Ground catchment ferrocement water tank

Developed by UNICEF's Eastern Africa Regional Office, the ferrocement water tank described in this article has been successfully used in Kenya for five years. With proper maintenance, it should last 20 to 30 years.*

THIS ground catchment water tank collects and holds 52,000 litres of rain-water. It is especially good for semi-arid areas with infrequent rains, as it can reach full capacity after only one rain storm. The tank is made by digging a hemisphere into the ground and covering it with layers of cement plaster, reinforced with barbed wire and chicken wire. A roof provides shade and reduces evaporation. Water is directed into the tank by means of two wide-angled soil-wall 'gutters'; the water runs through a simple silt trap which minimizes the soil carried into the tank. Water can be drawn using a bucket on a rope or a simple handpump, or it can be gravity-fed downhill.

The tank holds enough water to irrigate one-tenth of an acre for a full year, or to provide water for about seven head of cattle. If boiled, it can be used for human consumption, allowing annually 25 litres per person per day for a family of six.

Choosing the best position

The tank should be situated at the lowest part of the best catchment area: ideally below a slope of rock or soil with vegetation. It should *not* be placed in a basin or a river-bed; nor should any trees grow nearby, to avoid damage by their roots. If the water is to be used for irrigation, the tank should be situated above the area in order to gravity-feed the water to crops, without need for a pump.

Soil containing a fair amount of clay is best. Rock is difficult to dig out, although it provides the strongest foundation. Sandy soil should be avoided if possible, for obvious reasons; where there is no alternative, extra barbed-wire reinforcement or wire mesh should be used to make it stronger.

Excavation

The first step is to dig a hole in the centre of the chosen site. Place a strong pole, 80cm high, in the hole and hold it in place by pouring concrete into the base. Tie a string 3m long on to the pole and attach a stick to the other end of the string. Pulling the string taut, mark a circle in the soil.

Next, dig a hole within the circle which is 6m across and 3m deep. When the correct size and shape have been reached, remove the centre pole and the remaining soil (Figure 1). Dig a hole approximately 1 cubic metre at the point where the water will enter the tank. This will provide a silt trap to allow soil carried by the water to settle before the water enters the tank.

If the soil is sufficiently firm, dig a trench around the perimeter of the tank, making it deeper towards the outside. If the soil is not firm enough to hold a trench, then make it *after* plastering. Fill the trench with 1:2:4 concrete (cement:sand:gravel) reinforcing it with a strand of barbed wire. Keep it damp by splashing with water after allowing four hours for setting, then cover with plastic sheeting.

Plastering

The tank and silt trap are plastered with a 1:3 cement:sand mixture. The strength of the tank depends largely on:

- careful and thorough mixing of plaster;
- using only enough water to make the plaster workable; and
- curing the plaster by keeping it damp for four weeks.

The silt trap should be plastered first, left for four hours, then filled with clean water. Next, coat the tank with 'nil', a mixture of equal amounts of cement and water. This must all be done in one day, making sure that the nil is always moist.

The next day, a 2 to 3cm-layer of plaster is thrown on to the tank and the surface is left rough (Figure 2). Be sure to measure the sand and cement carefully, mixing them dry until the colour is even throughout, then adding water slowly. The plaster should be fairly stiff; if it is too wet, the tank may crack later on. This layer must be applied in one step and kept moist. Never let it dry to a light-grey colour. Four hours after plastering, splash water over it and cover it with plastic sheeting.

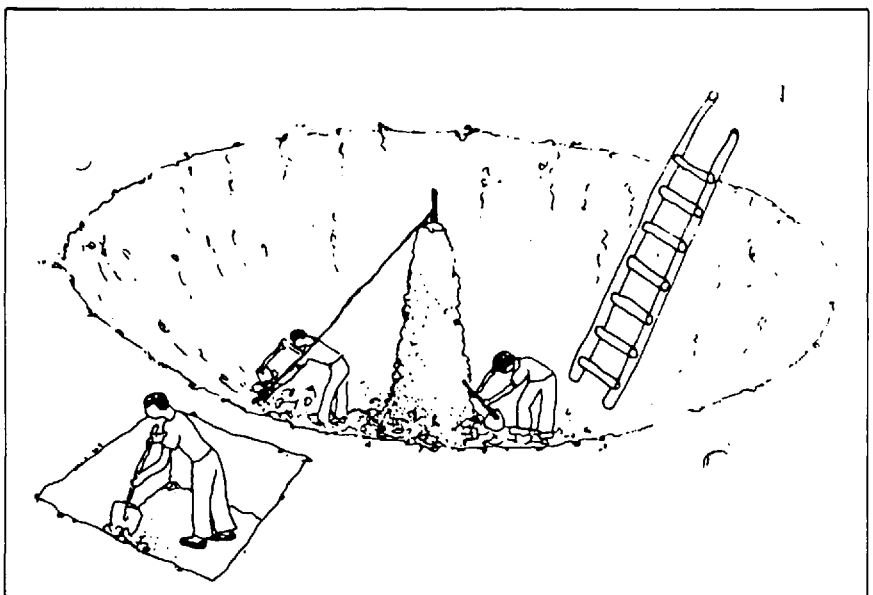

Figure 1

*This article has been extracted from a construction manual of the same title produced by UNICEF's Technology Support Section, Eastern Africa Regional Office, PO Box 44145, Nairobi, Kenya. Much of the development work was done by Frans Claassen and Laurie Childers.

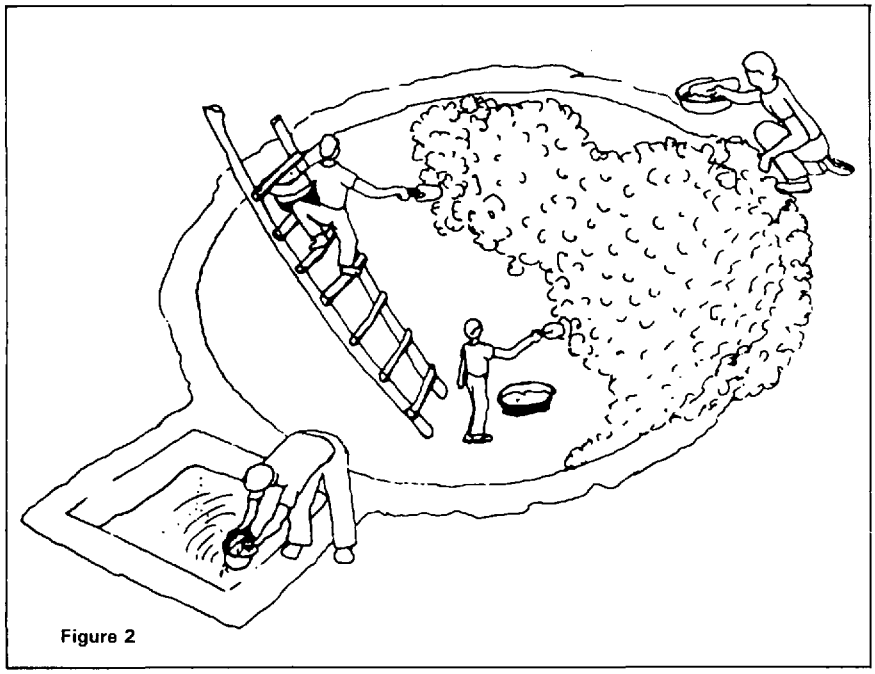

Figure 2

The following day, the plaster should be strong enough to support nails. Starting at the top, unroll chicken wire around the tank and nail it to the top edge using either U-nails or straight nails. Pull and fold the bottom edge of the chicken wire to conform to the bowl shape and nail it into place. Make a second row, overlapping the chicken wire by at least 15 cm. Cover the bottom with patches of chicken wire. Always overlap by 15 cm or more for good reinforcement.

Next, starting at the top, roll out the barbed wire and nail down two rounds at the top. Continue in a descending spiral at intervals of 15 cm. To strengthen the tank further, nail down barbed wire in a pattern that will take up vertical stresses, as shown in Figure 3.

The second coat of plaster is 3 cm thick. This layer is thrown on and trowelled smooth. Again this step must be done over one day, with the plaster kept damp and covered with plastic sheeting on completion. A final coat of nil, 1 mm-thick, is then poured on and pressed on to the surface with a steel trowel. Splash the tank with water to keep it damp, and cover it with plastic sheeting.

Reinforced with a ring of barbed wire, one or two courses of bricks are laid round the edge of the tank to prevent unfiltered water from entering and to support the poles for the roof. The span between the silt trap and the tank is left open. Opposite, a gap is left in the bricks to direct overflow water from the back (Figure 4).

The roof

The roof is constructed by tying four sisal poles together at the small ends. Four people then lift them into place, resting on the rim of the tank against the mortared bricks (Figure 5). Another 80 to 100 poles are added to form the roof. Strong vines or wires can be used to join the poles using a traditional basket-weaving technique (Figure 5).

The roof is essential for shading the tank. In semi-arid areas, 2 m of water can evaporate over a year. Green creeping plants, such as loofah or passion fruit, can be planted to grow up the poles. Their shade will reduce further loss by evaporation. The roof also helps to prevent animals or children from falling in (Figure 6). Fence the tank for maximum safety.

Silt traps and catchments

Silt can take up a significant volume in a water tank, reducing the amount of water that it holds. In addition, bacteria tend to cling to soil particles. By simply slowing down the water, the silt will drop. The silt trap described in the article is a simple but effective method. More complicated systems

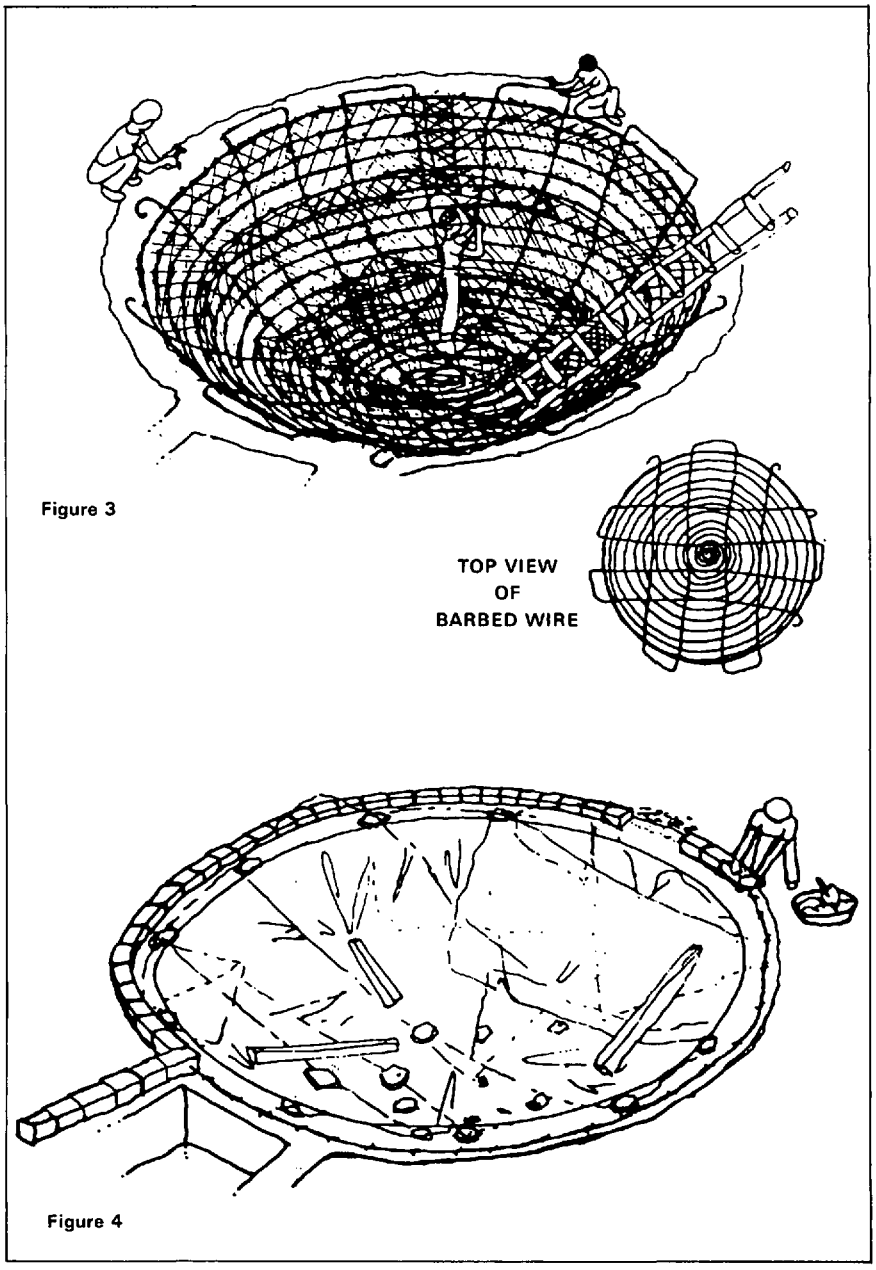

Figure 3

Figure 4

can be built, but the most effective way by far to keep water as clean as possible is to take care of the catchment area. Dirt that enters the ground tank is the product of soil erosion.

If the water is run-off from a road, place rows of stones across the gutters to slow erosion during the rains. Turn a corner to slow down the water (Figure 7a).

Build several tanks in a row, with the overflow from one filling the next. The second and third tanks will have very clean water (Figure 7b).

For catching run-off from a slope other than a road, make fairly wide soil gutters to direct water into the tank. Use the excavated soil to make short 'walls', forming gutters 100m in length. If the hill is rocky, the gutters should rise 1.5 cm per metre of length; if the hill is soil, the slope should be steeper: about 2 to 3cm per metre of length.

Plant grass on soil-catchment areas, fencing it to keep out grazing animals if the water is to be used for human consumption.

Maintenance

The silt traps should be cleaned before each rainy season and during the rains, too, if the trap seems to collect a large amount of silt. The roof should be repaired as required: a good plant cover should be maintained to minimize evaporation, so keep the loofah or passion fruit well watered.

Each rainy season, inspect the soil wall gutters and rebuild them where necessary. Lengthen them if the tank fails to fill completely. Once the tank has filled up, open the soil gutters and divert the water to prevent extra silt from entering the tank. Close them to redirect water into the tank when the water level starts to go down. After any big storm, inspect the gutters for damage. Growing grass on the catchment area will ensure that the cleanest possible water flows into the tank.

Repair

When structural cracks occur, they usually appear when the tank is full of water for the first time. Such cracks can be repaired with relative ease:

1. Chisel away all the plaster within 15cm of the crack.
2. Coat the area with nil.
3. Fill the area with plaster (1 part cement:3 parts sand).
4. Coat with nil, pressing it on with a steel trowel.
5. Keep it damp for three weeks – even as long as a year for full strength.

If the crack re-appears or water still leaks out, a new ferrocement tank must be built inside the old one.

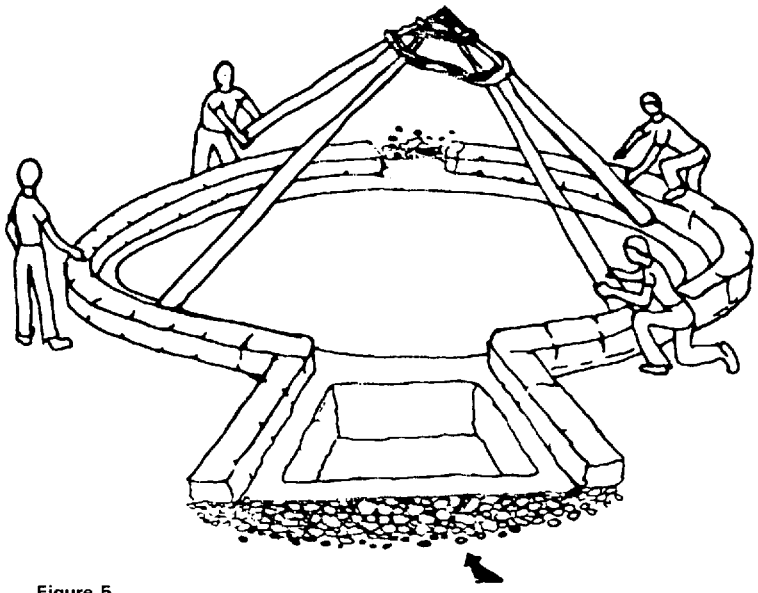

Figure 5

PLACE STONES HERE TO RETARD EROSION

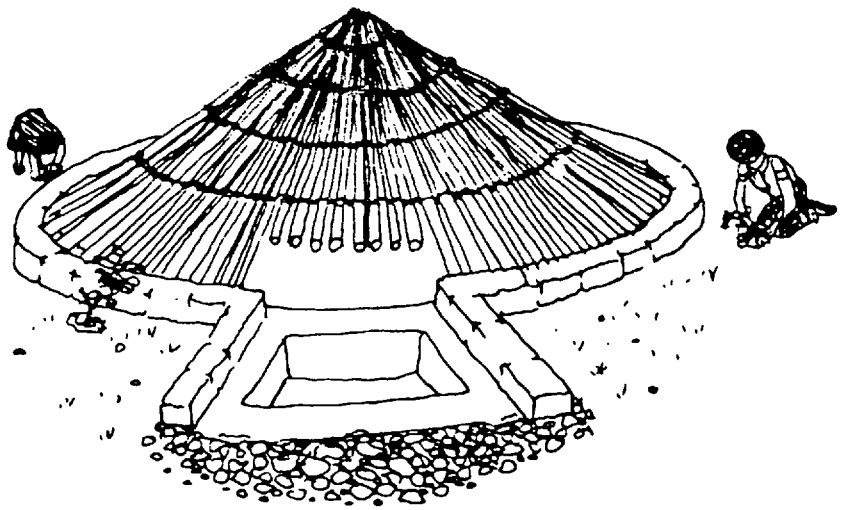

Figure 6

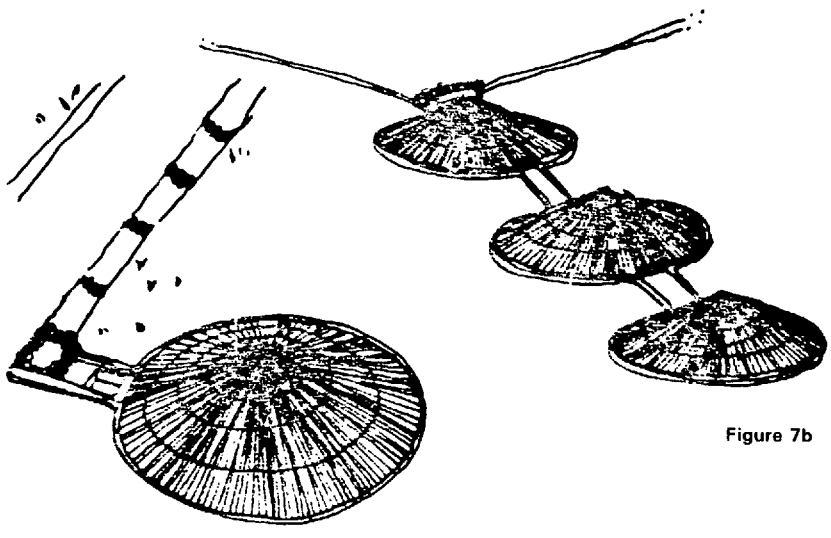

Figure 7b

Figure 7a