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| **Title** | **Onsite Sanitation in Lesotho**<br>**From an Eco-Idea to a Business Opportunity** |
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**Abstract:** oral (PowerPoint) and poster presentation

On-site Sanitation in Lesotho is a technological package where wastewater on premises with gardens is treated biologically (anaerobically and aerobically) and then used for irrigation and fertilization.
The two treatment steps are eliminating oxygen demanding pathogens in the first step and non-oxygen demanding pathogens in the second step. Thus the water is clean of diseases.

The anaerobic process produces biogas, which is used for cooking. As this is normally in rather small amounts, it is just a by-product. Potentially the gas produced can be increased if the premise has also animal dung or any other organic matter or waste paper available.

The technology follows the concept of DEWATS (DEcentralized WAstewater Treatment Systems) as developed by BORDA (Bremen Overseas Research and Development Association). The system is found appropriate particularly in Maseru as many households and institutions have serious problems and cost with the disposal of their sewage.

The cost and the headache for emptying septic tanks are a real disturbance for people whose houses are not connected to a central sewer line.

On-Site sanitation does not only save the cost for emptying the septic tanks, but also leads to economising the use of water as the treated water is suddenly available for the garden. Particularly in the dry winter period this allows to operate a vegetable garden the whole year round.

The commercial extension approach has led to a tremendous demand, which allows that the extension can be done without subsidies and Governmental input.

TED has managed to build 40 installations of this kind in Maseru in the last 2 years. The demand for the technology is high but the extension speed is kept under control to avoid drop in quality and to assure that the so far 6 trainees/implementers can securely and sustain ably earn their living.

Other than an often heard public opinion that biogas technology is simple, TED defines it as complicated and sensitive against technical and approach related irregularities and modifications.

# 1 Background

## 1.1 History

During the past 20 years Biogas Technology in Lesotho has had a very sad history. Of about 80 bio-digesters that have been constructed between 1980 and 1990, only a few are operating.

Biogas Technology Self Help Group in Lesotho's capital Maseru was established in January 2003 with the idea to master Biogas Technology for improved sanitation, onsite treatment and utilization of wastewater and the production of cooking gas from organic waste. In April 2004 the group managed to launch an NGO by the name of TED-Technologies for Economic Development, which focuses on the development and dissemination of environmentally friendly appropriate technologies in Lesotho. Technologies in our portfolio are specifically designed to address the most pressing environmental and socio-economic issues in Lesotho as laid in the Poverty Reduction Paper (PRSP).

The basis of TED was a grant provided by through a small project fund of the German Embassy Pretoria. The group which received this under the name" Biogas Technician Self-Help Group" has founded TED. DED (German development Service) Lesotho and GTZ (German Technical Cooperation) have supported TED's activities by providing office space and equipment and occasionally transport.

## 1.2 Findings

For many reasons, the majority of households in the capital Maseru are not connected to the main sewer line. It is clear that the alternative for such people is septic or conservancy tanks. These in many cases fill up so fast that the frequent emptying becomes a major problem. On the contrary, the municipality does not seem to have capacity to satisfy the demand of emptying the tanks, as people often have to wait sometimes two months before they get the service they have paid for. This is of course the main problem for those who use such tanks, as the consequence of this is the closing of water by the same municipality who fails to give the service of emptying the tanks. Besides, the cost of Maloti 150 per truckload is too high, as some people need to pay for five or more loads monthly.

People therefore need the appropriate technology to counteract these problems.

Our most sought after product - on-site sanitation executed by a bio digester followed by a constructed wetland - enables households to switch from septic tanks with their associated problems (availability and cost of sewage trucks for emptying, contamination of aquifers and surface water by seepage and spilling, waste of water and nutrients) to a system which has negligible costs of maintenance, produces gas for cooking and therefore preserves other forms of energy, has no negative environmental impact and saves water and nutrients for irrigation and fertilization of vegetable gardens and orchards.

## 2 Development

The technology originates from the dissemination of agricultural household bio-digesters to which a toilet was attached. In these digester designs it was necessary to mix the dung 1:1 with water. A much higher concentration of water was of disadvantage as more water going in would reduce the retention time, the gas production and press the slurry out of the system and replace it with water. The design constructed by TED does not require daily mixing, can tolerate wastewater streams (maximum amount of water would be 1/5 of the digester volume per day) and discharges the water first allowing the solids to remain in the digester for several years. In this time the reduction of long carbon hydrogen chains into biogas will be in the range of 90% whereas an agricultural digester that receives well-mixed slurry and discharges well mixed digested slurry.

## 3. The Technology Applied

### 3.1 Technical Fine-tuning

The technology available to the group is based on the *Chinese fixed dome design*, which had undergone over the last 20 years adaptation processes in African countries under the umbrella of GTZ (German Technical Cooperation) and DED (Deutscher Entwicklungsdienst)

### 3.2 Standardization

The digesters themselves are standardized. The difference in sizes follows a principle where the radius is changed from size to size by 10 cm so that all measurements can be kept simple. The digesters bigger than 6 $m^3$ will all produce the same maximum pressure so that several of different sizes can be interlinked on the gas-piping site. This is a big advantage when sewage or organic waste is produced at different locations for instance at an institution.

### 3.3 Research

Elements, which require further research, do not deal with the digesters, but rather with the constructed wetlands attached and the respective cleaning performance of the entire system. A systematic research will be conducted on this in cooperation with the National University of Lesotho. Furthermore the mode of operation in respect of serving customers needs to be modified from time to time.

## 4 Physical Execution

### 4.1 Waste Utilization

We digest sewage and animal waste on site into energy, fertilizer and irrigation water.

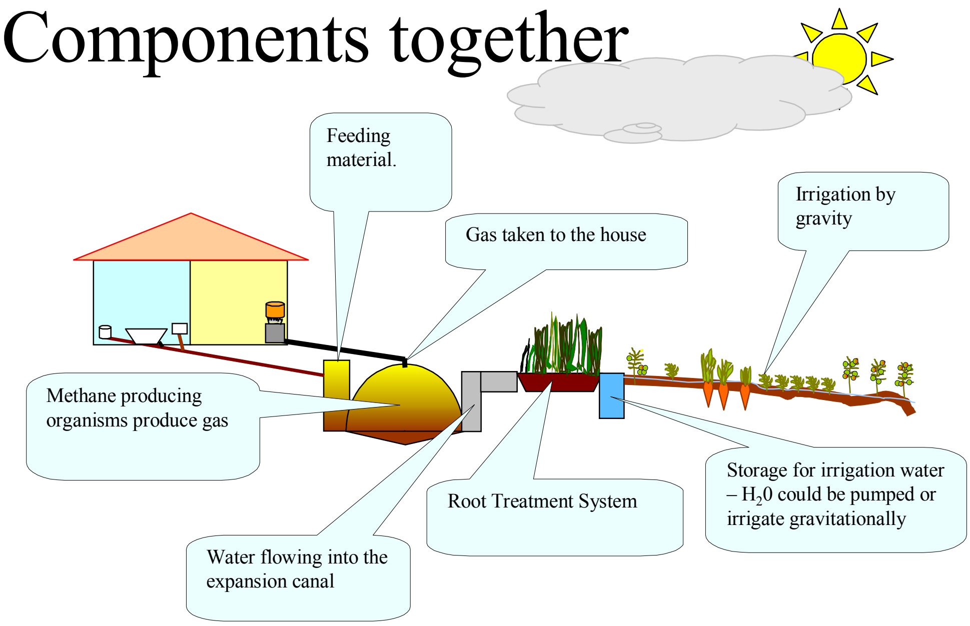
We encourage the use of urine as fertilizer (a resource everybody has).

We encourage waste separation and show cases how the waste fractions can be used productively.

TED tries to use to a large extend resources which are overlooked and regarded as waste. The gravel bed of constructed wetlands are filled with pumice stones originating from garment factories, dumped after stone washing jeans and collected by scavengers in bags and sold to TED. We cast prefabricated building materials with sand, which accumulates in slope drains and culverts (at the same time cleaning the drains). We fill displacement tanks with shredded plastic waste (3-6 m3 per digester) to create surfaces on which wastewater cleaning bacteria can settle.

### 4.2 Planning

Even though the centrepiece of onsite sanitation, the bio digester, is standardised, each site needs a planning process and adaptation of the technology to the site, factors to be considered are slopes, quantities of waste and wastewater to be treated, space availability convenience of operation, cost, utilization of existing resources. Thus in most cases one or two planning visits are required to come out with the final design which then can be cost.




**Sketch of biodigester replacing a septic tank**. Wastewater as well as kitchen and garden waste enter the digester and are broken down to biogas and fertile water.

**The advantages:** No more emptying of septic tank. Reuse of all water in the garden. Less cost on cooking energy.

### 4.3 Components forming *Appropriate* Technology for each individual case

So far TED has constructed 45 digesters most of them in the vicinity of Maseru. The components forming the onsite sanitation systems are:

- **Bio-digesters**, which differ in sizes, operate as settlers, accommodate and break down the organic matter entering the digester. The minimum retention time for the water is 5 days. The treatment of the sewage is anaerobic
- **Expansion channel,** a separate chamber that accommodates the displaced water when gas is stored. Here a further retention time is added
- **Constructed wetland**, which provides an aerobic post treatment to the water, which enters the gravel filled zone free of sediments.
- **Storage tank,** for the treated water. Here the water can be fetched conveniently with a bucket and used for irrigation.

- **A treadle pump**, which is used to pump the water to higher parts of the premises for gardening,
- **A channel system** through the part of the garden, which is lower than the gravity overflow from storage tank.
- In case a **septic tank** already existed on the site where the onsite sanitation is established, the tank is either used instead of the displacement tank or as a storage tank, which is filled with the treated water which is not immediately used for irrigation. In this case the water can be used later when need arises. The septic tank undergoes a prior cleaning.
- **The gas piping system** to the kitchen and a stove to use the gas.

In one case where a constructed wetland has existed before, an electric pump has to lift the partially treated water after the digestion into this system.

### 4.4 Economical Viability of Technologies

When Biogas Technology is considered as an energy technology, it is impossible to justify small household digesters without the presence of animals or animal manure being worthwhile to be constructed. The case is different when people obviously have a sewage problem. This is the case with most of the owners of septic tanks and conservancy tanks. The cost for emptying the tanks is considered very high. Onsite sanitation can save this cost and on top of it provide nutritious water for the garden. People see this benefit immediately if only the problem they are solving was considered big enough. In case the conditions are like this the digester pays back in a very short time. The gas is considered as a by-product. It covers in most cases only a part of the cooking energy requirements. Only when the premises hosts cows, pigs or chicken and more than 20 kg of manure enter into the digester per day, the gas quantity comes close to 100% of the kitchen's energy requirements.

### 4.5 Construction

Customers must buy the building material themselves and the construction only starts, when all the building material is on site. One of the masons is the foreman and is responsible to assure the quality of the work executed. The work is completed with landscaping the site to a presentable level.

Bio-digester under construction

### 4.6 Follow up

The constructed wetland has to be planted out with water tolerating plants originating from the vicinity when the inflowing water has filled up the entire system. The gas production will start only after a few months of operation of toilet and kitchen waste entering the digester. Inoculating the digester with cow manure can shorten the time. When the gas burns and the customer has bought the pipes, TED installs the piping system and the burner. The digester is now handed over. TED continues visiting the site occasionally, which is easier when the site is closer to the main operation area. There are occasional observations, which are unexpected and need to be explained to the customer.

These include:

- plants in the root treatment system may not pick up even though they were planted,
- people throw kitchen waste into the outlet instead of the inlet,
- gas is less than expected, particularly in winter.
- The top most concrete lid can fall into the inlet or the outlet of the digester.
- Handles of the main gas pipe may disappear,
- lids may get cracks.

All these weaknesses have to be addressed to minimise the after sales service input.

## 5 Activity Set Up

### 5.1 Team set up

A team of five masons construct the digesters on a permanent basis; the demand is so big that the team has to be increased soon. One person organises the acquisition and the customer relations and deals with the finances. A biogas expert employed by the DED, who provides technical and organisation backstopping on a voluntary basis, advises the entire team. The team has to be increased soon as it is difficult to deal with the demand.

### 5.2 On the job training

Only two of the masons have undergone a masonry school. This basic know how deficiency has been tried to iron out by on the job training, which does not always have the results we are aiming at.

### 5.3 Mode of Operation

It is a strict principle that we do not follow up potential or suspected customers. We start operating when we are clearly approached by at least a telephone call or a visit to the office. This principle is strictly followed and can be considered as one of the important secrets of the success. The other secret is the provision of an as good quality as possible.

### 5.4 Infrastructure

The infrastructure is absolute minimum; we possess a car, a store at a private house for tools. The tools are owned by the entire group and taken back to the store when a construction site is completed. The office is equipped with a computer and basic office material. The masons go to the sites by public transport, when the site is more than 30 km away from home the masons stay at the site.

### 5.5 Financial Flows

Customers pay to TED only for labour and some prefabricated material. They sign a contact and pay 50 – 60% upfront. Masons receive the money in small portions; it is their decision whom they involve as helpers or diggers. The second payment is due when the construction work is done. A final payment, usually 200 Rand, is left pending for the time before the piping is done. This assures that TED gets all its money. No money … no gas.

## 6 Business Approach

### 6.1 Advertisement (use each avenue)

TED advertises with all means that are available within the daily context and not expensive this is mainly via pamphlets and matchboxes with some information and the telephone number.

### 6.2 Demonstration

Interested individuals or groups frequently visit the first site where onsite sanitation was established. Since its establishment 1040 people have visited the site. Most demand is created out of these exposures.

### 6.3 Target group

There was never a definition of a target group from the “green table”. The interested customers are people who feel they have a problem with their sewage. TED has received about 500 phone calls of people who showed interest in the last two years. On the average two more are phoning or showing up in the office per day. At about 120 sites quotations have been made and 45 of these have been implemented. The approach is **demand driven.**

### 6.4 From-the-Point-to-the-Area-Approach

TED tries to encourage the construction of sites in the vicinity rather that in far distances. The team is still too new in the business that the supervision can be minimized. The few digesters, which have been built further away, are likely to have some problems incorporated which could have been easily avoided. Supervising a far away site is very expensive and tiring for all sites.

## 7 Conclusion

The success of TED in extending onsite sanitation technology is based on a number of principles:

- The core of the technology applied is mature.
- The execution of the work gives high priority to quality.
- The technological set up offered solves a problem, which the people really feel and which has impacted on their pocket.
- A customer has to actively demand the technology.
- Potential customers see an example of the technology in the negotiation phase.
- Many avenues are used for advertisement (probably there are more to be exploited).

This is the story of how - so far - 6 permanent work places have been created in the tiny Kingdom of Lesotho, based on **Onsite Sanitation**. It is planned to increase the team gradually to 20 persons by 2006.