe are linked to the brickwork of the wall. This continues as the courses of the wall and vent are built up.


The brick vent pipe can be built at low cost and is very durable. It is later capped by a corrosion resistant fly screen.


After the demonstration has been built the floor was cleaned down to allow the cement floor to cure smoothly. Building brickwork always leaves pieces of mortar on the toilet floor. Later the floor will be dished to allow for cleaning.

Demonstration of brick spiral shaped structure

The more durable and popular Blair VIP is the brick spiral version. This has the advantage that it has more space inside and no moving parts (eg door). If made correctly it can have a long life span. The life is normally linked to the capacity of the pit. Larger pits have longer lives. This version of the BVIP uses more bricks (about double) compared to the version fitted with a door. The roof area is also much larger. It is also more difficult to take apart and rebuild. The following photos show a demonstration of this unit being built by children at the Chisungu Primary School.

The bricks are laid down in a spiral (square or round spiral or combination of both as in these photos). The bricks for the wall foundation are also laid. The distance between walls at the entrance varies from 50cm to 60cm. The entrance to the toilet cubicle is the same. In this case the toilet entrance is 50cm wide.

Particular attention is paid to the four bricks making up the brick pipe. The brick pipe forms part of the brick superstructure.

A foundation of bricks is also laid at the entrance. The first course of bricks is laid over the slab and foundation to demonstrate the shape of the structure.

Using tubular pipes with the same slab.

The brick pipe has been the most popular type used in the rural program because it can be constructed from locally available fired bricks. However tubular pipes can also be fitted to the slab and are more efficient than brick pipes, although they are expensive to buy. A special concrete adaptor is made to fit over the 140mm vent hole for the 110m pipe. This can be cast in strong concrete (3:1) about 16cm X 18cm within bricks using a short (75mm) length of 110mm PVC casing as an internal mould. Four 3mm wires can be set in the concrete as reinforcing. The adaptor is bonded to the slab above the 140mm vent hole in cement mortar.

The concrete adaptor is made in strong concrete. This is bonded to the slab over the 140mm hole. The same series of superstructures can be built using the tubular pipe. These include simple grass and pole structures to brick structures built with doors or without doors.

A versatile slab

The 1.2m concrete slab is a versatile unit which can be used with a wide range of substructures (brick lined pits) and superstructures. In the upgradeable BVIP series, a vent pipe may not be fitted at first. In this case the vent hole is filled in with a weak cement mortar or capped with a concrete cover. A simple superstructure is then built around the slab for privacy. This unit can be upgraded over time by the family according to its wishes and to the funds available for construction. There is a wide choice of routes to follow up the sanitation ladder. Both tubular and bricks pipes can be fitted to toilets which have superstructures made of several materials. Fired brick structures are more durable and the door-less spiral version is the most durable.

The basic 1.2m slab

1.2m slab with vent hole filled in (temporarily) or with concrete cover.

1.2m slabs fitted with brick pipe or adapted for 110mm tubular pipes.

Teaching Ecological Sanitation in Schools

How to make a variety of toilet houses with poles and grass

Peter Morgan

Introduction

The use of treated gum poles and thatching grass can make very effective and durable superstructures for lower cost toilets. This manual illustrates three methods of using treated gum poles and thatch to make suitable structures:

Model 1. Poles placed in ground and straight walls with larger flat roof of poles and cement impregnated hessian
Model 2. Poles in ground and conical walls with domed roof of cement impregnated hessian
Model 3. Poles formed into panels which are each thatched with grass and mounted on the slab with a domed roof of cement impregnated hessian

MODEL ONE

Poles placed in ground and straight walls with larger flat roof of poles and cement impregnated hessian


In this demonstration a fibreglass slab has been used and placed over a concrete ring beam placed over a shallow pit. 6 holes are drilled with an auger around the edge of the ring beam


A door frame is prepared to attach between the two poles at the front of the toilet


The door frame is fitted to the main "king post" with rubber hinges. Meanwhile a timber roof frame is made up to fit over the 6 upright poles.


The roof frame is fitted and nailed to each of the upright poles


3 wires are attached tightly around the poles on to which the grass will be attached. Using thatching rope the grass is added to the structure.

Once fully thatched a cement impregnated roof sheet is made on flat ground and left to cure for 3 days under plastic sheet.

After curing the cement impregnated hessian sheet is lifted and carried to the toilet

The door is added to the main "king post" with rubber tyre hinges and a door covering made (hessian).

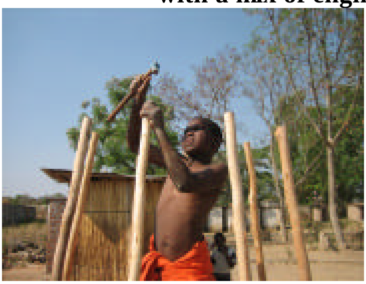
4

Model two

Poles in ground and conical walls with domed roof of cement impregnated hessian.

This grass structure is placed over a lined pit fitted with a 1.1m concrete slab. 8 poles are used in this case and holes are drilled in the ground around the slab to take the poles.

Each hole is drilled about 60cm down into the earth. The poles are treated with a mix of engine oil and creosote.



A 100mm nail is driven into the end of each poles. The domed roof (see instructions in another manual) has been predrilled with holes which the nails pass through. Each nail is bent over to secure


The poles should ideally be 50mm to 75mm in diameter to accept the nails and make the structure rigid. The soil around the poles is rammed hard in place.


A door is made to match the shape and distance between the two front poles. This is fitted with car tyre hinges and attached to the left hand post.


The structure is then thatched completely on 4 wires fitted to the posts. Thatching string is used. The door is fitted with a hessian covering

Model three

Poles formed into panels which are each thatched with grass and mounted on the slab with a domed roof of cement impregnated hessian


This model uses 12 upright poles to make 6 separate panels joined together top and bottom with shorter poles. The upright poles are 1.9m long, the lower spacer poles are 55cm long and the upper spacer poles 35cm long. The wooden panels are nailed together.


The panels are mounted over the slab (on a ring beam in this case) and held together with rubber initially, then wire.


Using wires attached to the side poles and thatching twine, the grass is attached to each panel. 5 panels are made up with one panel being used to support the door.


A domed cement impregnated hessian roof is added on top and can be wired in position for security.


A suitably sized door panel is made and fitted the main post with rubber hinges. A hessian door covering is attached to provide privacy.

Teaching Ecological Sanitation in Schools

(Outreach program)

How to make a toilet with gum poles and fabric or hessian as walling

Peter Morgan and Annie Shangwa

Introduction

It is possible to erect simple toilets very rapidly if treated gum poles and tough materials are available for making the walls of the toilet house. In these examples cotton fabric and hessian sheet were used to make the toilet house walls and doors. In both cases described the roof was fabricated from cement impregnated hessian sheet to form a dome.

Where gum poles are placed in the ground it is essential to treat the poles against termite attach. This can be done by buying pressure treated poles or by soaking untreated poles in a mixture of creosote and old engine oil. Some measure of protection can be gained my mixing wood ash with the soil used to ram the poles in place within the holes made for them. But termites are very determined and proper treatment is recommended.

In this case the toilet was made for a girl child and was fitted with a pedestal made from a bucket and concrete. The toilet was an *Arborloo* type made with a brick ring beam and small concrete slab.

The gum poles in this case were only 1.8m long (fence posts) but were ideal for use in the children's toilet. The lower 0.5m was treated with a mix of creosote and old engine oil. 6 holes were drilled with an auger around the ring beam. The tops of each poles were drilled with a hole and a 100mm nail was driven into the end for attachment to the domed hessian cement roof.

View of the nails hammered into the poles before and after the hessian cement roof was fitted.

A fabric sheet is wrapped around the toilet to provide privacy. It is held in place with wire. A simple door (without hinges) has been added. In this case using poles and an opened plastic sack held at the top and weighted at the bottom.

The interior of the simple toilet

3

The door made of hessian sheet and poles

A length of hessian sheet was cut and folded and stapled (or sewn) so that a thin gum poles could be attached to the upper and lower ends. The gum pole at the upper end was supported by two nails driven into the front house poles. This was held firm with wire.

Another pole was placed through the pocket made at the lower end of the hessian sheet. The door this hangs under its own weight.

4

A similar structure made of hessian sheet

A similar arrangement of treated poles can be covered with hessian sheet as the following series shows


The ring beam is placed in a suitable position. The slab, door and roof are prepared.


6 holes have been drilled around the ring beam and treated gum poles placed in each. In this method a short length of gum pole connects each upright pole near the top. A domed roof is fitted and nails are driven through the roof into the poles.


The hessian sheet is then attacked to the poles using cut pieces of wire used as nails.


The hessian sheet is fitted all round. The hole inside the ring beam can be dug before the toilet is built or during construction.


The door has been fitted with rubber hinges. The interior of the toilet, in this case fitted with a high quality fibreglass slab.


Teachers and staff talk to the homestead family and pupils on how to manage the *Arborloo*. The completed unit in Epworth.

Treating the hessian with cement paint.

The hessian may last longer and be less prone to damage if it is treated with cement paint. The paint is made by mixing Portland cement with water to make a liquid which is then applied to the hessian cloth with a large brush. To aid hardening a small tin of salt can be mixed in the water before it is added to the cement.


The cement mix is made in a large bucket and thoroughly mixed using long rubber gloves.


All the panels are treated with the liquid cement which is applied with a large brush.


The door panel is also treated. A hand washing facility has been fitted.

7

Teaching Ecological Sanitation in Schools

Making self closing doors for toilets

Peter Morgan

Introduction

For many years toilets built in the rural areas of Zimbabwe have been built with door-less spiral shaped structures. These units have no moving parts and have proved to be durable. However the roof area and walling of spiral structures uses a lot more material than smaller structures fitted with a door.

If a vent pipe is fitted and the properties of a VIP are required it is important that the interior of the toilet is semi dark. This means that if a door is fitted it must have hinges which are self closing. Self closing hinges can be made of suitably cut pieces of car tyre and nailed or screwed to the door and to the post on which it is hung.

There are several ways of making a light weight door. The method used in the Epworth Schools program uses wooden timbers called “brandering.” With some local skill gum poles could also be used. Plywood panels are used to link the various lengths of “brandering” together. Nails are used. The pieces of car tyre can be cut with a sharp knife. The door panel itself should be light and can be made of hessian sheet or cement treated hessian. Heavy duty shade cloth can also be used. It is best that the wood is treated in some way to avoid attack by termites. If the door is attached to posts which are made of treated gum poles, the termites may not pass up the pole to the wood of the door. Doors and roofs are made by the pupils as part of the schools program in Epworth.

Door frame made of “brandering” can be made with vertical sides or slanting sides to fit the type of doorway required. Also the middle reinforcing timber can be a diagonal or straight across as shown above. In each case the timbers are held together with plywood triangles nailed to the brandering as shown. This seems to be fast and effective for light doors.

The rubber hinges are made from car tyre, cut with a knife. They can also be made from sheets of polyurethane.

Method of fitting the door frame to the supporting pole

Two strong pressure treated gum poles form the "king posts" of several structural designs for new toilet houses. The poles are placed in holes drilled in the ground at the front of the toilet slab.

The upper and lower hinges nailed into position

3

Pupils making doors


Pupils putting together the door frame with triangular pieces of plywood and nails.


Pupils cutting the rubber hinges from car tyre.


Pupils attaching the rubber hinges to the door frame and supporting pole.

The material used to cover the door should be durable and light weight. Thin sheets of galvanised tin work well. A low cost method uses cement impregnated hessian sheet (2 layers) which is nailed to the door frame and painted. Doors do need care and maintenance to last.

Making and fitting a door panel

Once the door frame and hinges are made a door panel must be fitted to provide privacy. The panel can be made from a variety of materials including plywood, thin galvanised tin sheet, cement impregnated hessian, heavy duty shade cloth etc.

Making a door panel from cement impregnated hessian


Two sheets of hessian are cut to the required size to fit the door frame (0.5m X 1.5m in this case). A cement paint mix is made by adding 2litres of Portland cement to 1 litre of salty water (about 2 tablespoons salt added).


Using rubber gloves the cement paint is poured onto the hessian and rubbed in with the hands wearing rubber gloves (the cement is caustic). Once the first sheet is soaked the second sheet is applied over the first and rubbed in. More cement paint is applied all over. The hessian is covered with plastic sheet for several days before it is moved and mounted on the door frame with small nails. It is also best to paint the door panel with enamel paint to make it more attractive and long lasting.

Fitting the door panel and painting

Using small nails to attach the hessian cement panel to the door frame

The cement impregnated hessian door panel has been mounted on the door frame with small nails. It is allowed to dry and then painted with enamel paint if decoration is required. The door and its frame may require ongoing maintenance. The door panel and hinges must be kept in good condition and replaced in they are worn or damaged.

Teaching Ecological Sanitation in Schools

Construction of flat cement impregnated hessian roof sheet supported on wooden frame.

Peter Morgan

Introduction

Cement impregnated hessian is a useful material for making roofing sheets which are durable. Unlike the domed roof which is self supporting, the flat hessian sheeting is flexible and requires support from a wooden frame made from gum poles or wooden "brandering" used in the building trade. This manual describes the construction of roof panels of two sizes, 1.4m X 1.5m supported on a frame made of brandering and 1.8m X 1.8m supported on a frame made of gum poles.

1. Making the wooden roof frame from brandering

Roof frame from "Brandering"

The roof frame can also be made of brandering. In this case 7 pieces are cut to make a frame 1.4m wide and 1.5m long to suit the structure on which it will be placed. 5 pieces are cut 1.2m long and 2 pieces 1.4m long. The roof sheet overlaps a little all round.


The pieces of wood are cut and can be nailed together. They can also be wired together as shown in these photos.


A roof frame wired together and wired to superstructure poles

Preparing the cement impregnated hessian sheet

In this case the cement impregnated roof sheet was made 1.4m wide and 1.5m long. 2 layers of hessian were used. 8 litres of Portland cement mixed with 5 litres of water to which 300mls salt had been dissolved. The salt was first dissolved in the water in a bucket and then the cement was added to the salty water and thoroughly mixed using rubber gloves. The first hessian sheet was laid on a large piece of plastic sheet and the cement paint rubbed into the hessian all over. The second sheet of hessian was then added and more cement paint rubbed in all over. For extra strength and durability a third sheet could be added. In this case 10 litres of cement and the 6li water (and salt) is sufficient mix for the three layers of hessian. Finally the roof sheet was covered with another sheet of plastic and left to cure for several days before being lifted in position. This hessian cement method is useful for a variety off sizes of roof panel. The salt helps to harden the panel. The three layered version is stiffer and stronger and is preferred.

The cement paint is prepared and the hessian sheet laid on plastic sheet,

The cement paint is thoroughly rubbed into the first hessian sheet. Extra cement is added and the second hessian sheet is placed over the first. More cement paint is rubbed in all over. Then the sheet of covered with plastic sheet to cure.

Placing the wooden frame and roof sheet on the structure

There are two methods of adding the roof frame to the structure. The frame can be added first and the roof panel placed on this later or the roof panel can be added to the frame and the combination placed on the structure. In this case the frame was added to the structure first and the panel added later.

Attaching the frame to the simple treated gum poles structure. And adding the cement filled hessian sheet to the frame.

The roof sheet is attached to the roof sheet using small nails. The roof frame can either be nailed or wired to the supporting poles.

Roof frame from gum poles.

The roof frame is made from 9 small gum poles 1.8m long. These are bound together with thatching twine as shown in the photos. The roof timbers are cut to match the superstructure. In this case about 1.8m square.


Binding the roof timbers with thatching twine

2. Preparing the hessian sheet

The hessian sheet is cut and prepared to match the structure and roof frame. Standard hessian cloth has a width of 1.4m and is sold by the metre in Zimbabwe. In this case (to make a sheet 1.9m X 1.9m) 2 pieces are cut 1.9m X 1.4m and 2 pieces 1.9m X 0.7m. A plastic sheet is laid on the flat ground and the first later of hessian sheet is prepared so it measures 1.9m X 1.9m.

Laying the plastic sheet on the ground and laying the hessian sheet over this. Later the plastic sheet will be folded over to cover the hessian during the curing stage,

3. Preparing the cement paint

A cement paint mix is prepared by adding 10litres of PC15 (Portland) cement to a large bucket and adding 6 litres of water to which 400mls of table salt has been dissolved. The salt accelerates and helps to harden the cement mix once it has soaked into the hessian. This paint is applied to the hessian sheet using a cup and is rubbed into the hessian using long rubber gloves. The cement is corrosive to the skin.


The cement and salty water are mixed in a large bucket and thoroughly stirred using rubber gloves.

4. Applying the cement paint to the hessian sheet

Using rubber gloves the cement paint is rubbed into the hessian all over. At the overlap between the two pieces the paint is applied all over one sheet before the second sheet is soaked in paint. This makes a good bond between the two sheets. Once the first layer has been soaked in cement paint the second sheets of hessian are laid on top of the first sheets and more cement paint is added. A little extra paint may be required to soak all the material.


Adding cement paint to the first layer of hessian. Adding the second layer of hessian, once the first layer has been filled with cement.


Adding the cement mix to the second layer of hessian so that the upper and lower layers of hessian bond together. Once the two hessian sheets are filled with cement the roof is covered over with plastic sheet and left to cure for several days.

5. Lifting the sheet after curing and placing on roof timbers


The flexible cement impregnated hessian roof sheet is carefully moved on to the roofing timbers

6. Adding roof to toilet structure


The roof is then carried to the toilet and fitted on top

The roof timbers are bound to the structure with strong twine or wire. The roof sheet is also bound on to the roof frame with strong twine (thatching twine).

Teaching Ecological Sanitation in Schools

How to make vent pipes from reeds and cement filled fabric

Peter Morgan and Annie Shangwa

Making low cost vent pipes for low cost VIP toilets

In ecological pit toilets soil and ash are added regularly to the pit for help form pit compost. These additions also reduce fly and odour nuisance. However a vent pipe does help to withdraw air and water vapour from the pit (or vault) and makes the interior of the toilet less smelly.

There are several methods for making low cost vent pipes for ecological VIP toilets. Most use the method of making paint by mixing cement and water and applying this to Hessian cloth or other material which is laid over a mould. The mould is covered with plastic sheet and can be made with PVC pipe. The cement filled fabric is allowed to cure slowly and the material can set very hard. Portland cement (PC15) must be used for this type of work.

Method of laying cement filled cloth over reed pipes.

If PVC pipe is not available it is possible to make a pipe in the form of a frame from reeds or slit bamboos. Cement impregnated material can then be wrapped around the pipe frame and left to cure and get hard. The reeds or slit bamboos should be around 2.2metres long. They can be wrapped around old tins with the bottoms cut out for support being held by strips of old car or bicycle tube. Alternatively the reeds can be bound together around a series of wire loops of a suitable diameter to form a tube. If well bound these tubes can be quite rigid and form an ideal frame around which the cement impregnated cloth can be wrapped. It is best to soak the material (old cloths, sacking, hessian, thin cloth etc) in the cement paint to which some sand has been added to give it extra strength. The material can be held in place over the pipe frame with string.


Making tubes out of reeds fitted over old tins or wire loops. The reeds should be around 2.1metres long. The reeds (or bamboo) can be drilled out at certain points along the length and the wire loops threaded through them. Or cut lengths of reed or bamboo can be bound to the loops with string.

Old cloth is cut up into suitable sized pieces and then soaked in a mix of cement (1 part) and fine sand (2 parts) which has been made into a thin porridge like mix. This cement soaked material is then wrapped around the pipe. The material can be held with string. Small lengths of pipe frame are demonstrated at first and wrapped with smaller pieces of material


Demonstrating the method of making vent pipes at Chisungu school. At first short lengths of tube are shown and covered with cement and sand soaked material. This is left to harden. It is best to cover the slurry filled material with plastic sheet to stop it drying out. The slurry gets hard because it cures and not because it dries out. This process takes time and once hardened it is best to keep the cement wet to gain maximum strength.

Stout tubes can be made with reeds. A fly screen is bound to the end of the tube either before or after applying the material.

Full length pipes being covered with cement and sand impregnated cloth at Chisungu school. The technique takes a bit of practice to get it right.

A section of the cloth is coated in a strong cement and sand slurry to demonstrate the method. The full length pipe completed.

Teaching Ecological Sanitation in Schools

How to make a hessian cement vent pipe

Peter Morgan and Annie Shangwa

Introduction

Very durable and effective vent pipes can be made using hessian sheets filled with cement paint. The paint hardens more quickly if salt is added. Earlier pipes were made 90mm in diameter, but the larger 110mm version is more effective. The following steps are used to make the pipe

1. Preparing the hessian sheets

Two pieces of hessian sheet are cut 2.3m long and 40cm wide.

2. Preparation of plastic sheets

Three pieces of plastic sheet are cut. 2 are 2.4m long and 40cm wide. The third is 2.5m long and 50cm wide. Two will be attached to the pipe mould (a length of PVC pipe), the third will act as a ground sheet

3. Preparation of pipe mould

The pipe mould is made from a 2.5m length of 110mm PVC pipe. The 40cm x 2.4m plastic sheet is folded twice along the length and attached along the length of the pipe with tape. Next the second 40cm x 2.4m plastic sheet is wrapped around the pipe and secured with tape. The third sheet of plastic forms a clean sheet on which the pipe is made on the ground. The first sheet of hessian is laid down over the ground plastic sheet.

The folded sheet of plastic is laid along the length of the PVC pipe and taped in place. Later this will be withdrawn from the mould first. The PVC pipe is then covered with another sheet of plastic and taped in place. The hessian sheet is then laid on a further piece of plastic placed on the ground. The application of cement paint now begins. NOTE: The folded piece of plastic is withdrawn first after the cement has cured and hardened. Without this folded plastic the hessian pipe would be difficult to withdraw from the mould.

4. Preparation of cement paint

The cement mix is prepared by placing 6 litres of Portland cement into a bucket. 3 litres of water are added to another bucket and a small tin (150 ml) of salt is added and dissolved in the water. This salty water mix is added to the cement and thoroughly mixed using rubber gloves.

Stages in the preparation of the cement paint. 6 litres of PC15 cement is mixed with 3 litres of water to which 150mls of salt has been added. Here salt is being added to the water.

The salty solution is being added to the cement. The PVC pipe mould is ready and the first sheet of hessian laid down on a plastic sheet on the ground.

5. Application of cement paint.

Using an old cup the cement paint is poured on to the hessian sheet and thoroughly spread around and rubbed into the sheet by hand using the rubber gloves. The paint should be thoroughly absorbed into the hessian. The PVC pipe is then laid down the centre of the hessian filled sheet which is then wrapped tightly around the pipe. Extra cement paint is applied along the joint to seal it well. The cement paint should be applied liberally.

Stages of apply the cement paint

The second sheet of hessian is then laid on the plastic sheet and the cement paint is applied all over. The pipe is then placed down the middle of the sheet and once again the cement filled hessian is wrapped around the pipe. Extra cement paint is added to thoroughly fill the hessian. The pipe is then mounted on bricks. Finally an extra strip of hessian is cut and placed around each end of the pipe to give extra thickness. This is also filled with the cement mix.

Further stages of pipe construction

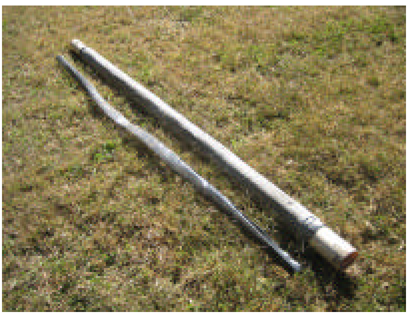
5. Sealing off pipe for curing

After the hessian is thoroughly soaked with the remaining paint, the plastic sheet is wrapped around the pipe. This will ensure that the cement will cure properly without drying out and will develop full strength. It should be left in place for at least 7 days before removal.

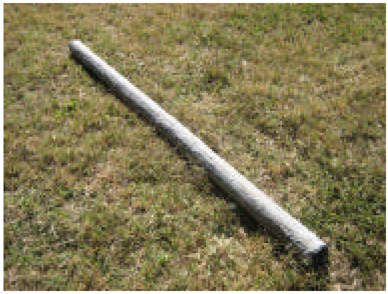
The cement impregnated hessian is allowed to cure a little and is then covered with the plastic sheet

6. Removing pipe from mould.

The folded plastic sheet is first removed from the mould. This loosens the pipe from the mould a little. The hessian pipe can then be removed from the mould with the plastic inside. The plastic sheet is then withdrawn from the inside the pipe.



Remove folded plastic sheet first. This loosens the pipe a little so it can be withdrawn from the mould. Then pull out the PVC pipe from the outer hessian cement pipe. Care is required



The plastic sheet is now removed from the inside of the pipe with a twisting motion. This leaves a free standing hessian cement pipe.

7. Adding the aluminium fly screen

To be effective as a fly trap fly screen should be added to the pipe. This is best made of aluminium or stainless steel as these are corrosion resistant. Aluminium screen is cheaper. A piece 15cm square is cut and attached to the end of the pipe with wire. Then a sheet of hessian filed with cement is wrapped around the pipe and covered with a plastic bag to help it cure. Leave for a few days before using.

Attaching the fly screen to the vent pipe

Making the vent pipe at the school

A length of folded plastic is laid down the PVC pipe mould and attached with tape. This is covered with another sheet of plastic which is also taped in position.

The cement paint is made as described earlier with 6 litres of Portland cement, and 3 litres of water in which salt has been added.

The cement mix is stirred thoroughly using rubber gloves.

The hessian sheet is then cut 2 pieces measuring 2.3m long and 40 wide. The first sheet is laid on plastic. The application of the cement paint begins.


The first hessian sheet is thoroughly soaked with the cement paint. This sheet is then wrapped around the plastic covered pipe.


The second sheet of hessian is then laid on the plastic next to the pipe and this is also filled with the cement paint. The second sheet is then wrapped around the pipe over the first sheet.

Further stages in pipe making

The hessian sheet is rubbed down thoroughly and any left over cement paint applied.

An additional piece of hessian is applied at each end of the pipe to strengthen it. The pipe is mounted on bricks and covered with plastic and allowed to cure for at least a week.

Withdrawing the pipe after curing


The pipe after curing. Removing the folded plastic sheet


Removing folded plastic sheet and withdrawing PVC pipe


A tug of war takes place and finally the pipe is removed. The plastic sheet is removed from inside the pipe with a twisting motion. The pipe is now ready for attachment of the fly screen

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Teaching Ecological Sanitation in Schools

How to make pedestals

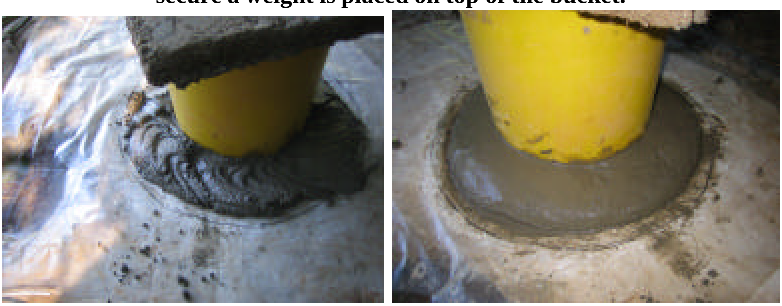
Peter Morgan and Annie Shangwa

MAKING LOW COST PEDESTALS

Very effective pedestals for sitting on toilets can be made with standard plastic buckets and concrete. If Portland cement is available the mix is one part cement to 3 parts sand. If masonry cement is available it may be best to make a 1:1mix. It is possible to make both a standard pedestal and a urine diverting pedestal using a 10litres bucket and concrete. The bucket provides the inside of the pedestal with a smooth wall which can be cleaned down. The outer shell of concrete (with some wire reinforcing) offers strength and durability. The unit can be painted in bright enamel paint colours once the concrete has been allowed to thoroughly cure and dry off.

The standard pedestal

A 10 litre plastic bucket is used and the base sawn off. The bucket is placed base down on a piece of clear plastic and a mark drawn 75cm around the bucket. To keep it secure a weight is placed on top of the bucket.



A mix of cement and river sand is now made up. If Portland cement is used the mix is 1 part cement and 3 parts river sand. If masonry cement is used a 1:1 mix is used. The concrete can be mixed in small lots with a litre of cement being mixed with the sand at any one time. The concrete is made into a neat round shape with a trowel. A ring of 3mm wire is placed inside the concrete.

This ring of concrete will become the seat of the pedestal. Additional concrete is then added half way up the side wall of the bucket. This is covered with a plastic sheet and allowed to cure for 1-2 days. The following morning the concrete is wetted down and a ring of 3mm wire prepared and wound around the middle of the bucket. The bucket is then carefully turned over.

The base of the pedestal is then built up in the same way using the same mark on the plastic sheet. A 3mm wire ring is placed in the concrete. The concrete is shaped neatly so that upper and lower layers meet to form a strong shell around the bucket. The pedestal is then covered with plastic sheet. The next day it is watered and kept wet for at least 7 days to cure.

After this period it is allowed to dry out in the sun. The seat section is then filed and sanded down to make it smooth. It can then be coated with enamel paint. Bright colours are best!

Children making the pedestals at Chisungu School


The procedure follows the one described above. A strong mix of cement and river sand is made.


The mix is applied with a trowel to the bucket mould


Wire loops are added around the bucket inside the cement to strengthen and prevent cracking.

The deluxe model!

The same technique can be used to make a very smart pedestal. In this case the pedestal is not painted by coated with an extra layer of cement mortar mixed with red oxide.


The 10 litre bucket (with base removed) is placed over a plastic sheet and a strong cement mortar (5 litres PC15 cement and 10 litres river sand) is added around the wider part of the bucket. A length of 3mm wire is placed within the cement. Next day the bucket s carefully turned over and the base made.



Once complete red oxide is added to a further mix of strong mortar and skilfully applied over the surface to make a fine looking pedestal.

5

Making to low cost urine diverting pedestal

This is made in a similar way to the simple pedestal, but additional parts are added to provide the urine diverting properties. A 20mm plastic polythene pipe is required and also a piece of specially shaped tin sheet (from a pea tin).


The base is cut off a 10 litre bucket. Carefully using a sharp knife a hole is made in the side wall of the bucket to take a 20mm polypipe fitting.


The hole must be cut precisely so the plastic pipe fits tight.


A tin sheet is cut from a tin, flattened and then cut into shape. This fits inside the bucket to form the urine diverter. It is held in place by wire.


The position of the tin sheet is marked and a series of holes are made in the bucket with a hot wire.


Wires are then used to secure the tin in position. The wires are bent over the tin sheet.


One wire passes along the top of the tin sheet and through the bucket and is bent over at each end. This secures the tin well. Chewing gum is used to make a seal between the bucket and the tin sheet. The sheet can be replaced later if required. The wire is best galvanised so it lasts longer.

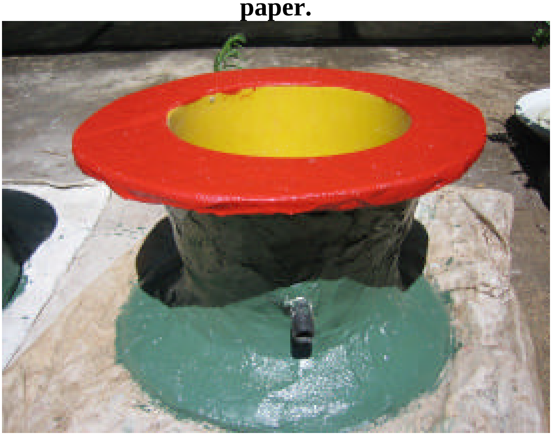
A mark is made around the bucket about 75mm away in a circle. Using a concrete mix and careful shaping the seat of the pedestal is built up. If Portland cement is available a 1:3 mix can be used (3 parts river sand and 1 part cement). If masonry cement is available the mix is 1:1. Make the concrete up in small quantities using a litre of cement at a time. A 3mm wire ring is inserted in the concrete. In this case the wider part of the bucket will be uppermost and have the seat formed around it. This is left to cure for a day.

After a full day of curing the bucket is turned over and placed back on the plastic sheet. More concrete is missed and built up around the base and also around the side walls of the bucket and around the plastic pipe. The concrete is then allowed to set overnight and then is cured over the course of a week or more. It is kept wet at all times to allow the concrete to develop full strength.


It is important that the concrete work be allowed to cure fully to gain maximum strength. After this period the pedestal is placed in the sun and allowed to dry out completely.


Rough edges are filed down with a steel file or smoothened with course sand paper.



After this the concrete can be painted with brightly coloured enamel paint. The unit will still work if not painted, but is more attractive if brightly coloured. The urine pipe placed above slab level makes it possible to divert the urine to a tree or plastic container even when the toilet is placed over a pit.

Teaching Ecological Sanitation in Schools

How to make urine diverting slabs

Peter Morgan and Annie Shangwa

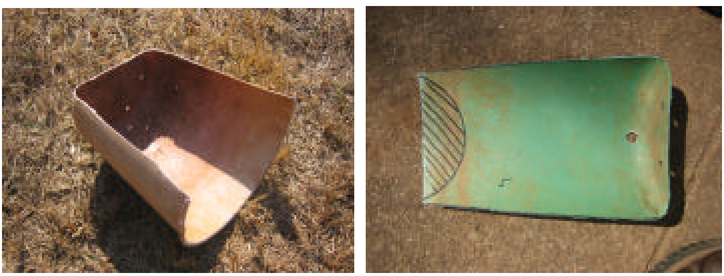
Making a urine diverting slab in concrete.

Urine diversion is a relatively new technique which makes it possible to collect urine when using a toilet. Urine is directed into a urine catching area in front of the "drop hole" and is piped out of the toilet into a container or into a seepage area. The faeces drop directly into a shallow pit or vault built above ground level. Most urine diverting toilets are built above ground level. Some have a single vault, most have two vaults, the use of which is alternated. Sometimes a bucket or other container may accept the faeces. Ash and soil are also thrown down on to the faeces to help dry them out and promote composting. There are many ways of making urine diverting pedestals and squat plates. This method is quite simple and requires mainly cement, sand and wire. Some form of plastic container like a bucket is required to make the "urine catcher" and a pipe to lead the urine down from the urine catcher to a plastic container.

1. Making the urine diverting slab

(With urine outlet below slab)

First a plastic "urine catcher" must be made to fit into the concrete slab. In this case a 10 litre plastic bucket has been chosen. This is cut with a saw to the shape shown in the photos. It is best to use a pre-made template (a shaped piece already made) to fit over the new bucket and mark the outline. Then the bucket can be cut around the mark. Two "urine catchers" can be made from one 10li bucket.



The 10 litre bucket is cut with a saw. The width of the narrow end depends on the size of the squat hole. In this case a 160mm squat hole is used and the width of the narrow end is 170mm. The width of the wider end is 185mm.

A hole is drilled in the “urine catcher” as shown in the photo. Urine will drain through the hole into a pipe fitting and then through a plastic pipe to the outside of the toilet. The “urine catcher” is laid down over a sheet of plastic and placed close to a suitable mould for the squat hole (diameter about 160mm). This can be a round pipe. The end nearest the squat hole is held down with a wire or nail so it lays flat next to the squat hole. A mould of bricks is laid around these parts which offers a large enough in area to accommodate two foot rests on either side of the squat hole. The slab area can be the same as the final slab required, or smaller so that it can be adapted to fit into larger slabs of various shapes and sizes later. The smaller slab can be fitted within a larger mould and the extra concrete added.

Cut “urine catcher” placed within a brick m ould together with a squat hole mould. Design by Annie Shangwa.

A hole in the “urine catcher” will become the lowest point when the slab is turned over. This is the drain hole for the urine. A 20mm plastic pipe fitting is placed over the hole and held in place by a length of wire (or screwdriver as shown). In this case a 20mm plastic hose connector has been used. But PVC fittings can also be used. This pipe can be attached before hand with hard setting putty. Or as shown in this case, can be held in place by the concrete which will be added. Urine passing into the urine catcher passes down the pipe into a plastic container or into a seepage area outside the toilet.

A strong mix of concrete is then prepared (3 parts river sand and 1 part cement). This is then added around and over the plastic parts. 3mm reinforcing wire is also added within the concrete.

The pipe connector held in place. Concrete mix being added to mould.

The concrete is added to a depth of 30 – 40mm. The concrete is laid carefully around the urine pipe. The concrete is allowed to cure for at least 3 days before the slab is turned over and laid on bricks, so the footrests can be added and the final surface of the slab made.

The slab is then turned over and laid on bricks around the rim.

The wire used to hold the plastic is removed and the exit hole for urine smoothened down. The foot rests can now be added. These can be hand shaped or freshly made concrete can be placed in wooden moulds as shown.

Each foot rest mould is filled up and made smooth and neat. When the concrete has started to harden, the moulds are carefully removed and extra cement plaster is used to smooth down the entire surface of the slab.

The unit shown can be made as part of a complete slab (either round or rectangular), or (as shown above) it can be made as a special smaller unit which can then be placed within a larger slab caste around it. Where a smaller unit is made first, this can form the central part of a larger slab. The technique is shown below.

A hole is dug in the ground and a sheet of plastic is laid over it with a hole in the middle.

The slab can then be placed over the plastic sheet so the urine pipe enters the hole.

A circle of bricks is laid down around the slab to the required size. This is then filled with concrete with some reinforcing wire inserted. It is left to cure. This urine diverting slab offers a clean non absorbent surface for urine collection, which can be made at low cost.

2. Making a urine diverting slab
(Outlet pipe above main slab)

This is similar to the urine diverting slab described earlier, but the slab is designed so the pipe comes out above the main slab and not beneath it. Urine is directed into a urine catching area in front of the "drop hole" and is piped out of the toilet into a container or into a seepage area. The faeces drop directly into a shallow pit or vault built above ground level. This method allows the urine diverting device to be placed on top of an existing slab which can be mounted over a pit as well as an above the ground vault. The plastic components are made first.

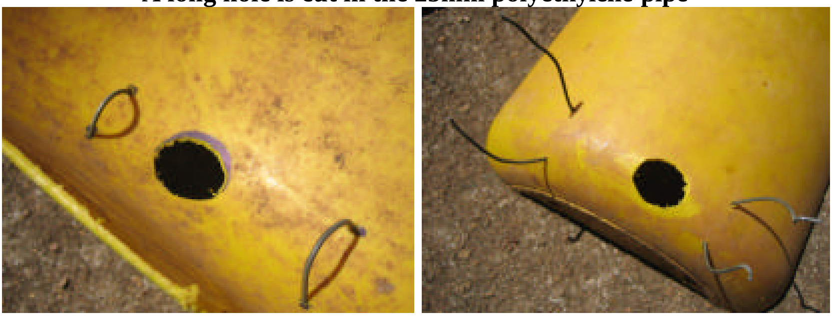
Making the urine diverting slab

First a plastic "urine catcher" is made from a 10 litre bucket. This is cut with a saw to the shape shown in the photos. It is best to use a pre-made template (a shaped piece already made) to fit over the new bucket and mark the outline. Then the bucket can be cut around the mark. Two "urine catchers" can be made from one 10li bucket. In this case a plastic pipe is attached to the lower end of the plastic urine catcher and this directs urine to the slide of the slab in which the device is caste.

The 10 litre bucket is cut with a saw. The width of the narrow end depends on the size of the squat hole. In this case a 160mm squat hole is used and the width of the narrow end is 170mm. The width of the wider end is 185mm. A hole is cut in a 0.5m length of 25mm plastic pipe as shown.

A hole is drilled in the “urine catcher” as shown in the photo. Urine will drain through the hole into the pipe and then drain away to the side. The following photos show the sequence.

A long hole is cut in the 25mm polyethylene pipe



A hole is also cut with a sharp knife in the cut section of bucket at the lowest part where the urine will collect

Small holes are then drilled into the bucket, through which wires are massed to secure the polyethylene pipe. Urine will fall into the urine collector and then through the pipe and out of the slab.

This plastic “assembly” is then placed in a concrete slab as shown in the following photos. The assembly is placed in the middle of a mould made of bricks. It is then filled with strong concrete (4:1 river sand and cement). Note the plastic pipe passes through the concrete and then out of the slab. It will later carry urine to a container.

First additions of concrete. Note the polyethylene pipe passes through the concrete and then out of the slab area.

Later additions of concrete up to the level of the urine catcher

The two foot rest moulds are then added filled with concrete. These are allowed to set and the wooden moulds removed. The slab is smoothed down with a strong coast of cement mortar. The slab is cured for several days.

When cured the slab (which is quite heavy) can be mounted over the main toilet slab of a pit toilet or above the ground vault. The urine pipe is fitted with a connector to a pipe extension which is then led to a plastic container or a tree nearby. Ideally the concrete surface should be smooth and painted with an epoxy paint or a gloss enamel paint to reduce urine being absorbed into the concrete which will make it smell.

Teaching Ecological Sanitation in Schools

How to make hand washing devices

Peter Morgan and Annie Shangwa

How to make hand washing devices

If health benefits are to be gained from a sanitation programme the inclusion of a hygiene and hand washing component is essential. Hand washers of many types are easy to make and cost almost nothing. They should be fitted to every toilet made. Hand washers can be made from tin cans and plastic bottles and cups as the following pictures show.

Making a simple hand washer from plastic bottle ("dip technique")


There are several types of simple hand washer. This one uses a plastic bottle. Cut the bottom off about one third up. Make a hole in one corner of the base near the edge with a sharp nail or sharpened piece of wire.


Wrap some thin wire around the bottle and hook up to part of the toilet. To use the washer it can be dipped into a container of water on the ground or some water from another bottle can be added to the washer. The water comes out slowly, but it is sufficient to wash the hands. It uses water economically. Tin cans can also be used. This is described next.

Making a simple hand washer from plastic bottle (“screw cap” technique)

In this method the airtight seal made by the cap of a plastic bottle is used. The plastic bottle should have firm sides and ribbed bottles may be best. A small hole is made in the lower part of the bottle with a heated nail 2 or 3mm in diameter. The smaller the hole, the more economical the hand washer become in terms of using water. A cut section of a “ballpoint” pen cartridge can be inserted in the hole to make water use even more economical. The unit is filled with water and the cap done up tight. When the cap is unscrewed water flows from the hole for hand washing. When the cap is done up tight the water flow stops.

A variety of bottles can be used. A heated nail makes the hole

Heat the nail with a flame and carefully push into the base of the bottle

Water flow with a 3mm hole or reduced with a pen cartridge.

Making a simple hand washer from an alloy can

Take an alloy can (coke etc) and take the top off with a can opener. Make two holes with a nail at the top of the can with a nail and another hole half way between these holes at the base of the can.

The can is placed over a log or pole which makes the hole easy to make with a nail. Two holes are made on either side of the can at the top. Then a single hole is punched into the base of the can in a position between the two holes at the top of the can. A good nail diameter is 3mm.

A length of wire about 30cm long is then taken and passed through the two holes at the top of the can. The wires are twisted together behind the can as shown. A loop is made at the end of the wire. The hand washer is hung from another wire attached to the toilet roof.

A container of water is required as a source of water. The hand washer is dipped into the water and then hung up on the wire hook. Then hands can be washed. A bowl of flowers or herbs can catch the washing water.

The water container for hand washer

The hand washing device requires a container of water beneath it from which to charge the washer. This can be made from a traditional pot or a bucket. To make a more permanent fixture the bucket can be mounted in a concrete base. The hand washing device can be hung on a wire hanging from the roof of the toilet or can be mounted on a wire attached to a pole mounted in the ground.

Hand washing device suspended on a wire fitted to the gum pole of an *Arborloo*. The water container can be a traditional clay pot or a bucket. Alternatively the hand washer can be suspended from a wire frame attached to a pole placed in the ground.

Mounting the bucket

The plastic bucket is placed in a suitable position just outside the toilet next to the place where the hand washer hangs. The bucket is then concreted in position as shown. Bricks are laid around the bucket and the space between the bucket and the bricks is filled with concrete. This is finished off neatly.

Fitting the hand washing device over flower or tree

The waste water which pours from the hand washing device washes the hands and then falls to the ground. It is a very good idea to use this water to irrigate a tree, flowers or herbs which are also valuable. A small garden or flowers or a pot of flowers or herbs can be placed under the hand washer so they are regularly watered.

Soap or wood ash?

Soap can be drilled with a hole and hung on a wire from the toilet roof. Also a wider tin container can be attached to the side wall of the toilet and filled with wood ash. The fingers are wetted first, dipped into the ash and then washed again. It is a very effective and simple method of washing hands.

Watering a flower garden or tree with the hand washer.

A tree can also be watered with used water from the hand washer. In this case the tree is best planted to the side of the toilet.

Small gardens of flowers or herbs beneath the hand washer

Hand washer over flower garden and also a tree

The importance of hand washing

There are few things related to health more important than hand washing. Hands can carry bacteria that carry many serious diseases. Hand washers like the simple ones described here cost almost nothing to make and can be placed in several places in the garden or in or near the kitchen. They do not use much water. This simple device can make a huge difference to the health and wellbeing of a family. The next page shows photos of passing on the message about hand washing devices at a schools exhibition in Harare, Zimbabwe.

Passing on the message about hand washing devices

Making simple hand washing devices is very easy and uses discarded cans and bottles. The photos below show pupils of the Chisungu Primary School Epworth, demonstrating these techniques to several hundred school pupils at an exhibition held at the Mukuvisi Woodlands Association in Harare. The Chisungu pupils won a prize for their exhibit for their demonstration of hand washing and the *Arborloo*. The *Arborloo* is used in the woodlands wilderness area.

The pupils prepared large numbers of hand washers

Hundreds of pupils from other schools were shown how to make them.

A practical demonstration of the *Arborloo* was also given

Teaching Ecological Sanitation in Schools

Building a urine collection tank attached to the boys urinal

Peter Morgan

Building a urine collecting tank attached to the boys urinal.

A huge amount of urine is deposited in every school boys urinal and this material can be put to good use if it collected and applied to the school garden correctly. This chapter describes how to make a tank which will store urine from the urinal and a method of pumping it out of the tank into buckets which can then be conveyed to the school garden. The urinal is inspected and a suitable urinal wall chosen so that a PVC pipe cut in half along the length can be attached to the wall. The pipe is sloped so that urine collected in the pipe will flow downwards outside the toilet into a brick lined tank outside.

Preparing the tank slabs

Two concrete tank slabs were prepared off site.

Concrete base slab for tank. This is one metre in diameter and made using a mix of 10 litres cement and 35 litres river sand and 4 pieces of 3mm wire.

The tank lid is made slightly smaller (diameter 0.9m) with two holes, one for the urine inlet and one for the pump.

Central hole of upper tank slab with stainless steel screen and also the concrete plate made to hold the 50mm steel pipe socket in which the hand pump (Blair Pump) is screwed.

Preparing the PVC urine collecting pipe

A length of 75mm PVC pipe is prepared and cut to suit the urinal. The pipe is mounted along one of the urinal walls so that it will collect urine which will drain into a tank outside the urinal. The pipe is sloped a little to allow the urine to flow into the tank. The pipe is fitted loosely at first to get the correct position.

The PVC pipe is used as a urine collector and attached to the existing wall of the urinal. The pipe was 2.5m long made from 75mm PVC pipe. A section of 1.7m was cut out to form a channel in which the urine will flow. A hole is made in the external wall of the urinal and the pipe is placed along the existing urinal wall leading out through the wall to fit over the tank outside.

The position of the pipe outside the urinal is calculated and the hole for the tank dug around this point.

Once the position of the end of the pipe is established the hole can be dug down below ground level. The tank will be constructed inside the hole.

The concrete base slab is placed level on loosened soil laid down inside the hole. The brick wall is now built up to ground level.

Bricks are laid in strong cement mortar within the hole and on top of the base slab. The inside of the tank is low coated with a strong cement mortar to make it water tight.

The tank is plastered from within using a strong cement and pit sand mixture.

The base of the tank is also plastered with the mortar. The lid is then fitted with mortar being laid on the upper brickwork in which the lid is embedded. The pipe is laid in position to check that the end lies over the tank opening

The PVC pipe is then mounted within the urinal and is supported by short brick columns. The pipes slopes downwards slightly allowing urine to flow towards the tank. The pipe should fit neatly against the urinal wall.

Once the pipe is in its final position cement mortar is placed around the pipe as it passes through the brick wall. In this case only one section of the urinal is used to direct urine to the external tank.

Securing the pipe in the urinal brick wall. Fitting the pump support ring. This is made with a 50mm steel pipe socket which is embedded in a ring of concrete. The unit is embedded in strong cement mortar t the tank lid. This is allowed to cure before the pump is fitted.

Photo showing the arrangement of the pipe and tank. The plastic Blair Pump is fitted and a platform of bricks on which the bucket will be placed.

Photo of the urine held in the tank. If the urine fills the tank, an overflow pipe is required. This can be fitted within the tank itself through the upper part of the wall. Or another PVC channel can be fitted beneath the urine outlet pipe. Urine is pumped out of the tank with a modified Blair Pump into a bucket. This model of the Blair Pump is made entirely of plastic and rubber. It is threaded into the socket held in the lid only when urine is required.

Pumping urine holds a certain fascination! It is now standard practice at the Chisungu School. Rubber gloves are usually worn and frequent hand washing when handling urine.

Teaching Ecological Sanitation in Schools

Demonstrating the effect of urine on vegetables and maize in small "ring beam" gardens

Peter Morgan and Annie Shangwa

Demonstrating the effect of urine on vegetables and maize

Urine is always disposed of and never used, but in fact it is a very valuable source of nitrogen and other minerals which plants can use to increase their growth. Urine, when diluted with water can have a dramatic effect on the growth of many green vegetables, maize, trees and other useful plants. Because no one believes this, it makes sense to demonstrate the effect of urine treatment of plants at the school.

The method

The aim of this school experiment is to show the pupils, teachers and visitors that urine can be used as a fertilizer for green vegetables, maize and trees. A section of the school garden is chosen for the trials, cleared of other plants and levelled off. The experiment is performed in a series of miniature gardens called ring beam gardens. These are small gardens enclosed in a ring of bricks. This defines the area of the garden and special amounts of urine can be added. It is an experiment. In real life people are more likely to grow vegetables in specially prepared vegetable gardens.

Preparing the ring beam gardens

Bricks were taken and arranged in four rows, each with three ring beams. A total of 12 ring beams were made in this experiment.

The trainer, Mrs Annie Shangwa talks to the pupils to describe the experiment they are about to perform to show the effect of urine on plants.

2

Plants chosen

Rape, spinach, maize and banana were chosen for this first experiment. Seedlings of rape, spinach and maize were found and also 3 small banana plants.

Different treatments

For each plant (rape, spinach, maize and banana) there were three ring beams. In the first the natural soil was used. This was very poor soil and maize planted in it during the rainy season grew very poorly. In the second ring beam diluted urine was added. In the third ring beam some of the natural soil was removed from inside the ring beam and replaced by toilet compost. Also to this third ring beam diluted urine was added. So for each type of plant the treatment was as follows:

1. **Treatment 1** watering only on natural soil
2. **Treatment 2.** Application of diluted urine twice a week. For each ring beam treated in this way 800mls of urine was diluted with 2400litres of water (3:1) and added to the garden. This was measured uring a jam jar of capacity 400mls.
3. **Treatment 3**. This was the same urine treatment as treatment 2. But toilet compost had been added to the natural poor soil.

The urine was collected in 2 litre empty milk bottles. Schoolboys were asked to go to their existing toilet and provide the urine. This was done at the request of the trainer and the teacher and the boys collected the urine quite happily. In the home urine can be collected in various ways. Urine can be collected in potties, for girls and women and in containers for men. Also a funnel fitted in the cap of a plastic container can be used in a private place in the garden. This is called a “desert lily” or “eco-lily.”


Urine was collected from the boys in bottles. The soil within each ring beam is loosened up.


In one series of ring beams six buckets of natural soil were removed from inside the ring beam. Half of this was replaced together with 3 buckets of compost.


The soil in each ring beam was loosened and levelled off and then the seedlings were planted. Approximately the same number of seedlings were planted in each ring beam for each plant.

The arrangements of maize plants (left) and spinach, maize ands banana (right).

Preparation of the diluted urine, first by the trainer, then by the pupils. A 400mls jam jar was used. This mixture added to urine treated ring beams was 800mls of urine to 2400mls of water. This was applied with a bucket and spread over the soil in each ring beam between plants.

The diluted urine was applied twice a week (Mondays and Fridays) to each treated ring beam. Water was applied to untreated ring beams. On other days all the ring beams were watered to keep the plants healthy.

The watering of all plants continued regularly with urine treatment twice a week. The seedlings and small bananas were planted on 31st January 2008 and the rape and spinach were cropped on 5th March, 5 weeks later.

The results were as follows (shown as average weight of plant in grams and number of plants in brackets)

Plant	**no urine**	**urine only**	**urine plus compost**
Rape	**15.125 (24)**	**103.88 (18)**	**121.90 (21)**
Spinach	**42.22 (9)**	**165.45 (11)**	**135 (12)**

Thus the urine treatment alone increased the weight of rape by 6.8 times and of spinach by 3.91 times. The treatment with urine and compost increased the weight of rape by 8 times and of spinach by 3.19 times. It is not known why the increase in weight of spinach was less with both urine and compost treatment. However the results are clear enough. The application of urine to green vegetables like rape and spinach is very considerable and was very noticeable in the experiment. The same applied to the effect on maize.

The untreated and urine treated plants. In each case for rape, spinach and maize the effect is very noticeable.

Rape growing on natural soil in Chisungu school. On the left watered only, on the right treated with diluted urine.

Spinach growing on natural soil in Chisungu school. On the left watered only, on the right treated with diluted urine.

The effect on maize was also very dramatic as these photos show. The effects of urine alone was very significant, but the combined effect of compost and urine even more so. The experiment impressed everybody!

Miniature experiments showing effect of urine

Plants like maize and spinach respond very well to urine and can be used to show the effect of urine on plant growth very well. The experiments can be shown in small pots, 10 litre buckets, ring beam gardens and vegetable beds.

Experiment in small pots. Here a single maize plant has been grown in each small pot filled with garden topsoil. Diluted urine has been added to the two pots on the left almost daily. Only water on the right. The effect of the urine application is striking and valuable as a training aid.

In this experiment a single maize plant has been placed in a bucket of road sand and another with a 50/50 mix of road sand and toilet compost. A 3:1 water urine mix has been added to each bucket twice a week. The difference in growth is very significant. This demonstration shows the effect of the humus like soil in converting the nitrogen in urine (which cannot be used by plants) into a nitrate nitrogen which can be used by plants. Special bacteria (nitrifying bacteria) in the soil change the urine nitrogen into nitrate nitrogen. The road sand has few of these bacteria but when compost is mixed with the poor sand the bacteria are present in the soil and can thus convert the nitrogen into a form which can be taken up by plants. In other buckets the maize is planted in a mix of soil and road sand in which no urine is added. In this case the growth is increased compared to the road sand alone, but not as great as when urine is added. The urine contains much nitrogen, which when converted has a significant effect on the growth of maize and many green vegetables.

Teaching Ecological Sanitation in Schools

Gardens trials with urine on vegetables grown in buckets, basins, ring beam gardens and vegetable beds

Peter Morgan and Annie Shangwa

Garden trials with urine on vegetables grown in buckets, basins, ring beam gardens and vegetable beds.

Before an outreach programme can begin it is important to test for the effect of urine and toilet compost on valuable food plants at the school. This can be done as a series of simple but very important experiments on a small scale before the larger scale use of them method is implemented. In this way the teachers and pupils can get an idea as to how effective the urine treatment is on a variety of plants. Urine treatment is known to have a positive effect on most green vegetables like spinach, cabbage, rape, covo and tsunga, and also onion, tomato, beans and maize. It also helps the growth of valuable plants like lemon geranium, which is mosquito repellent and

Ways of testing for the effectiveness of urine in buckets and basins.

The simplest way is to start promoting the use of urine on a small scale by using 10 litre buckets or basins (even those made of cement, using the basin as a mould). Two buckets or basins can be chosen for each selected plant. The same type of soil is placed into both and then the urine application can start with one of the two basins, with the second basin being treated with water only. It is best to plant the seedlings in both basins or buckets and then keep them well watered before urine treatment begins. A week is normally enough, so that the young plants can establish themselves in the soil. If urine is applied too early it may slow down or even kill the young seedlings.

The urine should first be diluted with water, 3 parts water to 1 part urine. A convenient measure is a plastic jam jar of 400mls capacity. This is diluted with 1200mls water (3 jam jars). Each 10 litre basin or bucket should receive 400mls of diluted urine, three times a week with water being applied regularly to keep the plants healthy.

Several examples of the effect of urine


Onion – treated and untreated after about 2 months.
Many trees respond well to urine treatment like mulberry, gum and banana.


Maize responds exceptionally well to urine treatment. The extent of maize growth is related to the dose of urine. Also pumpkin responds well.


Cabbage treated with urine after 2 months (urine treated 9X the weight).
Spinach also responds well to urine treatment. The leaves can be cropped as the plants grow, particularly for spinach.

Ways of testing for the effectiveness of urine in ring beam gardens.

These are small, round gardens and were used in the preliminary trials at the Chisungu school with rape, spinach and maize. They are useful because the can be easily cared for and treated with diluted urine. The seedlings are planted and watered for a week before urine treatment. The dose of urine for a 1m diameter ring beam garden is about 3 litres of 3:1, three times a week. In practice two 400mls jam jars full of urine are added to a bucket or small watering can and six jam jars of water are added to make up the 3:1 mix. This is applied to the soil within the ring beam garden three times a week. The garden is also watered at other times.

Green beans in ring beam garden

Mixed crop in ring beam garden: cabbage, tomato and garlic in a single ring beam garden. To enhance the crop of tomato, comfrey liquid feed has also been added (see section)

4

Spinach


Spinach crop (over a 12 month period 26kg of spinach was cropped from a small 1m diameter ring beam garden using urine treatment. On the right spinach has been planted in 2 ring beams in which very poor soil was placed. Urine treated spinach yielded 7 times the crop compared to spinach that was watered only.

COVO


Covo plants also responded very positively to urine treatment when planted on very poor soil. In this case production within the ring beam was increased by 5 times as a result of the urine treatment. Signs of nutrient deficiency can be seen in the leaves of plants.

Ways of testing for the effectiveness of urine in vegetable beds

In this case a part of a vegetable bed (a new bed or an existing bed) is chosen and dug and prepared for the trial. Ideally the treated section and the untreated section should be the same size, but this is not essential. The seedlings are planted and watered for a week before urine treatment. The amount of diluted urine applied depends on the area of the bed and the number of plants. For an experimental bed about one metre square, the same amount of diluted urine is applied as in the ring beam. That is about 3 litres of diluted urine (3:1) three times a week (Mondays, Wednesdays and Fridays).

RAPE

Rape, before and after urine treatment in two beds. The treated bed was about 1 square metre in area. After about 4 weeks the average weight of each rape plant had increased by four times (45gms treated, 11gms untreated) as a result of urine treatment. Treated section nearest camera.

Untreated rap show signs of nutrient deficiency. Pale green leaves reveal lack of nitrogen. Mauve leaves reveal lack of potassium.

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RAPE

Rape at second cropping after a further 6 weeks. After the first cropping the plants continued to be treated in the same way (about 3litres of 3:1, three times a week). In this case the average weight of treated plants was about 7.5 times that of untreated plants.

TSUNGA

A bed of tsunga was planted around 18th June and divided into treated and untreated sections. The treated zone was about 2 square metres in area. the first cropping was made on 21st July, about 4.5 weeks later. At first about 3 litres of 3:1 water and urine was applied, three times a week to the treated area. After the second week this was increased to 6 litres, three times a week. Each plant was weighed at cropping. The urine treatment increased the average weight of each plant by 3.6 times (treated 47.15gms, untreated 13.63gms).

The tsunga bed early in in the trial and on the day of first cropping 4.5 weeks later. The untreated section is on the left hand side of the bed. The average increase in weight of plants was 3.6 times.

Increasing the output of vegetables in beds using diluted urine at the school

We have already seen that diluted urine can have a remarkable effect at increasing vegetable production in ring beam gardens at the school. The next stage is to test the same principles in larger vegetables beds in the garden.

The earliest trials were undertaken with spinach and rape, both of which respond very well to urine treatment. The beds were prepared and rape and spinach seedlings planted.

Planting spinach seedlings on March 25th 2009

By April 14th differences were appearing between urine fed and water fed plants. On left the water fed plants were lighter in colour than the urine fed plants in the background. On right photo, the urine fed plants are growing at the same rate as the commercially fed plants o the right.

Watering the spinach with dilute urine and water.

By May 8th 2009, the urine fed plants are larger and greener than the water fed plants (left photo) and also compared to commercial fertilised plants.

The plants on left photo show urine fed spinach (left) and plants fed with commercial fertiliser (right). Right photo – the plants are cropped on May 8th. The plants were fed 2li of urine diluted with 8 litres of water in a watering can twice a week. The technique is simple and effective.

Teaching Ecological Sanitation in Schools

Increasing the yield of maize on poor soils using urine and toilet compost as fertilisers

Peter Morgan and Annie Shangwa

Increasing the yield of maize on poor soils using urine and toilet compost as fertilisers

Maize is the single most important crop in Southern and Eastern Africa, being the staple diet for hundreds of millions of people living in the sub-region. And most of these people live on poor soil which is unable to provide sufficient nutrients for a full harvest of this precious crop. When manure is available it certainly helps to increase crop yields – but manure is commonly unavailable especially in the peri-urban and urban areas. Commercial fertilisers are normally vital to attain a good crop, but these are expensive and often scarce. Growing maize in back yard plots is a common way of growing food in the peri-urban and urban settlements of Zimbabwe and some surrounding countries. Small garden plots also surround homesteads in the rural areas.

In Zimbabwe maize takes about 4 months to grow, mature and produce cobs. Maize seed is normally planted in mid November, with the crop being harvested in late February or March. This period also coincides with the hottest time of the year when plant growth is at its greatest. Also the rains are best from December to February. However in recent years climate change may be having an effect on the reliability of the rains, and periods of below average rainfall are now interspersed with heavier rain.

Maize is a hungry feeder and nitrogen its main nutrient. Where commercial fertilisers are used an initial dose of “Compound D” is used (containing a mix of nitrogen, phosphorus and potassium) followed by ammonium nitrate – the best source of commercial nitrogen.

Earlier experiments carried out in Epworth revealed that urine is an excellent source of the nutrients for maize. Urine contains an abundance of nitrogen, but almost 100% of this is wasted and never put to use. In an era when food is short and fertilisers both scarce and expensive, urine can become a valuable commodity to increase the yield of maize and also green vegetables and other valuable crops. This was demonstrated in the school garden in earlier experiments.

Previous work carried out in Epworth revealed that about one litre of urine was required by each plant during the growing season to attain good sized cobs and this amount has been used again on the trials described in this book in the school garden.

The strongest seedlings seem to grow when planted in rich soil or compost rather than poor soil. This leads to early vigour of the seedling and later to a healthier plant. So the best crops grow when the seed or seedlings are planted in a plug of good soil or compost rather than in the poor soil. Maize is always planted in the garden or the fields as seed, with often two seeds being planted in a single "planting station" in case one fails to germinate. So if the soil is poor it is best to plant the seed in a "plug" of compost – the amount being the same as can be contained in a pea tin (about 400mls). Compost derived from an ecological toilet like a *Fossa alterna*, or from the garden (leaf or garden compost) is ideal. The seed then germinates in a richer soil which adds vigour to the young plant.

Whilst it is not the normal method, there may be some sense in planting maize seed in richer soil held within seed trays and nurturing and artificially watering the young seedlings during the first two critical weeks of their life. This may overcome the probability of poor germination if the rains are poor at this crucial time. The seedling can then be planted in the "plug" of compost dug in each "planting station." Seeds are planted about 30cm apart in rows about 90cm apart. Whether the seedling grows from seed planted in the ground direct or from a transplanted seedling, the urine is applied weekly from the time the plant is about 5cm high. This will be about 2 to 3 weeks after planting seed.

The method of urine application may vary, but one of the best is to apply 125mls of a 50/50 mix of urine and water to each plant followed by a pea tin of water (400mls) once a week until the time when the first tiny cobs appear. Then the dose is doubled to 250mls of the 50/50 urine water mix followed also by the tin of water once a week. The additional water helps to push the diluted urine into the soil and under the surface after application. This reduces the loss of nitrogen from the urine. Using this method a full litre of urine can be applied per plant over most of the full life of the plant extending into the "grain filling" stage when the cobs are growing fast.

Urine can also be applied neat (125mls once a week) with the rain diluting the urine and pushing its down into the soil. But rain can be unreliable and for smaller plots which surround the homestead the method described above is more efficient if some water is available.

A plastic pill bottle with a wire handle serves as an excellent urine dispenser. This one contains 125mls of liquid. The bucket contains diluted urine – in this case 50% urine and 50% water. After urine application (either 125mls or 250mls of the 50/50 mix, the urine is allowed to seep into the soil and is then a further 400mls of water is added from a pea tin.

Planting maize seed

Planting seed in the soil direct

The normal method is to plant the maize seed directly in the soil. If the soil is poor it is best to plant the seed or seeds in a "plug" of good soil or compost placed in a small hole made in the soil. This will provide a better medium for germination of the seeds and produce a seedling of greater vigour. Since most seeds will germinate if well watered a single seed may be good enough. In the past two or more seeds were placed in each planting station, but this may be unnecessary. A "pea tin" of good soil or compost (400mls) is enough.

A hole is scooped out in the soil and the compost added. The seed or seeds are then placed within the compost and pushed in and covered over.

Planting seed in seed trays

The early germination and vigour of the young seedling is important for a good healthy plant. Where early rains may be unreliable with the result of poor germination and where the number of plants is hundreds rather than thousands, it may be more effective to plant the seeds in seed trays which are watered regularly and then transplant the seedlings into the field, plot or garden when the plant has germinated and is between 2 and 3 weeks old. This may seem a curious method, but the trials undertaken at the school indicate that the resulting crop may be far greater.

Maize seeds being planted in seed tray on 26th December 2008 and then transplanted into the field on 7th January. The seeds had been soaked in water for 3 days prior to placing in the seed tray. Thus a period of about 2 weeks elapsed between initial soaking and transplanting.

Transplanting the young healthy seedling from seed tray to field.

Maize trial 1


The field is marked and holes made for the seeds. 25th November 2008.


A tin of hybrid seeds and urine dispensers. Sewing the seed


The fields 3rd Feb. 09 and 25th Feb.09. The small plants to the left have not been treated, those to the right treated with 125mls neat weekly.

 

By March 10th the cobs were enlarging considerably. April 14th. 2 days before harvesting.

Harvesting day – April 16, 2009

 

Picking the cobs on harvesting day. Extremes of growth a large cob fed with urine and a small cob not fed with urine.

 

Holding cobs of varying sizes. Plants not fed with urine on this poor soil were tiny. The urine treatment increased the mean weight of cobs by 76 times!

Maize trial 2.


An area of field was cleared and planted with 5 rows of maize seedlings on 7th January 2009. One row was watered only and left untreated with urine. The other 4 rows where planted with seedlings held in a plug of leaf compost pl aced in a hole made in the plating station.


Each seedling was extracted from the seed tray and planted in the plug of leaf compost.


Each plant was then watered.

 

A 50/50 mix of urine and water was then made up in a bucket by adding 2 litres urine followed by 2 litres of water.

Using the 125mls pill bottle urine dispenser 125mls of this diluted urine was added to each plant in a hollow made around the plant. This was followed by 400mls of water.

 

This routine was followed weekly (125mls of diluted urine per plant followed by 400mls water) until small cobs first appeared. Then the dosage of urine was doubled by applying 2 X 125mls of diluted urine followed by 400mls water. This application was continued until a full litre of urine has been applied per plant. Photos on 3rd Feb. and 9th Feb. 2009

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Harvesting day – 16th April 2009

Stripping plants from urine fed plants and also fr om plants not fed with urine.

Measuring the cobs on a scale. The difference between urine fed and unfed plants is huge.

The soil is so poor that without plant food a maize cob remains tiny. These small unfed maize cobs and the much larger urine fed cobs are shown in the s in the experiment are shown in the photo on right.

11

Maize trial 3

This was the most successful of the maize experiments undertaken at Chisungu. Seedlings planted 11th January, 2009

After clearing the field two rows of 15 holes were dug in the soil

Each hole was filled with a pea tin full (400mls) of toilet compost taken from a *Fossa alterna*.

The two rows of planting stations were thus prepared for planting

Maize seedlings were then carefully extracted from the seed tray each between 2 and 3 weeks old.

Each seedling was then planted in the plug of toilet compost and watered.

The diluted urine was then prepared by mixing equal volumes of urine and water in a bucket (2litre + 2litre).

Using the pill bottle dispenser 125mls of the diluted urine (50/50) was applied to each plant. The soil was dished around each plant for form a basin in which urine and water could be poured.

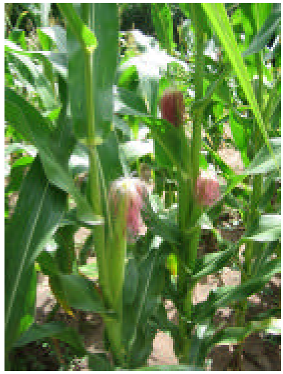
The seedlings were well watered 400mls or more. The rows of seedlings on 21st January. During periods of poor rainfall the plants were watered artificially.

The maize plants during the initial growth period on 29th January 2009.


The plants on 3rd February and 9th February 2009


The plants after further growth


The plants on 21st February and 6th March 2009. Cob formation started on week 9 or 10. At this time the dose of diluted urine (50/50 with water) was increased from 125mls to 250mls followed by watering.

By 10th March the cobs were forming very rapidly. This later technique – planting seedlings in toilet compost and applying diluted urine followed by watering) was far more effective than the technique of planting seeds in the poor soil and applying neat urine diluting mainly with natural rainfall.

HARVESTING DAY – 16th April. 2009


Harvesting the cobs from the urine fed plants (left) and also from plants nearby in the same field which were not fed urine


Unfed maize in the untreated parts of the garden developed small cobs. Urine treated plants large cobs. The effect is startling.

RESULTS ON HARVESTING DAY

All the maize cobs were harvested on 16th April a few weeks after litre of urine had been applied to each plant over the main growing period and also a few weeks after urine application had stopped. The maize cobs continue to crow after the last application of urine. Also carbohydrates are transferred from leaf to cob during the later part of the grain filling stage.

Each maize cob was weighed on a delicate weighing machine from treated and untreated sections of the garden. Striking differences were found in the weight of cobs found in urine fed plants compared to plants grown nearby without urine.

THE RESULTS

	Total gms	**no.cobs**	**mean wt/cob**
Maize trial 1			
a) Untreated plants	30gm	14	2.14 gms
b) Treated plants	15 992gm	98	163.18gms
Increase in production	X 76.25		
Maize trial 2			
a)Untreated plants	2gm	5	4.6gms
b) Treated plants	5 488gm	39	140. 71gms
Increase in production	X 30.59		
Maize trial 3.			
a) Treated plants	7172gm	28	256.14gms
b) Surrounding plants	257gms	18	14.27gms
Increase in production	X 17.94		

Explanations

Whilst individual cobs weights cannot be shown here, there were huge differences between urine treated and untreated plants. Also there was much variation within each group, some urine fed plants being small, but most being large. Also a considerable variation exists between the mean cob weights of urine treated and untreated maize plants in different parts of the garden. All plants in this trial were fed a total of 1 litre of urine, but the results reveal that the application of urine alone was not the only influencing factor on final cob weight. The experiment reveals that the condition of the soil as well as the amount of urine applied has a large influence. The soil in some areas of the garden were clearly more fertile than others, with previous applications of compost, manure or even chemical fertilizer having an influence. These differences in soil fertility are not obvious from viewing alone.

Of particular interest is the variation in mean cob weight between the three trials. Trial 2 revealed the smallest mean cob weight (140. 71gm) and trial 3 the largest (256.14gm) with trial 1 (163.18gms) in an intermediate position. There may be several reasons for this. The ground soil where trial 1 and 3 took place appears to be richer than the ground soil in trial 2. Also the trial 2 plants were in a tree shadow until mid morning. Mean weight was highest in trial 3 which was close to trial 1, but the method of planting the maize and applying the urine was different. Planting seedlings rather than seeds in poor soil helped increase the final crop. Also the method of diluting the urine (50/50) with water and applying first and then applying water to push the urine into the ground also helped. This trial and earlier ones reveal that it helps to plant seed in small amounts of compost to get a strong seedling. Where the early rains are unreliable it helps to plant seedlings in trays or in a small area where artificial watering is possible.

The variation in cob size of untreated plants varied a great deal in the garden which revealed a great variation in soil nutrients. Mean cobs size varied from 2.14gms in the poorest soil to 4.6gms intermediate soil to 14.27gms in soil to which some compost had been added. The overall conclusion is that urine application has a huge effect on the growth of maize and the final crop of cobs produced. Increases of 18 times production and also 30 times and 76 times were recorded.

From a practical perspective growing seedlings in seed trays and then transplanting them is not the most convenient method of planting maize seeds. Under practical conditions and were water is available it is best to plant the seed in a plug of compost at each planting station and water these sites regularly by hand. Then the seed if offered the best chance to gain vigour at an early stage. Once the seeds have germinated and the seedlings are 2 to 3 weeks old then the application of diluted urine can begin at each planting station with the addition of extra water being applied. This extra water drives the urine below ground level reducing the loss of ammonia and also offers the plant more water. This procedure may be important in poor sandy soils which do not hold moister well and also where climate conditions are changing, with periods of poor rains followed by periods of good rains or even excess rain.

Various techniques already exist in traditional practice for improving the quality of poor soils. These include adding cow manure to the fields before planting and also digging in maize stalks and other compostable materials prior to the rains. A large cupped handful of compost placed within a scooped out hollow of soil made at every planting station helps to increase crop production.

The maize and vegetable trials at the school is having a large impact on the surrounding communities who are beginning to use these techniques, especially the addition of compost to soils and particularly the collection and addition of diluted urine to crops. The acceptance of this method by teachers and senior community leaders has helped this new approach to gain acceptance.

The pupils and teachers participated in cropping and measuring the maize cobs.

The pupils are active at every stage of the trials

Huge differences were revealed between urine treated maize and untreated maize. On the left photo the largest cob (urine treated) and the smallest cob (not urine treated) are shown!

Teaching Ecological Sanitation in Schools

Planting single trees near pit toilets

Peter Morgan and Annie Shangwa

Planting trees near pit toilets

In the *Arborloo* concept a tree is usually planted in topsoil added to the pit when it has almost filled up with a mix of excreta, soil and ash. However it is also possible to dig or drill a hole near to the pit and plant a tree long before the pit is full. In fact it is possible to plant a tree near a pit toilet even at the same time the toilet is built. In this way the tree will grow at the same time as the toilet is in use. Very often the trees are planted in shallower pits dug near to the toilet pit.


A hole has been dug about a metre away from the toilet. The hole is filled with a mix of compost and soil and a young tree is planted.


The tree site is surrounded by bricks, watered and cared for.

Planting trees in deeper tubular pits dug near the main pit

It is also possible to drill a deeper tubular pit near to the main pit with an auger so that the tree pit is the same depth as the pit which will fill up with excreta. In these photos shown here the pit was dug at a school and for convenience was one metre deep. A tubular pit was drilled also a metre deep and filled with a mix of garden compost and soil. A mulberry tree was then planted on top. Under these conditions the tree roots have underneath them a tube of rich humus like soil through which they can penetrate easily to greater depths. The taproot is able to go deep and eventually tap the nutrients derived from the excreta which penetrate the soil beneath and around the pit.

An earth auger is being used to drill a tubular hole about a metre deep next to the toilet. When the auger has been filled with soil it is extracted from the hole and the soil removed.

The earth auger filled with soil. A mound of soil extracted from the auger

3


A view of the drilled hole. A mix of compost and soil is placed down the hole.


A young mulberry tree has been planted in a bucket and is now transferred into the head of the drilled hole filled with fertile soil.

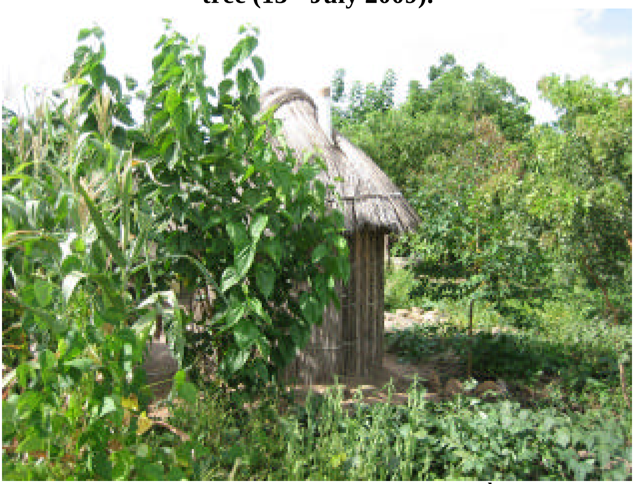

School girls drill the hole and plant a mulberry tree in a mix of soil and compost placed into the drilling. Water from the hand washing device irrigates the tree.

4

A case of two trees being planted next to an *Arborloo*

In this case a mulberry tree was added first in a hole dug down about 0.5m and about 0.5m outside the supporting ring beam. This was filled with a mix of good soil and compost. Some months later a tubular hole was drilled 0.5m from the ring beam on the other side. A gum tree was planted in a mix of compost and god soil added to this hole.

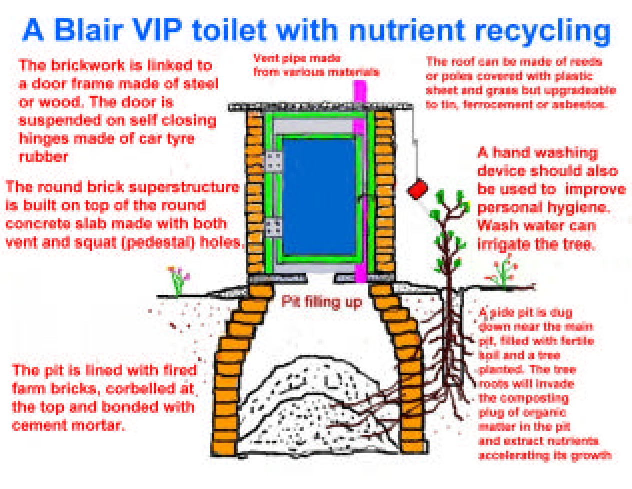
Planting the original mulberry in a hole dug near the ring beam (7th January 2009). Later drilling a second hole near the ring beam and planting a gum tree (13th July 2009).



Both trees have grown well as this photo taken on 16th February 2010 shows Periodically diluted urine was added to each tree to accelerate its growth.

Recycling the nutrients in the pit with a tree

In this case the tree or trees planted in smaller pits dug or drilled next to the main pit will eventually perform the recycling of the nutrients held in the toilet pit. Tree root growth is encouraged by planting the tree in good soil and feeding the tree. The tree itself will decide at what time the organic pit contents are suitable for invasion. The roots will invade the soil around the pit first. Toilet pits contain a large amount of valuable nutrient material which normally remains unused and is therefore wasted. In this concept they are tapped by the tree itself and can therefore be utilised in the form of fruit, timber, fuel and medicine, depending on the choice of tree chosen. Where trees are grown around the pit during the filling stage of the pit it is best to plant gum trees which grow fast and where the foliage quickly rises above the toilet. In the case of trees being planted on filled *Arborloo* pits a much wider range of trees can be planted. This is because excessive foliage around a toilet can reduce the efficiency of a vent pipe if it is fitted. The exchange of nutrients takes place underground, and is therefore safely out of sight and out of mind. This method can be used on both old filled pits and also newer pits which are filling. Damage to the pit lining is possible – but by this time the pit may have filled - only time will tell!



A method of recycling nutrients from standard pit toilets – with a tree! The technique works with both lined and unlined pits. With lined pits gaps can be left in the brickwork allowing nutrients from the excreta to percolate through the wall into the soil surrounding the pit.

6

Teaching Ecological Sanitation in Schools

Planting a ring of trees around toilet pits

Peter Morgan and Annie Shangwa

Introduction

Pit toilets can be made more ecological if the nutrients in the composting excreta are recycled in some way and the threat of pollution of the environment is reduced compared to the standard pit toilet. There are various ways of achieving this.

First the pit can be dug shallower, perhaps between 1m and 2m deep rather than 3m (in the standard VIP) to increase the distance between the pit contents and the ground water table below. Thus the risk of underground contamination will be reduced. Second trees can be planted around the pit. This can have two beneficial effects. The first is to withdraw nutrients from the soil surrounding and beneath the pit. Trees tapping nutrients derived from the excreta will grow faster. Fast growing taproots of some trees can do this effectively. The gum tree is one example. The other benefit is that the tree will extract and transpire nutrients from the ground surrounding the pit, thus reducing the potential for ground water pollution further.

Some trees respond very positively to high levels of nutrient derived from excreta. The gum tree *Eucalyptus grandis* is one. Its increased growth as a result of urine application has been described in another manual. Its increased growth resulting from a combination of urine application and planting in dog manure is also dramatic as shown in the photo below. These photos reveal that this species of gum can tolerate and respond to high levels of nutrients derived from excreta.

The effect of high levels of manure on the growth of the gum tree. On the left the gum tree is in its original planting jacket. The tree on the right has been transplanted to soil to which a high level of dog manure was mixed.

Planting trees in a rosette formation

In this case 5 trees were planted in a rosette formation around the pit with the 6th position occupied by the hand washing facility and its water supply and miniature garden. Each hole was drilled about one metre deep and about one metre away from the toilet. The deep drilling is filled with a mix of compost and top soil. This assists the young tree roots to penetrate deeply into the soil around the pit. The pit fills with excreta as the trees grow. The tree roots tap nutrients from the soil surrounding the pit.

Holes are marked around the pit about a metre from the structure. A series of holes are drilled with an earth auger (diameter 150mm). The holes are drilled down to a metre. In this case 5 holes were drilled around the pit.

The earth auger can be weighted by a pupil standing or sitting on it. The auger is emptied after every filling. Loose soil is scooped out of the drilling.

Preparation and mixing of soil and compost


Soil and compost are mixed together in equal proportions. Compost is gathered from a compost heap or from under trees where leaves have fallen.

Tree planting


Each hole is filled with the mix of soil and compost and watered.
The young tree is then taken out of its plastic bag and planted in the compost.


The soil is levelled and watered


Each tree is planted in turn sand surrounded by a circle of bricks to demarcate. A layer of leaves is added as a leaf mulch.


The trees are then watered 5th October 2009


The trees are watered regularly. Diluted urine (2 litres in a 10 litre watering can of water) applied each week to two trees accelerates their growth.

Steady growth of the gum trees

These gum trees were given about a month to stabilise and then fed diluted urine every week to accelerate the growth. 2 litres mixed with 8 litres of water (total 10 litres of 4:1) were enough to feed 2 trees.

19th November 2009

December 8th 2009

15th February and March 12th 2010

Planting young trees where the growth has been accelerated by the application of dilute urine prior to planting around the toilet pit

A series of young gum trees were transplanted from their original planting bags into new deeper (50cm) planting bags and treated with dilute urine for a few months before being transplanted around the toilet pit. The compost used in the new bags was derived from a *Fossa alterna.* Another manual deals with this subject. During this preliminary growth period, the growth of trees was accelerated considerably prior to planting around the toilet pits.

First a series of 5 holes were drilled around the pit about one metre deep and one metre away from the structure.

The accelerated trees were taken on to site. The trees were carefully extracted from its bag by cutting the bag open with a knide and carefully lowering the 50cm column of composted soil in which the roots were growing down into the hole. Gathered compost was then place around and below the tree to fill the hole. Note that at first the trees were extracted by pulling the column of compost out of the bag from the end, but this method damaged some of the roots. The ideal method is to keep the column of compost in tact and carefully introducing it down the hole and surrounding by rich compost soil. The aim is to plant the column of compost and enclosed roots without disturbing the roots of the tree. This column is surrounded by compost to fill the hole. The soil within covered with mulch made of leaves or grass.

The method of extracting the column of compost by pulling from one side was not satisfactory.

The best method is to cut the bag and take out the full column of compost in tact.

Compost is first added to the hole and then the full column of compost surrounding the tree roots is carefully lowered into the hole.


Once the tree is positioned correctly in the hole compost is carefully added to fill the hole around the tree.


Each hole is planted and protected in turn around the pit. A ring of bricks is added around each tree and covered with grass or leaf mulch. Each tree is thoroughly watered. Watering continues daily.

Views of the rosette of trees around the pits

Two toilet pits were encircled by gum trees at the school in October 2009.

The trees are thoroughly watered soon after they are planted (9th Oct. 2009).

The area around the new pit and its circle of trees is levelled off. The newly planted trees and the toilets are inspected by government officials and staff of the Ministry of Health.

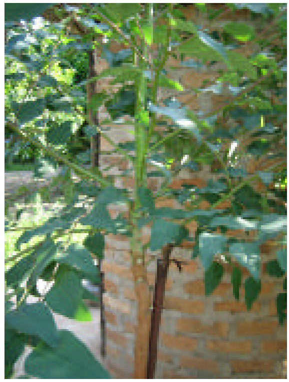
Rapid growth of the trees

Adding diluted urine to accelerate the growth of the trees. 16th February 2010

March 2nd 2010. The grass conical structure has been replaced (upgraded) by a brick structure (left of photo). Trees now higher than toilets!

Pruning the trees

In this case the gum tree *Eucalyptus grandis* has been used. When the tree reaches the height of the toilet or just beyond it is best to prune the lower branches of the trees to promote upward growth. The foliage will then quickly rise above the level of the toilet and vent pipe. Vent pipes work better if the air flow around them is not disturbed by trees.

The lower branches are carefully pruned to a level just below the green new growth of the tree trunk.

After pruning the tree will start to grow upwards faster. The weekly application of diluted urine (1 litre urine + 4 litres water) on each tree continues. Regular watering is also required on younger trees in addition to urine treatment. Eventually the tree will tap nutrients from the pit contents.

Teaching Ecological Sanitation in Schools

The effect of urine on tree growth

Peter Morgan

Introduction

Urine is known to accelerate the growth of many plants including green vegetables and maize. A great deal of evidence is now available to prove this without question. The urine is best diluted either before it is applied or by water applied following the application of neat urine. Urine also can have a considerable effect on the growth of important trees which provide fruit, timber, fuel or shade. This manual describes how urine can be used to accelerate the growth of trees held in bags before planting in the ground or after planting has taken place.

1. Effect of urine on gum tree *Eucalyptus grandis*

Gum trees planted in two 10 litre buckets on 20th March 2009. One of the trees was fed 125mls urine + 275mls water (400mls) with extra watering once a week after the trees had become established. Right photo on 19th April.

Effect of urine treatment becomes more apparent. Left photo 6th May 2009 and right photo 9th July 2009.

Dramatic photo showing effect of urine on the growth of *Eucalyptus grandis* taken on 30th August 2009

Method of applying urine to young trees held in planting bags

A pill bottle holding about 125mls of urine is poured into a 400ml tin which is then topped up with water, This is then poured on the soil around the treated tree. More water is poured on during the dry season to keep the tree well irrigated. This water applied after the diluted urine has been applied helps to the drive the nitrogen rich urine beneath the ground.

Accelerating the growth of tree before planting near toilets

Several trees respond to the application of diluted urine and this can be undertaken before planting the tree in the ground as well as continuing after the tree has been planted in the ground. In another experiment several gum trees (and mulberry trees) were planted in longer planting bags before transfer to the ground during the dry season. The best time to plant trees near toilets (or at any place) if regular watering cannot be guaranteed is during the early part of the rainy season. It is possible to accelerate the growth of trees prior to ground planting by transferring the seedling tree either into a bucket or into a deeper planting bag, which can be placed in a position where more regular watering and urine application is possible.


A series of gum trees (*Eucalyptus grandis*) were planted in deeper planting bags half a metre in depth filled with compost from *Fossa alterna* toilet and treated with urine every week. This considerably accelerated the growth of the trees compared to trees held in the original seedling bags. Left photo dated 9th July 2009 and right photo 6th October 2009.


Left: Original trees in smaller bags. Right: Original trees in smaller bags compared to transplanted trees in larger bags and urine fed.

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Evidence from the field

The most dramatic results so far achieved have taken place in the valuable tree *Eucalyptus grandis.* This tree is being tested in several sites in Epworth, both at the school and within the outreach program. The young trees were originally purchased from the Forestry commission nursery in Harare. Some have been planted directly as purchased from the nursery, others fed with a diluted water urine mix before final planting near the toilet. The trees on trial have been planted in a tubular pit drilled between 0.5m and 1.0m from the edge of the pit – that is from the edge of a ring beam in the case of the *Arborloo* or from the edge of the slab in the case of toilets which are built on brick lined pits. The amount of urine added to each tree varies slightly but a practical guideline consists of making up a mix of 2 litres of urine and 8 litres of water (4:1) in a ten litre watering can and applying this to 2 trees once a week. That is added 1 litre of urine + 4 litres of water for each tree weekly. The trees are watered regularly in addition until the roots have reached deeper layers. Circles of bricks are laid around each tree and mulch made of leaves or grass added on top.

Banana and mulberry also respond well to urine treatment, and several other tree species are being tested.

Left: Effect of urine on growth of mulberry. Right: Mulberry planted at end of upgraded well water run-off being watered with diluted urine.

Trials in the school and outreach program


Transplanting gum trees around a pit toilet. Left: standard trees in a rosette around pit in the outreach program. Right accelerated trees in a rosette around pit at the school.


Trial in the outreach program. Trees planted 19th November 2009 (left) and growth by 15th February 2010. This is just less than 3 months.


Trial in the school. Trees planted on 9th October 2009 (left) and growth by 16h February 2010. This is just over 4 months. Urine treatment stopped during the school holidays.

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Teaching Ecological Sanitation in Schools

Planting and fertilising a woodlot of gum trees

(using diluted urine as a fertiliser)

Peter Morgan and Annie Shangwa

Planting a woodlot of gum trees and accelerating the growth with diluted urine

The evidence derived at the school for the beneficial effect of adding diluted urine once a week to gum trees, prompted the headmaster to request that a woodlot of gum trees be planted in the school. The rapid growth rate of gum trees treated with diluted urine weekly, in both the school and the outreach environments provided sufficient evidence for extending this concept to woodlots. Fuel is in short supply in Epworth, as it is in most parts of Zimbabwe and an effective and simple method of growing more timber, using excreta as a source of nutrients seemed like a viable and practical concept.

Choice of tree species

Many species of gum trees are available for this type of work. The project had used the fast growing *Eucalyptus grandis* in its first trials. This had proved very successful. However another fast growing and drought resistant species *Eucalyptus tereticornis* was more easily available at the time of planting and was chosen. Whilst gum trees are known to take up large amounts of water from the soil, they are valuable in many ways – not least for building and for fuel. Their use around toilets helps to reduce the flow of fluids from the pit and thus helps to reduce the potential of underground water contamination.

The trees were purchased from the Forestry Commission Nursery

Site selection and drilling holes for tree planting

School staff chose the most suitable site for planting and holes were drilled with the 170mm diameter earth auger used to drill other holes for trees. Holes were drilled 0.6m deep and 1.5m apart.

The earth auger fills up with soil and this is removed after each filling and placed back in the hole to drill deeper.

Soil is removed by knocking the auger with a bar to loosen the soil then emptying by hand or with a stick

Filling holes with good soil

Each hole is filled with rich soil or a mix of compost and excavated soil. This helps the plant roots penetrate more quickly into the soil.

A source of rich soil has been located and excavated for use in the woodlot.

Tree planting

Each tree is carefully taken out of its planting bag and placed in a hole made in the soil within the drilled hole. The soil is pressed down around the tree. The tree is thoroughly watered. It is a good idea to place a “mulch” of leaves or grass over the soil around the tree to reduce the loss of water by evaporation after watering.

Each tree is carefully planted and watered in each planting hole

The trees are watered regularly if there is no rain. Gum trees in woodlots like all other planted trees are best planted during the rainy season, especially if sources of water are distance or scarce. In this case water is taken from the school well fitted with a hand pump. Urine application starts about 2 weeks after planting to allow the trees to establish.

Collecting urine

In this trial urine was collected from the urine tank connected to the boys urinal. A modified plastic “Blair pump” is used to pump out the urine. Large amounts of urine can be collected from the tank and one of the best ways of using this is to dilute it with water and feed trees.

Collecting the urine from the urine tank

Urine application

Urine is diluted with water before being applied to the trees. 2 litres of water are diluted with 8 litres of water in 10 or 12 litre bucket or watering can. This is a 4:1 dilution and is enough to treat two trees. Thus each tree is given one litre of urine. The urine is applied once a week. After the urine has been applied each tree is given a further 5 litres of water.

A 2 litre plastic milk bottle (opened up) serves as a measure. The bucket or watering can is filled up with water.

Each tree is fed individually with the diluted urine either from a bucket or from a watering can

Watering

When the trees are young they need to be watered regularly, especially if the rains are poor or if the trees are not planted in the rainy season. As the roots penetrate more deeply they rely less on watering. If a tree shows signs of dying it should be replaced.

Liberal watering helps a l ot in the first few weeks

Later editions of this manual will reveal the growth of trees in this woodlot

6

Teaching Ecological Sanitation in Schools

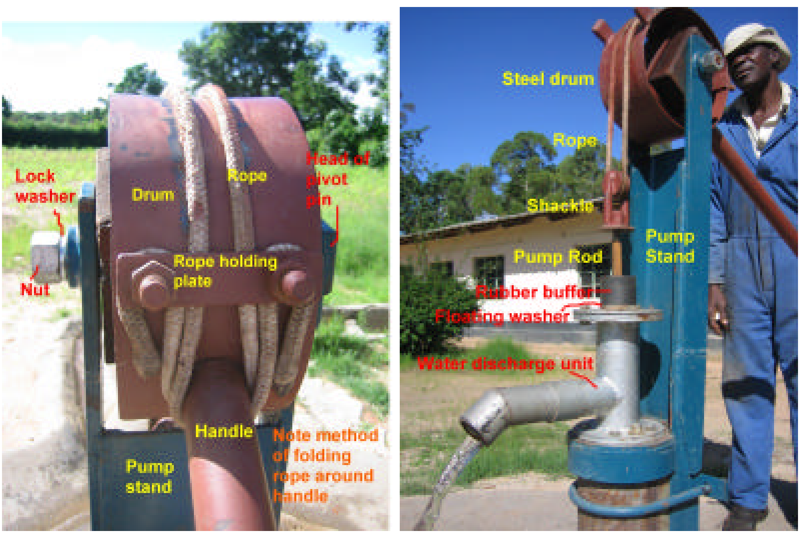
Maintaining the school hand pump

Peter Morgan

Introduction

The school hand pump is a very important piece of technology at Chisungu School. It serves 2500 pupils and staff. The pump itself is called a Zimbabwe Bush Pump. The Bush Pump was first designed in Zimbabwe in 1933 and several adaptations of the original design have been used in national programs. The current national standard is known as the “B type Bush Pump” and has been the national standard hand pump since 1989. Over 40 000 pumps of this type have been installed throughout Zimbabwe. The model used in the Chisungu school is not the “B” type but an experimental design known as the “C” type Bush Pump. This differs from the “B: type in having an experimental head which uses a rope to link the pump head to the pump rods. The pump can also be used with smaller steel pipes under the ground than the “B:” type. The Chisungu school is one of several dozen locations where the pump is being tested and evaluated.

The school pupils in the “ecosan” group have been trained in maintaining the pump head, which basically involves tightening some of the bolts and ensuring that the rope is in good condition. These photos show some of the activities of the program linked to the school pump.



The head of the experimental “C” type Bush Pump

Pupils adjusting the rope of the pump head


A large spanner is used to secure the nuts on the pump head


Pupils making a rubber buffer for the steel handle at the rear of the pump


Pupils making the rubber buffer anchor and also improving the pump apron where the water is collected in buckets.

3

Teaching Ecological Sanitation in Schools

The brick building demonstration unit

Peter Morgan

Introduction

The method of brick construction for a toilet superstructure in the shape of a "horseshoe" rather than an open spiral has merit because it uses fewer bricks and because less experienced people can build it without the fear of collapse. This is due to the shape of the structure which does not have a free standing wall. A special demonstration and training unit has been built at the school so less experienced or inexperienced people can practice. The unit also serves to demonstrate that even brick structures bonded with weak cement mortar (16 parts pit sand to 1 part cement) can be strong and durable and yet can be taken apart and rebuilt with relative ease. Brick structures of this type can be built relatively quickly (in an afternoon) and taken apart quickly. Most bricks used in the rural program are off poorer quality, but if higher quality fired bricks are used they can be used for construction and after some years taken apart and used again. Higher quality fired bricks can also be built on edge using this technique – a method which uses fewer bricks.

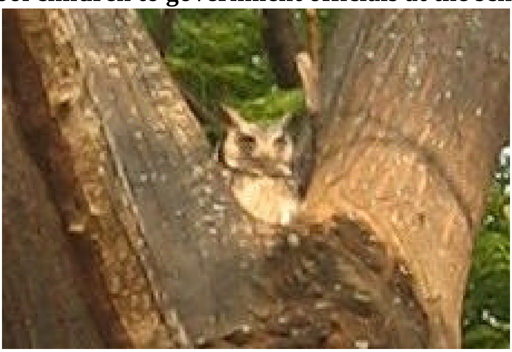
A standard 1.1m diameter concrete slab is made and placed in the demonstration site and raised on bricks. Two treated gum poles are mounted in front of the slab in drilled holes.

Using bricks as mould strong concrete is laid around the poles and also all around the slab over the bricks which support the slab.

2


The unit is being built and the final unit ready for use.


Bricks are brought in and stacked neatly for use. The unit is explained by the school children to government officials at the school.



A curiosity of interest – during the demonstration an owl observed the event.

Teaching Ecological Sanitation in Schools

(Outreach program)

Building an Arborloo with a conical structure

Peter Morgan and Annie Shangwa

Introduction

This method uses a ring beam made of concrete with a shallow pit dug within the ring beam. This is capped by a concrete slab. The superstructure is built by drilling holes around ring beam and inserting a ring of 6 treated gum poles. The roof in this case was an experimental domed design made of cement impregnated hessian. Nails were driven through the roof into the poles to secure. Also a length of gum pole was secured by nails near the head of each upright gum pole. Once the superstructure frame had been made, a suitably sized door frame was made to fit the two main king posts at the front of the toilet. The whole superstructure was then covered by hessian sheer. The door was covered separately with hessian sheet. Finally the hessian was covered with a thin cement slurry made by mixing cement and paint and applying this to the material.


The ring beam in this cases caste to one side and positioned in a suitable position. At first experimental cans were placed within the ring beam to see if these would support the poles, but they would not. Holes for the poles were drilled around the ring beam.


6 treated gum poles were placed inside the drilled holes and the experimental domed roof fitted. A matching door frame was made to fit within the two front posts.

The hessian sheet was attached to the poles and secured with small nails made with cut pi eces of 3mm wire.

Several generations were involved in the construction ranging from the young pupils and their instructor (Mrs Annie Shangwa) to an older builder who was being shown the method.

The door frame was fitted with rubber hinges (see another file) and then covered with a sheet of hessian


Meanwhile the hole was dug down inside the ring beam (in this case after the superstructure was built). In this case an experimental fibreglass slab was used to cap the pit.

Applying cement paint to the structure


The cement paint was made by mixing 4 litres of PC 15 cement with e nough water to make into a thin paint which was applied with a large brush. A small tin of salt was added to the water to help hardening of the paint.


The paint was applied all over the hessian sheet with a second layer being added. The final structure painted.

Teaching Ecological Sanitation in Schools

(Outreach program)

How to upgrading a family well (without a windlass)

Peter Morgan and Annie Shangwa

Introduction

It is now well known that improvements in the design of the "head-works" of a well (the surrounding concrete apron and water run off) can improve both safety of the well from a child's point of view and also the quality of the water. Building a strong concrete "apron," raised collar and water run-off helps stop wastewater discharged at the head of the well pouring back into the well chamber. The water run off leads unused or waste water away from the well head. This water can be utilised effectively by planting a valuable tree at the end of the run-off. This manual describes how a well in the "schools outreach program" was upgraded with an improved head-works but built simply without a windlass system.

Views of the original well head and down the well chamber

1. Preparing the new concrete well apron

A new well slab is made with a raised collar and raised rim. This will function as the well apron and channel water into the run-off channel and avoid waste water running back into the well. In this case the apron was made 2m in diameter with a central well access hole 30cm in diameter.

The well apron is made to one side of the well in strong concrete (4 parts river sand and 1 part Portland cement (10 litres). Steel shuttering is used.

Using a shaped piece of timber the rim of the apron is raised about 3cm high and 3cm wide all round apart from the section where the water will spill over onto the water run-off. Here an extension of the slab is made. The central portion of the run-off has a raised collar surrounding the well access hole.

Stages in making the well apron.

An extension to the apron is made on one side to allow water to flow off into the water run-off channel.

After a week of curing (being kept wet at all times) the apron is moved on to the existing well slab

The new well apron is set in position so that the water run-off channel will carry water slightly down hill to a seepage area planted with a tree

The new well apron is laid on the exiting well slab and cement bonded in position

Making the water run-off channel

In this method the water run-off channel is made using a length of cement impregnated hessian moulded over plastic laid over an asbestos sheet. Two layers of hessian are used with a cement mix made into paint with water.

The hessian cement water run-off channel 1.5m long


The hessian cement water run-off channel is laid down as shown and supported by bricks. Water must flow down the channel along a gentle slope.


Cement mortar is used to secure the water run-off channel in position. Next a 1m deep hole is drilled at the end of the run-off channel in preparation for tree planting.


Drilling the hole with an earth auger can be good fun. The hole is about 15cm wide and 1m deep.


A mix of compost and soil is placed down the drilled hole. This combination will help the tree to grow fast together with the water which is discharged down the run-of. A mulberry tree is planed over the hole.


A neat circle of bricks is laid around the tree. A leaf mulch is added to the soil.


Once the tree is established it can be fed every week with a 4:1 mix of urine and water (8 litres + 2 litres urine) mixed in a watering can. Routine maintenance involves keeping the well head clean. A tin lid is placed over the well access hole. This system can be upgraded with a windlass later.

Teaching Ecological Sanitation in School

(Outreach program)

How to upgrade a family well (with windlass)

Peter Morgan and Annie Shangwa

Introduction

Many family wells have been dug in Zimbabwe, possibly as many as 200,000. They are commonly dug in most of the communal lands where the ground water table is moderately high, and also in deeper localities. Also they are common in several peri-urban settlements around the towns and cities. In recent years they have become more common as sources of drinking water even in the cities. The best way of improving water quality taken from wells is to fit a hand pump sealed to the concrete well cover. Also locating the well away from pit toilets reduces the risk of underground pollution. However it is now well known that improvements in the design of the "head-works" that is the surrounding apron of the well also helps improve water quality. Building a strong concrete "apron" and water run-off helps to stop wastewater at the head of the well pouring back into the well chamber. Also fitting a windlass helps because the rope or chain does not lay on the ground where it may pick up contamination. This manual describes how a well in the schools outreach program was upgraded with an improved head-works and windlass system.


The existing well on the surface and down below

STAGES OF CONSTRUCTION

It is assumed that the well exists and is capped by some sort of concrete slab. The well hygiene is improved by improving the apron, making a water run-off, adding a windlass system and planting a tree at the end of the run-off. Water is channelled from the apron down the run-off to irrigate the tree.

1. Making the windlass system

This can be made using several methods. Two methods are described. Both use treated gum poles as windlass supports which also act as bearings. The two gum poles are embedded in a high strength concrete anchor which also provides an opening for access of the bucket into the well.

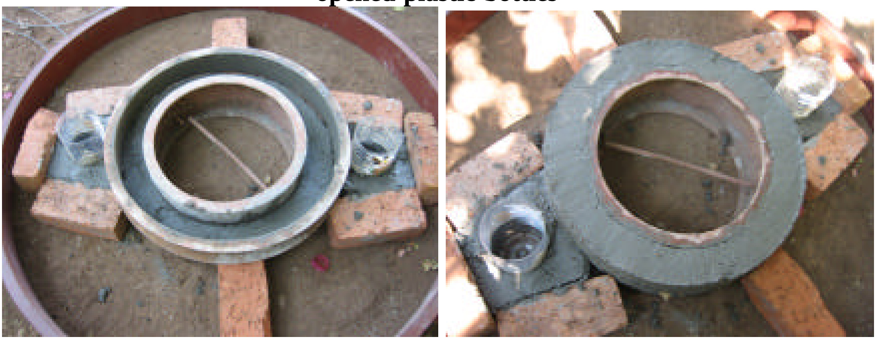
Method one for windlass mounting

Two steel shutters and bricks are used to make the windlass mounting. The outer diameter of the inner shutter is 30cm and the inner diameter of the outer shutter is 40cm. A very strong mix of river sand and PC15 Portland cement is made up and added between the shutters with 3mm wire as reinforcing. Two plastic bottles have the tops cut off and are used to house the gum poles.

The outer shutter is then removed and a series of bricks are laid to surround the two opened plastic bottles which will later house the treated gum pole windlass supports.

Stages in making the windlass support anchor

The outer shutter has been removed. Bricks are laid down to surround the opened plastic bottles



The brick moulds are filled with concrete well supported by 3mm wires for reinforcing. The outer shutter is then replaced and an additional layer of concrete added.

More bricks are added around the plastic bottles together with more reinforcing wire. The concrete is then shaped. The inner shutter must be removed before the concrete has set hard.

A windlass is then prepared from steel, The drum section of 65mm pipe is 30cm long with the shaft made of 20mm round bar. 30cm of round bar project from either side of the drum. The handle measures 18cm long and 15cm. Two gum poles measuring 90cm long and 75-80mm wide are cut.

Two holes are drilled with a brace and bit 25mm wide and 75mm down through the two poles. In one of the poles the hole is opened up with a wood chisel as shown.

The two gum poles are then mounted centrally in each opening made by the plastic bottle. Very strong concrete (3:1 with river sand) is rammed into the opening around the poles to secure. The windlass is then mounted on the poles and a wooden piece nailed in the open slot to hold the windlass. The concrete is left to cure for a week.

Method two for windlass mounting

In this method the windlass support poles are mounted closer together directly into the concrete anchor. This is a simpler method. The poles are drilled and chiselled in the same way and mounted in very strong concrete supported by lots of 3mm wire as reinforcing.

Making the water run-off channel

In this method the water run-off channel is made using a length of cement impregnated hessian moulded over an asbestos sheet. Two layers of hessian are used with a cement mix made into paint with water.

The hessian cement water run-off channel 1.5m long

Adding the windlass system to the well


Strong cement mortar is laid around the hole in the well slab and the windlass anchor and support unit is placed on top.


Bricks are laid around the existing well slab as a mould which is filled up with strong concrete to make a rim and apron around the slab.


The run off is then placed in a channel running slightly down hill from the apron and mounted in a strong cement mortar mix.

A hole is drilled with an auger at the end of the run-off. A mulberry tree will be planted in this.

The hole is drilled down about one metre and filled with a mix of compost and soil. The mix is being prepared in this photo.

The soil compost mix is added to the hole and the mulberry tree planted on top

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The area around the tree is levelled off and surrounded by bricks and a leaf mulch is added.

The completed well. A fitting tin lid is prepared to make a well cover. Diluted urine can be used to fertilise the tree. 2 litres of urine diluted in a 10 or 12 litre watering can or bucket of water can be added once a week. As the tree grows larger extra manure or compost can be added to the soil surrounding the tree. The advantage of planting a tree at the end of the well run-off is that the tree will receive water regularly.

Teaching Ecological Sanitation in Schools

Growing spinach from seed and fertilising with urine in homestead gardens

Peter Morgan and Annie Shangwa

Introduction

Part of the schools outreach program involves showing householders how to enhance the growth of vegetables and maize with diluted urine. In some cases the homesteaders are given seeds to plant and in other cases small seedlings grown in seed trays. The effect of urine on the growth of spinach is particularly spectacular. This effect has already been described in other manuals. The homesteaders vary in their reaction to the application of urine on vegetables. Those who have seen the school experiments are more inclined to accept the method. The acceptance by the school teachers also helps. But the best method is to demonstrate the effect in homesteads.

Growing spinach in seed trays

Spinach can be grown in seed trays easily. But the normal method is to sow the seeds in a protected part of the homestead garden and provide with shade.

Mr Kano the school teacher shows the pupils how to plant the seedlings in a prepared bed. Compost is added to the bed if possible and the soil well turned.

Seeds from the seed tray are planted in the garden and covered with dry grass. They are watered regularly

The beds of spinach grow well if cared for and watered and given a dose of diluted urine every week. In this case about 2litres of urine in a watering can of water (about 10 litres) every week has made a big difference to the crop.

Chinese cabbage were also planted in the beds as well as spinach in this garden in the outreach program

Chinese cabbage and spinach are popular vegetables.

Pumpkin are also growing with the spinach in another outreach garden.

Most green vegetables respond well to the application of diluted urine.