Taking care of our ECOSAN

and the reuse of

HUMANURE

and ECOFERT

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Foreword

Family Ecosan toilet

The Urine diversion toilet is a unique sanitation management facility that is built above ground consisting of a vault where the faecal matter is deposited and a container for urine collection.
The Urine diversion ecological sanitation (Uri dive) or (Urisep) toilet is designed structurally almost like a BVIP toilet, the major difference being that the Uri dive is constructed above the ground with a vault underneath the superstructure. Inside, the Uri dive is fitted with urine diverting pedestal consisting of two chambers the small chamber which is in front collects urine while the bigger chamber below it, provides a passage way for the faecal matter to be deposited in the chamber below the toilet super structure. The urine is channeled from the small chamber by a 20 mm diameter pipe into a 20 L container usually stored in a secured pit dug behind the toilet structure.
Users are encouraged to add ash, soil or lime into the faecal chamber whenever they visit the toilet for faecal deposition. Ash lowers the pH of the faecal matter to levels not conducive for most pathogenic bacterial multiplication. Ash also absorbs some moisture from the faecal matter and activates the drying process. The absence of excess moisture together with the raised pH discourages fly breeding and reduces odours. The top soil introduces natural decomposition agents into the faecal matter which will activate aerobic decomposition process when the faecal matter is put into a compost heap. When the feacal chamber is full the manure is removed from the toilet using long handle spades on to compost, where temperatures have been shown to rise to as high as 50 degrees (Proudfoot, 2002). It is anticipated that most of the pathogenic bacteria are eliminated during the composting process rendering the manure relatively safe for use. Ideally the faecal matter should be on the compost heap for about six months depending on the local climatic conditions and should not be used for at least six months in the case of Zimbabwe.
Similar toilets have been constructed in Marondera, Zvishavane, Chirumanzu, UMP,and Beit Bridge districts with Materera, ,Mapanzuli, Chinyuni, Muzika, Nyagade and Old Nuli as examples. Over 40 schools are now using Ecosan latrines and over 800 households are also using Uri-dev latrines. It has proved to be a handy technology in addressing sanitation problems in places where the water table is high and in rocky environments where it is difficult to dig 3m deep pits. From the experiences with school urine diversion toilets at the mentioned schools, basic operation and maintenance guidelines have been developed.

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What is Ecological Sanitation?

Ecological sanitation has attracted many definitions. Morgan (1998) defined ecosan as a system that makes use of human waste and turns it into something useful and valuable with minimum pollution of the environment and with no threat to human health. Guzha (2001) defined ecological sanitation as an environmentally friendly way of managing human excreta in a way that benefits people and their environment. Ecosan, according to Morgan (1998), is a system in which toilets are designed to:

- Store and prepare human waste for use in agriculture by formation of humus through the addition of ash, soil, lime or any other biodegradable materials.
- Provide a means of removing human waste safely and simply from the toilet.
- Reduce the pollution of the ground and atmosphere as much as possible.

Ecological sanitation views waste as a resource and seeks to prevent surface and ground water pollution as a result of indiscriminate disposal of human excreta and other domestic waste products. Ecological sanitation involves people, sanitation technologies and the use of human derived nutrients in agriculture. In ecosan practice people do not regard human excreta as a waste but a resource. There is a symbiotic relationship between people technologies, and the environment.

2.0 Operation and maintenance

2.1 Management issues

- When a new Ecosan toilet is built at home the household head should gather all family members and explain how the toilet is used.
- A builder or health worker may also be invited to help the household head to explain the operations and functions of the toilet.
- The family should make an effort to appreciate and understand the Urine Diversion toilet and its link to Ecological sanitation.
- Each family should collect all the ash that they produce throughout the week and sieve it to remove all the charcoal, charcoal is the main culprit in causing pipe blockages.
- Every household member should make an effort to leave all the faeces and urine at their home not at the bus stop, beer-hall or in the bush.
- The family should target to use the nutrients for production and every member should contribute.
- If there was a pit toilet at home this should be closed so that all the nutrients are captured for use in agriculture when the season comes.
- Visitors to the home where an ecosan toilet is in place should be taught on how the toilet functions and its operation and maintenance.
- The family should make a commitment to use treated sanitized human excreta as manure and fertilizer for crop production.
- All household or family members should take turns in monitoring the hygiene of the toilet.
- A piece of land about an acre should be identified and prepared as early as April where urine can be deposited in planting pits.
- Where ash is not available the household can make arrangements to go and collect it from boilers or brick molding ovens or simply use top soil or agricultural lime.
- All household members and visitors should be encouraged to use the urine diversion toilet to ensure that a maximum amount of urine and faeces is harvested for use in crop and tree production.
- In Marondera district in Mashonaland East households are frequently holding come together parties as a way of ensuring maximum urine harvesting.

2.2 Using the pedestal

✎ Children should be taught and supervised by the mother, father or elder brother or sister on how to use the Urine diversion toilets.
✎ Children should sit on the pedestal and should not squat or stand on it.
✎ Faecal matter should be directed into the bigger chamber and urine into the small chamber.
✎ Every user should make an effort to direct urine and faeces to go where it should go.

2.3 Technical issues

✎ The ash should be mixed with soil at 1:3 so as to stabilize the ash and ensure that it does not produce a lot of dust
✎Soil is a good source of natural flora and fauna to initiate further bacterial action when the faecal matter goes through the composting process.
✎ Anal cleansing material should be put into the faecal channel as these have been responsible for many of the blockages.
✎ A bucket full of sieved ash and a pouring cup should always be available in the toilet and the school authorities must check at the beginning of the day, after break and after lunch to make sure that enough ash is available.
✎ Enough ash to cover the deposited faecal matter should be sprinkled on top of the faecal matter after each visit to the toilet, care must be taken to make sure that ash does not sprinkle into the urine channel.

2.4 Pipe blockages

One of the challenges with the urine diverting toilet is the blockage of urine pipes, the blockages are caused by the following:
✎ Solid materials such as ash and sand sometimes find their way into the urine pipe network especially if enough care is not being taken when sprinkling them over the fresh faeces..
✎ Urine itself causes blockages due to a salt compound that is formed as a result of the chemical reactions of the urine's mineral contents, a process called mineral calcification.
✎Salts accumulate around the internal surface of the urine piping until it finally blocks the pipe causing blockages.

2.5 Removing the blockage

✎Urine blockages will always be formed, they can however be minimized by increasing the urine pipe diameter to as big as 23mm.
✎ Make pipe connections from the toilet to the urine storage tank as short as possible, a meter long pipe is normally recommended.
✎Take a 2mm diameter flexible wire and use it to remove the blockage, if you can't remove it pour sodium hydroxide liquid, this dissolves blockages due to calcification into a spongy or jelly like substance which can be pushed through using a prodding wire.
✎Pour warm water through the urine chamber and urinal at least once a week

3.0 Sanitizing and using human excreta in agriculture

As the family continues to use the urine diversion toilet faecal matter would be accumulating in the vault and urine into a container where they go through some basic treatment. It has been shown in our experiments in Marondera district in Zimbabwe that an average family of 7 people fills the Zimbabwean Urine diversion toilet vault twice in a year and a twenty litre urine container at least once a week.

3.1 Faecal matter

- The faecal matter goes through a primary treatment process in the vault. This primary treatment makes the faecal matter relatively safe and easy to use in agriculture.
- Absence of urine from the vault makes the faecal matter odourless. It is believed that odour in mixing toilets is caused by a bacteria, *Bacterium ureae*, found in urine. This bacteria feeds on faecal matter and odorous gases are some of its by-products.
- Ash has a great affinity for moisture, as soon as it comes in contact with faeces it quickly absorbs all the moisture in the faeces making them completely dry.
- Ash has a direct bactericidal effect when it comes in contact with bacteria thereby immediately reducing the bacteria load in the faecal matter.
- The addition of ash changes the pH of the faecal matter from acidic to alkaline. Most common enteric pathogenic bacteria are cannot grow in alkaline conditions.
- Infective and reproductive stages of bacteria require moisture. Removal of urine from faeces retard growth and multiplication of bacteria including pathogens.
- Some bacteria form spores under hostile conditions to regenerate themselves later.
- When the vault is full the faecal matter is removed from the vault using a long handled shovel and put to further treatment through composting.

- The faecal matter can also be put into black poly plastic bags for six months. Storage worms and short root plant can be planted in these sacks and/or bags.
- After six months the manure can be put into the trenches or pits and covered with soil before planting seedlings.
- Faecal matter that has been kept in the vault with addition of enough wood ash or lime for six months can be used for crop production.
- Further treatment and quantity enhancement can be achieved through composting
- Composting can be enhanced through moisturizing. This process activates the flora and fauna essential for decomposition including spores.

- Aerobic composting conditions should be created so that temperatures are raised to 50 degrees Celsius to kill off the spore forming bacterial now activated.

3.2 The Urine (Ecofert)

✎Urine, generally believed to be sterile, accumulates in the plastic containers where it also goes through some form of treatment in case some faecal contamination had occurred.
✎The pH changes that occur due to ammonia pressure kills off some bacteria making the urine relatively safe.
✎When the 20litre urine containers are full they are removed from the holding chambers, closed and stored for at least two months before being applied in the field.

Application

✎Urine should be applied into the soils not on top and at a distance of at least 15cm from the plant.
✎50mls dose of urine applied when the crop is 4 weeks old has been shown to cause plant growth and good yield.

Hygiene issues

✎Remove the urine containers or temporarily disconnect the pipe leading into the urine container and pour some warm water through the urine chambers on a weekly basis, allow the water to run to waste or into a soak away.
✎Any drops of urine or faecal matter that accidentally soil the seat should be wiped off immediately, otherwise this will discourage the next user from sitting on it.
✎Male users should be encouraged to use the mono urinal usually situated on the side of the toilet.
✎When cleaning the Urine diversion toilets avoid pouring water into the faecal and urine chambers.
✎All cleaning water should be channeled into a soak away and always prevent pools of water near the toilet.
✎Always have a hand washing facility near each eco-san toilet if its not constructed with the toilet.
✎Users must wash their hands with soap after using the toilet.
✎If water has been accidentally poured in the faecal chamber pour ash-soil mixture enough to absorb the excess water

4.0 Ecological sanitation practice

To maximize investment benefits, a full ecological sanitation practice, need to be put in place. We need to move beyond having ecosan technology only into actual reuse of nutrients (humanure and ecofert) from the toilets.

Ecological sanitation is an environmentally friendly system of managing domestically produced by-products such as urine, faeces, ash and grey water in a way that is beneficial to people and the environment. Ecosan is not about technologies or toilet structure it is about the reuse of human derived nutrients. It is a practice and a culture that recognizes waste as a nutrient resource. The practice seeks to prevent surface and ground water pollution that arises from indiscriminate disposal of human excreta and other domestic by- products by using them for agricultural production thereby enhancing agricultural productivity. Ecological sanitation puts emphasis on safe, hygienic disposal of excreta in a manner that does not spread diseases and therefore protect human health and good nutrition.

The whole approach evolves around people, sanitation technologies and the use of human derived nutrients for trees and crop production. Eco-san is therefore based on the creation of a symbiotic relationship between people, their by- products and the environment. People begin to see their excreta as a valuable resource and seek to benefit from it by applying it to crops to enhance food production.

Use of Urine (ecofert)

Collection

Urine is collected from the small chamber of the pedestal and from the mono urinal normally situated on the side wall inside the toilet. The urine is channeled by a network of pipes into a container usually 20L, stored in a 0.5m deep pit dug at the back of the toilet. The pit has a cover slab to protect the urine from vandalism. Pipes from the toilet into the urine container should run along the walls of the toilet. and into the pit. Only 10cm of the link pipe into the urine container should be in the container to ensure that pipes are not dislodged when trying to remove the container.

Removing the urine container

- Users should always check whether the urine container is full or not and this is done regularly by looking into the container. It has been shown that an average family of 6 people fills one 20 liter container per week, all losses considered.
- When the urine container is full it must be removed from the pit and tightly closed.
- To remove the container disconnect the link pipe from the toilet first.
- Remove the urine pit cover slab and gently place it on the side of the pit.
- Do not bang or throw the cover slab down as rough handling of the slab will break it
- Lift the container vertically up without bruising it against the walls of the pit
- Tightly close the lid of the container.

Storage of urine

✎Proper storage of collected urine is very important to minimize the loss of nutrients.
✎Urine should be stored in a translucent dark container as opposed to a transparent container, and in a dark place.
✎The urine containers should be stored in a cool place (e.g a shed or under a granary) until it is reused.
✎The urine may be stored for a minimum of two months before it is applied to crops.
✎During storage the following processes take place

1. Ammonia vaporization occurs which generate pressure and this helps to kill some pathogenic organisms.
2. The pH of urine changes from acidity to alkalinity (pH of about 8 to 9). This also kills off pathogens.

Taking the urine to the field

✎The urine is carried to the field in 20L urine containers in A wheelbarrow, scothcart or by hand.
✎In Zimbabwe, normally men or boys carry the urine to the field in wheelbarrow.
✎Carrying urine to the field is a job which can be shared by both males and females.

Application

✎Urine is poured into a small container usually a graduated 5litre plastic cup.
✎It can also be poured in a 750ml bottle and then poured to the plant or crop
✎In Zimbabwe 50ml of concentrated urine is applied to each crop
✎A hole is dug with a stick or hoe handle into the ground 5cm from the crop or seed.
✎The hole should be at least 10cm and not more than 20cm deep
✎Urine should be poured into the hole and covered with soil immediately to minimize losses due to evaporation.

Off season urine management

Sometimes urine (ecofert) accumulates during winter when the demand may be low. Under such circumstances two methods are employed to take care of the urine (ecofert) these are:

1. Fertility trench application

✎20cm deep trenches are made in the field where the urine is to be applied and covered immediately with 10cm depth of soil.
✎The trench and/or pits should not be covered completely with soil to ensure easy location when actual cropping time comes.
✎Alternatively urine is applied in fertility pits which are 15cm in diameter and 20cm deep pits dug in the field where the crops are to be grown. When cropping season begins seeds should be dropped in these shallow pits

2. Seed or seedlings application

The seeds/seedlings are then put on the soil on top of the urine (ecofert) layer and covered with a layer of soil twice the size of the seedling or sufficient to bury all the roots.

Compost

Alternatively the urine is applied evenly on the compost heap. The composite heap should be made up of straw or crop residues. Cow dung is an important resource in preparing urine (ecofert) based compost heap .Cow dung is naturally very deficient in crop nutrients. Once it is collected and put on a compost heap and urine added to it, becomes nutrient enhanced, rich and valuable soil conditioner and crop fertilizer. The cow dung has the following function in the compost heap:

a. It is highly urine-phobic, it therefore absorbs all the urine and prevents seepage and percolation into the soil.
b. It stores the urine and then releases it slowly at the rate that ensures maximum intake by plants.
c. It provides a resource for the fauna and flora that starts the decomposition of the organic materials in the compost heaps.
d. It also generates heat essential for the decomposition process

Compost is made from organic materials from plants or animals. The material to be decomposed takes different periods to rot depending on the Carbon to nitrogen ratio of the matter. Succulent matter has a low C: N ratio. The layer should be about 30cm. On top of this layer humanure, faecal matter, animal manure or decayed compost should be spread. This will provide food for the aerobic micro-organisms before they can oxidise the matter to be decomposed. On top of the manure a layer of about 5cm of topsoil should be added. Topsoil contains flora and fauna micro-organisms that help to decompose the materials, so this is a way of introducing the decomposers to the compost. Ensure the layers are moistened because microbial activity takes place in a moist environment. Moisture can be in form of water or (urine) ecofert. Ecofert has the added advantage of reducing C: N ratio and provide bacteria with Nitrogen which is essential in their reproduction and multiplication.

The layers are repeated until the heap is about 1,5m high. A stick is inserted in the middle of the compost and can be felt to find out if decomposition is occurring. The warmer it is the better. The heap should be turned after a month or so to ensure even rotting of matter. In general a compost heap moistened by urine can be expected to mature after three months whilst one irrigated by water may take a bit longer.

At all times the heap should never be compressed as this reduces air circulation, which is necessary for bacteria's respiration. Water and oxygen are needed for the decomposition of complex proteins and other organic compounds present in matter. This then means that water and oxygen should be made available throughout the decomposition process.