Improved Ventilated Pit Latrines for Rural Areas

In Appropriate Technology Vol.6 No.3, we featured an article on the Ventilated Pit Privy, a latrine design which had proved quite successful in Zimbabwe. This has now been improved, with even greater success, as Peter Morgan and Ephraim Chimbunde* report.

There is a great demand for improved sanitation in many developing countries, not only to provide for peri-urban development, but also to cater for schools, clinics, farms and other centres as well as for families living in rural areas. One technology now gaining wide acceptance employs a method of protecting the pit latrine with an efficient ventilation pipe. The VIP latrine, as it is often called, has already developed a reputation as an effective and practical system, and is widely used in rural development programmes in Zimbabwe. Its popularity is mainly due to its easy construction and maintenance and ability to overcome the two main drawbacks of earlier pit latrine systems: odours and fly breeding.

In a recent review of the United Nations Development Programme World Bank Project on Low-cost Water Supply and Sanitation, it was clearly stated that many VIP latrine designs are still too expensive for low-income communities: several being planned for use in rural or peri-urban development programmes are prohibitive because of their cost. Two of the lower-cost latrines referred to in the review originated in Zimbabwe, where a wide range of technology options has been developed to suit specific needs.

This range includes a commercial VIP latrine kit model for use where rapid erection and portability are desirable. Mass-produced ventilation pipes are sold with instruction leaflets, fulfilling a need in areas where bricks and ferrocement can be used for building. However, many of these techniques are still too expensive for the villager. Consequently, ventilated pit privies have also been designed specifically for people with low incomes living in rural areas. These models are affordable, manageable, acceptable and easy to maintain. The two designs described in this article both use a high content of local material, which keeps the costs low.

Basic components and operating principles

Ventilated pit privies consist of a pit dug in the ground, a base slab covering the pit, a superstructure including a roof and an efficient ventilation pipe fitted with a corrosion-resistant flyscreen (Figs 1 and 2). The pit is protected against collapse by a collar at its rim, made from mortar or bricks. This also helps to prevent surface-water erosion and provides a foundation on which to build the superstructure. All base slabs are built with two openings — one for the ventilation pipe and one for the squatting hole. The superstructure is designed to provide semi-darkness and is commonly built in a spiral, doorless shape around the squat hole (Figs 3 and 5). The opening of the structure should preferably face north or south, to prevent the morning or afternoon sun from penetrating the interior and thus attracting flies. If possible, the opening should face the prevailing wind as this aids ventilation. In most designs for rural use, the roof is made from thatch. Ventilation pipes can be made from many materials including PVC, asbestos, brick, plastered reeds and plastered hessian. All pipes should be fitted with corrosion-resistant screens made of materials such as fibre-glass, as exhaust gases are very destructive.

Once the base slab has been sealed over a pit and one of the openings has been fitted with a ventilation pipe, air is drawn down the other aperture to replace the air passing up the pipe (Fig. 1). It appears that the main force causing the air movement is the wind blowing across the top of the pipe. Thus, the rate of air-flow through the system changes constantly with the wind. A solar heating effect also contributes to the air-flow with warmer air in the pipe rising, but this is thought to be of lesser significance. Since fresh air is always passing down the squatting hole, foul air from the pit cannot pass into the structure, which should remain almost odourless. However, odour does pass out of the pipe and is diluted in the atmosphere (Fig. 1). This may attract flies from surrounding areas, but they cannot pass through the screen to infest the pit. Any flies about to fly out of the pit will seek the greatest light source and, as the structure is in semi-darkness, will be attracted to the light showing through the top of the pipe. They fly to the screen where they are trapped and eventually die. Thus, very few flies are actually able to breed in the pits of ventilated privies.

The system is simple and has been

*Peter Morgan and Ephraim Chimbunde can be contacted at the Blair Research Laboratory, Harari, Zimbabwe.

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FIG. 1 AIR FLOW AND FLY MOVEMENTS IN A VIP.
proved to work not only by scientific testing but also by very successful field trials. The fact that spiders and lizards often reside permanently on many ventilation pipes in order to capture their prey provides the very best evidence for the reliability of the system and its ability to harmonize with the natural world.

Constructional details

The first technique to be described, uses a timber base with a mud and wattle superstructure; the second a concrete base with a brick superstructure. The ultimate choice will depend on the availability of local timber and whether materials and skills needed to make concrete are locally available. The concrete base is certainly preferable from the designers' point of view, but the wooden log base is often more popular, at least initially, simply because it is a traditional technology.

Log base with mud and wattle

Equipment and preparation

This technique requires one bag of cement, local timbers, grass for thatching, mud and a fly-sutch. Once a suitable site has been chosen a rectangular hole is dug in the ground 1.5 m long, 0.6 m across and 3 m deep. Once the pit has been dug, the sides and rim are plastered with a mixture of one part cement to eight parts sand. This operation requires a half packet of cement.

Construction

1. The cover slab is made by laying two logs, 2.3 m long and about 100 mm in diameter, along the pit 300 mm apart, so that their upper surfaces are flush with the ground (Fig. 2). Smaller logs are then placed across these longitudinal logs, leaving no gaps, and are secured into position with wire or nails. Apertures for the vent pipe and squat hole are formed at the appropriate places by using pairs of shorter logs extending to the inner edge of the longitudinal logs (Figs 2 and 3). The timber base is bedded into the mortar around the rim of the pit. All the timbers selected should be resistant to termite attack. In Zimbabwe, the 'mopane' (Colophospermum mopane) and 'mususu' (Terminalia sericea) are commonly used as they are very resistant. Less-resistant timbers must be protected by coating with liberal quantities of wood ash, used engine oil, carbolineum or dieldrin.

2. Next, the superstructure is built using either mud and wattle or sun-dried mud bricks. Fig. 3 gives dimensions which are suitable for both types of structure. If poles are to be used for the frame, about 30 will be required, 1.8 m long and about 50 mm dia. The lower ends of the poles are cut roughly to a point so that they can either be driven into the ground or wedged between and nailed to the log base. The upper sections of the poles are kept in place by fastening rings of green saplings around them with wire. A traditional roof is then made with thin poles and thatch, leaving a recess in position for the pipe (Fig. 2). The entire roof is wired on to the structure framework.

3. The application of mud to the inner and outer walls now begins. This material should preferably be taken from termite hills which have better adhesive qualities than common soil and are more durable. Following application to the walls, mud is plastered over the base slab to form a latrine floor which slopes in all directions towards the squat hole; a step is made at the entrance of the latrine. As the first application of mud dries, cracks appear which are filled in by a second mud covering. If a good-quality termite soil is used, this method of construction will last for many years.

4. The remaining half bag of cement is now used to plaster the floor of the latrine and the ventilation pipe. Home-made vent pipes are either made with bricks or by rolling up a mat of reeds 2.4 m long and 0.6 m wide with wire or string to form a tube. The mat is wired to a series of 200 mm dia. rings, made from wire or green saplings to form the tube. Before mortar is added to the pipe, a piece of fibreglass flyscreen is wired on to one end. Plastering the pipe requires some practise as it is important to make it airtight and flyproof. If extra strength is required, a length of thin wire can be wound spirally around the tube and an extra layer of mortar added. The tube is left to cure in a moist state for several days and is then erected over the vent pipe aperture of the base slab (Fig. 2). The pipe base is mortared in position and its upper end is wired to the superstructure.

5. Any exposed parts of the slab are covered with soil and sloped away from the latrine. Grass can be planted to further protect against erosion by rain. If bitumen can be afforded, a thick layer may be laid over the cement floor to prevent the absorption of urine by the cement.

Test for efficiency

A smoke test is applied to each latrine. This involves lighting a small fire, with grass, in any pit. All the smoke should rise out of the vent pipe, and the interior of the latrine should remain smoke-free. This clearly indicates the passage of air through the system and is an excellent method of demonstration.
Concrete base and brick version

This is a more permanent construction, and although it uses a little more cement, it is not necessarily more expensive as nails and wood preservatives are not used. This time the pit is circular rather than rectangular. For family latrines, the excavation will be 1.2 m dia. capped by a concrete slab 1.5 m dia. For communal units, a hole 1.5 m dia. is covered by a 1.8 m dia. slab. The following description applies to the family unit and requires one and a half packets of cement in its simplest form, that is, when sun-dried bricks and termite-hill mortars are used for the structure. More cement will be required if fired bricks and cement mortar are used.

Construction

1. The pit is dug 3 m deep and its walls are lined with cement/sand mortar (1:8). The mortar is extended to the rim of the pit and a ring of bricks or stones are laid down to act as a collar (see photograph); about half a packet of cement will be needed. In very loose or wet soils, the pit may have to be bricked.

2. The slab is constructed by arranging a 1.5 m dia. ring of bricks on the ground to form the mould, into which two templates are inserted to make the apertures (Fig. 4). These can be made from bricks or tin cans. Next, the concrete is made; if small stones are available they should be added to make a mixture of 4 parts stone, 2 parts river sand and one part cement; half a bag of cement is sufficient to make a 1.5 m dia. slab. If stones are not available, then well-washed, sharp, river sand can be added to the cement in the proportion 6:1. Half the concrete mixture is poured within the bricks, and reinforcing wire is added; 8-gauge wire (3.12 mm) arranged in a grid formation with 150 mm spacing is ideal. The remaining mixture is poured on top of the wire and trowelled until flat. The slab is then cured in a moist state for one week, then placed over the collar and mortared down to make it airtight.

3. Next, a spiral brick superstructure is constructed: the arrangement is shown in Figs 3 and 5. A considerable part of the structure does not lie over the pit and is supported by the ground, helping to prevent pit collapse. The same technique is used for both fired bricks with cement mortar and earth bricks with termite-hill mortar. Normally, 20 courses of twenty bricks should provide an adequate structure.

When bricks are used for the building, it is also common to use them for the pipe, too; it is possible to incorporate one wall of the pipe into the superstructure (Fig. 3). The brick pipe will normally take 25 courses of six bricks which are arranged to leave an internal cross-section of 225 x 225 mm. Brick vent pipes are best made with burnt bricks and cement mortar to avoid erosion from rain-water. Finally, a roof is made, normally in thatch for rural structures, and the latrine floor is plastered as before.

Other uses

As ventilated pit privies are sometimes used as washrooms, they should be built sufficiently large to cater for both facilities (Fig. 5). When the structure is used as a washroom, it is desirable to plaster its entire inner surface, as this is more hygienic and prevents erosion and wall collapse.

Maintenance and durability

Once the latrine is built and field-tested, it should provide excellent service. Ventilated pit privies have been in ‘active service' in Zimbabwe for nearly 10 years and many of the units have been examined closely by laboratory staff. The most important maintenance procedure is to wash the floor with water regularly. This procedure will happen automatically in family units and the slow but consistent addition of water to the pit prolongs its useful life.

Another maintenance requirement is the regular examination of the flyscreen, a component that must remain intact if fly control is to be efficient. Many types of screen have been tried, but fibreglass appears to be the best. Occasionally, a vent pipe may become blocked with cobwebs, and this drastically reduces the effectiveness of venting and fly control. This problem is overcome quite easily by throwing a bucket of water down the pipe. Another coat of bitumastic paint (if this can be afforded) on the floor is desirable, as the paint does wear away. Well-maintained ventilated pit privies should last for many years. Studies carried out in Zimbabwe indicate...
that in family units where water is added regularly and paper used for anal cleansing, the rate of accumulation may be as little as 0.02 m\(^3\) per person per year. This means that if the latrine is abandoned when the contents rise to within 0.5 m of the surface, a rectangular pit 3 m deep should last 112 man-years, and a 1.2 m circular pit 3 m deep 146 man-years. Thus, most families should expect about 20 years service from a latrine. This factor is a good argument in favour of spending a little extra money in making the latrine permanent, as collapse is more likely to occur in temporary structures before the pit is full.

It is possible to desludge pits. This exercise is now being tried in Zimbabwe using a manually-operated Bumi Pump made locally. This robust diaphragm pump uses two larger rubber balls as valves and seems able to suck up sludge with ease. The addition of water, even to unlined pits in family units, appears to liquify the contents sufficiently to allow the Bumi Pump to operate. Ventilated pit privies have also been built over tanks with an outlet pipe for effluent discharge. In this case, the contents are very liquid and can be removed with ease. This possibility, which has been tried many times in Zimbabwe, places some doubt on the usefulness of expensive double-vault latrines being advocated elsewhere.

**Conclusion**

Ventilated pit latrines have been actively promoted by Zimbabwe’s Ministry of Health since 1975 and tens of thousands of instructional pamphlets have been circulated during this period. The system appears in the primary school syllabus, and films on construction are shown through 20 mobile cinema units. A large number of Government Health Assistants, health workers and builders have been trained in constructional techniques both at central and provincial level, and numerous demonstration units have been built in the provinces. Mission hospitals and major aid organizations are playing an active role in promoting the technology.

The ventilated privy system described here is simple, cheap and effective and employs the forces of nature to overcome the passage of disease. By doing so, it can be relied upon to maintain protection with limited supervision for long periods of time. Perhaps it will make safe, affordable and acceptable sanitation for the family a reality in the developing world.

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**References**


**Notes**

a. VIP Latrine refers to Ventilated Improved Pit Latrine.

b. When a single bag of cement is used for a whole latrine, the method of dividing up the bag is very important. A useful technique is to divide it into eight 5-litre (1 gallon) tins of cement. Half a bag of cement (four tins) is used for the pit. One tin of cement is mixed with three tins of sand to mortar the pipe, and the remaining three tins are mixed with four times their volume of sand to render the floor and cement the pipe in position.

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*The collar used with the concrete slab consists of a ring of bricks mortared to the top of a circular pit. Ideally, the brick-work and the pit should be plastered, leaving only the base exposed to allow liquid wastes to seep away.*

*Ventilated pit privy made from local materials with a plastered reed pipe.*