CHAPTER 3

Water

Water is critical to life, but it is also a limited resource and several interrelated factors are decreasing its availability. These factors include climate changes, increasing demand, lowered water tables and environmental degradation. There is also the growing threat of international and intercommunity disputes over water supplies. It is important, therefore, that communities manage their water resources better and supply water for specific uses.

For most people, it is not a problem to obtain the minimum amount of water necessary to sustain life. Rather, problems relate to the quantities of water required for different activities (resource allocation) and the quality of the water available (source suitability). Many places with water shortages actually receive abundant rainfall and community-based initiatives could alleviate water scarcity. Such initiatives may incorporate traditional approaches and include water management and conservation measures; sustainable rates of extraction; sustainable crop production; catchment protection; rainwater harvesting; and soil conservation.

3.1 **Providing community water supplies**

To promote community health an easily accessible water supply should be available that provides sufficient safe water to meet community needs. Household water needs can be estimated by questioning community members about their daily water use. If this is not possible, a minimum water need can be calculated by assuming that the average person uses 25 litres per day for drinking, cooking and personal hygiene. More water will be needed for laundry, but this may be available from other sources such as rivers or ponds. To ensure that the water is potable, either the water supply should be protected or the water should be treated before use. Low-risk water supplies for drinking and other domestic uses can be provided to communities in many ways. Often, unprotected water sources, such as springs, traditional wells and ponds, can be improved and this may be preferable to constructing completely new supplies. However, unprotected sources are open to contamination and pose a potential health risk. Community hygiene programmes should therefore promote the use of protected drinking-water sources.

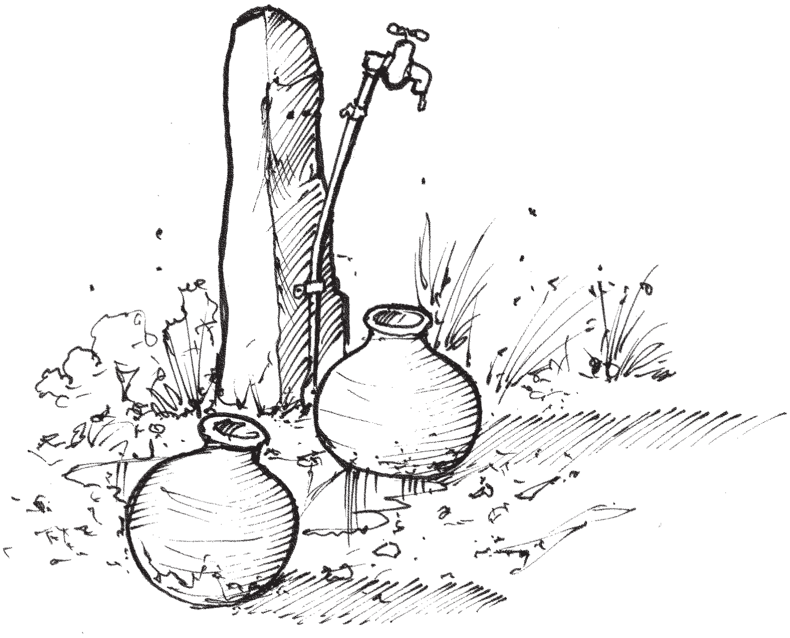
Characteristics of low-risk water sources

- The water source is fully enclosed or protected (capped) and no surface water can run directly into it.
- People do not step into the water while collecting it.
- Latrines are located as far away as possible from the water source and preferably not on higher ground. If there are community concerns about this, expert advice should be sought.
- Solid waste pits, animal excreta and other pollution sources are located as far as possible from the water source.
- There is no stagnant water within 5 metres of the water source.
- If wells are used, the collection buckets are kept clean and off the ground, or a handpump is used.

When resources are limited, it may be necessary to decide whether greater emphasis should be placed on the quality of the water, or on its availability. Where sufficient safe water for all is not immediately available, intermediate steps should target the provision of larger quantities of lower-quality water. Deciding on an acceptable level of contamination is difficult and depends on the willingness of community members to pay increased costs for better water, as well as on their willingness to treat water within the home. If payment is required for water use, it must be affordable to the whole community. In any case, water with high levels of contamination, particularly with faeces, should never be used. Local health officials should be consulted about the quality of water provided and the level of health risk.

Many rural water supply programmes aim to develop water sources that can be fully managed by users, with only limited additional support from local government. While this can make a sense of community ownership more achievable, it also requires communities to make long-term commitments, such as maintenance of improved water sources, and even to contribute financially towards their construction. If this is not done, the water supply may deteriorate as shown in Figure 3.1. This means that it is important to involve communities during all stages of development of the improved water sources, from initial planning and implementation to long-term management. Community members should be actively involved in selecting the type of water supply they receive and have access to information that allows them to make informed decisions. However, discussions must be balanced and should also

Figure 3.1 ***Unhealthy practice (water supply is damaged)***



consider what the supporting agency considers feasible, not simply what the community desires. On the other hand, solutions chosen solely by outside agencies are more likely to fail.

From the outset it is also essential that community members are fully aware of the short- and long-term implications of their choices, for while it is relatively easy to build an improved water supply, sustaining it is often a major problem. For example, boreholes with handpumps are often recommended to communities, but this technology requires relatively expensive maintenance, and access to spare parts and tools is essential. In one country, spares for handpumps were available only in the capital city, a two- or three-day journey for remote communities. As a result, the handpumps were likely to fail in a very short time and the investment would have been wasted.

Checklist for communities considering water supply improvements

- Have community members been fully consulted about the type of water supply?
- Have community members had previous experiences with water supply improvements and have these been relayed to the relevant agency?
- How will the water supply be managed to ensure that it is reasonably accessible to everyone in the community?
- How will initial costs be paid and is the community expected to provide labour?
- Will labour be provided free or will the community have to raise funds to cover labour charges?

- What are the long-term financial implications of the choice of water supply?
- Can the community afford to pay expected operation and maintenance costs?
- What spare parts are required and how often should they be replaced?
- Who sells these spares and where are they obtained?
- What tools are required and where can they be obtained?
- Who will be trained to operate and maintain the water supply?
- What skills should operators have and what training will they receive?
- What long-term support can the community expect from the government and other agencies?
- If major repairs are required, whom should you contact and who will pay?
- Will the quality of the water be tested?
- How often will testing be done and how will the information be communicated to the community?

3.2 **Types of water sources**

3.2.1 **Protected springs**

A spring is where underground water flows to the surface. Springs may occur when the water table meets the ground surface; these are called gravity springs. Other times water is forced to the surface because the water-carrying layer meets an impermeable layer (gravity overflow springs or contact springs). In some cases, groundwater is held under pressure and springs come to the surface because of a natural break in the rock, or because a shallow excavation is made (artesian springs).

Springs can make very good water supplies provided that they are properly protected against contamination. If springs are found above the village, they can feed a pipe system for providing water close to homes. When a spring is at the same, or lower, level than the village, it can still be protected, but greater care is needed and it is unlikely that water will flow through the pipe system by gravity. The first step in deciding whether a spring should be protected is to determine whether it provides enough water for the expected number of users. This is easily done by measuring the time it takes for the spring to fill a bucket of known volume.

Estimating whether a water source has sufficient flow rate

- A spring fills a 20-litre bucket in 6 seconds, corresponding to a flow rate of 3.3 litres per second (20/6 = 3.3).
- In 24 hours, this spring would provide 285 000 litres (3.3 × 60 × 60 × 24).
- If each person uses 25 litres per day, the spring will supply the daily needs of 11 400 people (285 000/25).
- **NB**: a storage tank may be needed so that water flowing from the spring at night can be stored and used during the day, instead of running to waste.

To protect a spring, a retaining wall or box is constructed around the "eye" of the spring, where the water emerges from the ground. The area behind the wall or box is backfilled with sand and stones to filter water as it enters the box and help remove contamination in the groundwater. The backfill area is capped with clay and grass is planted on top.

The whole area should be fenced and a ditch dug above the spring to prevent surface water from eroding the backfill area and contaminating the spring. The collection area should be covered with concrete and sufficient space left beneath the outlet pipe for people to place jerry cans and buckets. A lined drain should be constructed to carry spilled water away from the spring. The water could be used for laundry, to feed an animal-watering trough or for irrigating a garden. In other situations spilled water may be drained to a soak-away pit or to the nearest surface water body. To prevent mosquito breeding, water from the spring should not be allowed to form pools. An example of a well-protected spring is shown in Figure 3.2.

As discussed earlier, all water supplies need to be maintained. Although protected springs require very little maintenance, far less than a borehole with handpump, the following basic checks should be carried out every 1–3 months.

Examples of basic checks for protected springs

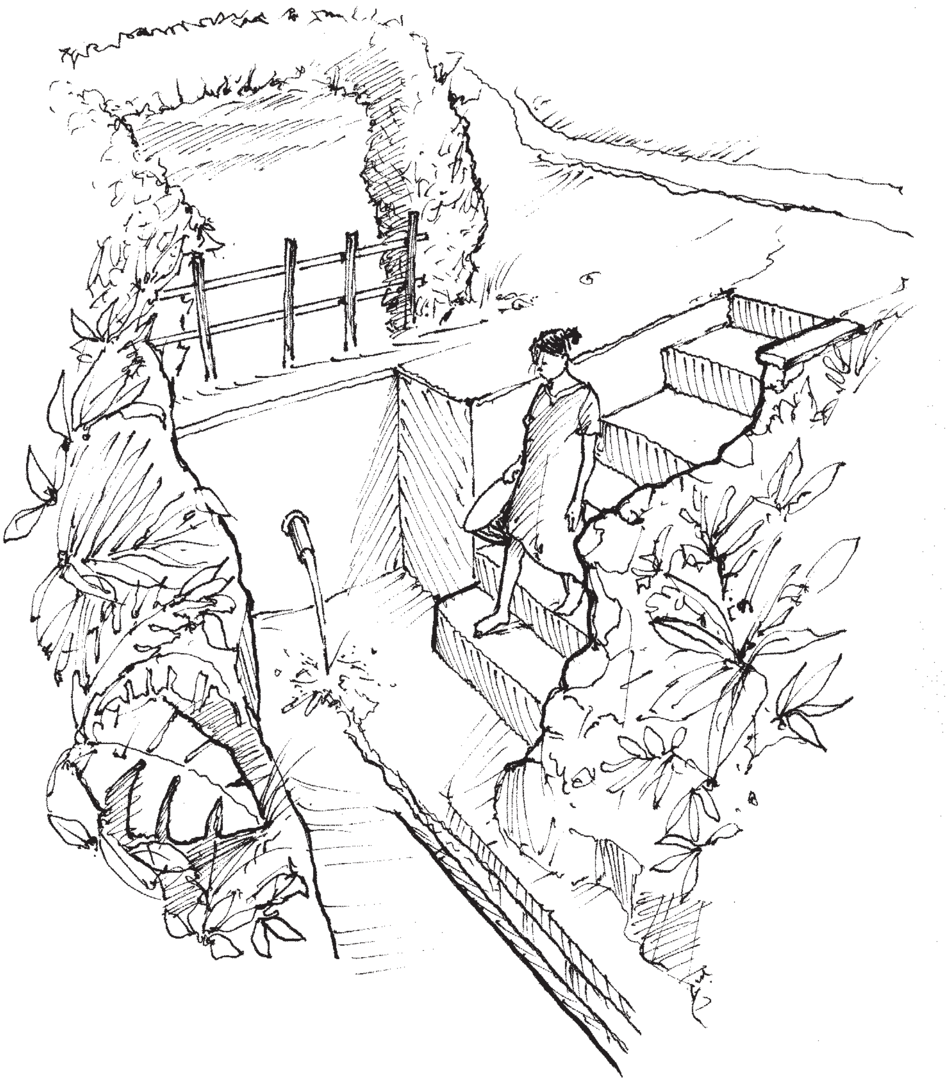
- Does the water change colour after rain?
- Has a water-quality test been carried out recently?
- Did the community receive the results of the test?
- Is the area behind the retaining wall losing the grass cover?
- Does the retaining wall show signs of damage?
- Can this be repaired locally?
- Does the uphill ditch need clearing?
- Does the downhill ditch need clearing?

- Does the fence need repair?
- Does the grass behind the retaining wall need cutting?
- Do the outlets leak?

3.2.2 **Dug wells**

Dug wells are usually shallow wells dug by hand, although some may be quite deep, and they are often lined with bricks. However, unless artesian water is tapped, many dug wells go dry or have very little water in dry periods because it is difficult to sink wells below the water table without using more sophisticated techniques. In some arid areas, dug wells have traditionally been constructed in sandy riverbeds. Where flooding is rare, such wells can be improved to provide dry-season water sources. To protect the well from river

Figure 3.2 ***Collecting water from a protected spring***



damage during the rainy seasons the well opening can be covered with a concrete slab and a concrete barrier built upstream from the well. In sandy riverbeds with water-resistant bedrock beneath, walls can be constructed under the sand to create sand dams. These collect the river water and can ensure that nearby wells are productive for longer periods in the dry season.

The shaft of an improved dug well has a concrete lining above the dry-season water table and a series of concrete rings (caissons) sunk below this level to ensure a year-round supply of water. The lining acts both to protect the shaft from collapse and to prevent surface water from infiltrating into the well at shallow depths. The top of the well (the wellhead) is built up by at least 30 cm and an apron is cast around it to prevent surface water from entering the well directly. Usually a permanent cover is put over the well and water is drawn by a handpump or windlass and bucket. People should not use their own bucket to draw water from the well as this may contaminate the water in the well. A communal rope and bucket attached to the well can be used to draw water, but the bucket and rope should be kept off the ground. One way to do this is to put a hook inside the well and always store the bucket on it. Once a dug well is completed it should be cleaned with chlorine and the pump installed.

The advantage of improved dug wells is that they can be deepened and, if the handpump or windlass fails, water can still be collected, although care should be taken not to contaminate the water by using individual buckets. However, dug wells are more likely to go dry in prolonged dry periods, or if large volumes of water are pumped from nearby deep boreholes, and they are easily contaminated. Nevertheless, they provide a low-cost water supply and communities can be actively involved in their construction. Abandoned wells should be closed to avoid polluting groundwater.

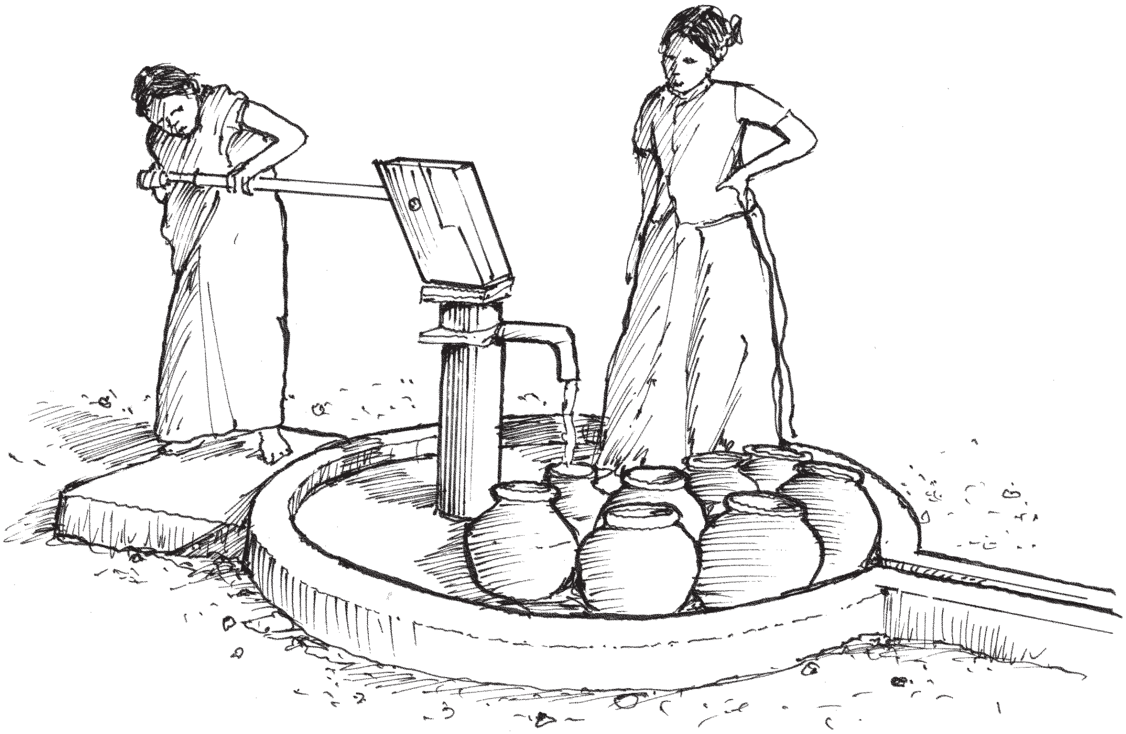
3.2.3 **Boreholes**

Boreholes are narrow holes drilled into the ground that tap into groundwater. Boreholes can be drilled using motorized rigs operated by trained staff, but this is expensive. Boreholes can also be drilled by hand using an augur, or by forcing water into the ground under pressure (“jetting”). If a community is involved in the actual sinking of the borehole, it is likely to use auguring or jetting because these are less expensive methods, but it is not possible to sink deep boreholes with these methods. Depending on the depth of the groundwater, a handpump may be required to bring the water to the surface. The practical limit for most handpumps is 45 metres; beyond this a motorized pump (diesel-, electric-, wind- or solar-powered) may be required.

As the borehole is drilled, a lining of plastic, steel or iron is sunk to protect the hole from collapse. The lining has slots in the bottom section to allow water to enter the borehole and gravel is placed around the bottom of the lining to improve flow and provide filtration. The top few metres around the borehole should be sealed using concrete, and a concrete apron is cast around the top of the borehole to prevent surface water from flowing into the lined shaft. A stand is usually cast into the apron to provide a stable base for the pump. Once the borehole is completed it should be cleaned with chlorine and the pump installed.

Boreholes with handpumps are often provided to villages, with the community being given responsibility for operation and maintenance. An example is shown in Figure 3.3. Unfortunately, many boreholes worldwide are no longer working because simple repairs have not been carried out. Consequently, if a borehole is drilled in a village, it is important that maintenance costs and activities can be met by the community. This may require additional training in financial management to ensure that funds can be raised for maintenance. In addition, it is particularly important to make sure that all required spares can be purchased within a reasonable distance from the village. For major repairs beyond the skills of the community, clear information as to how these repairs will be carried out should be requested from the relevant agency. If the agency is unable or unwilling to provide this information, the community may not wish to commit to working with the agency, since failure of the project may not be

Figure 3.3 ***Handpump on a borehole***



seen as the fault of the agency, and may bar the community from future support.

Boreholes usually provide good quality water, but the water sometimes contains harmful chemicals, such as fluoride and arsenic, or nuisance chemicals such as iron. Although a village would not be expected to carry out chemical analysis, community members should request that tests be carried out by the government agency or development partner, and the results fully discussed with the community. In villages with existing boreholes, community members should share their experiences with agency representatives before more boreholes are drilled. This will help both parties to make better decisions about the water supply.

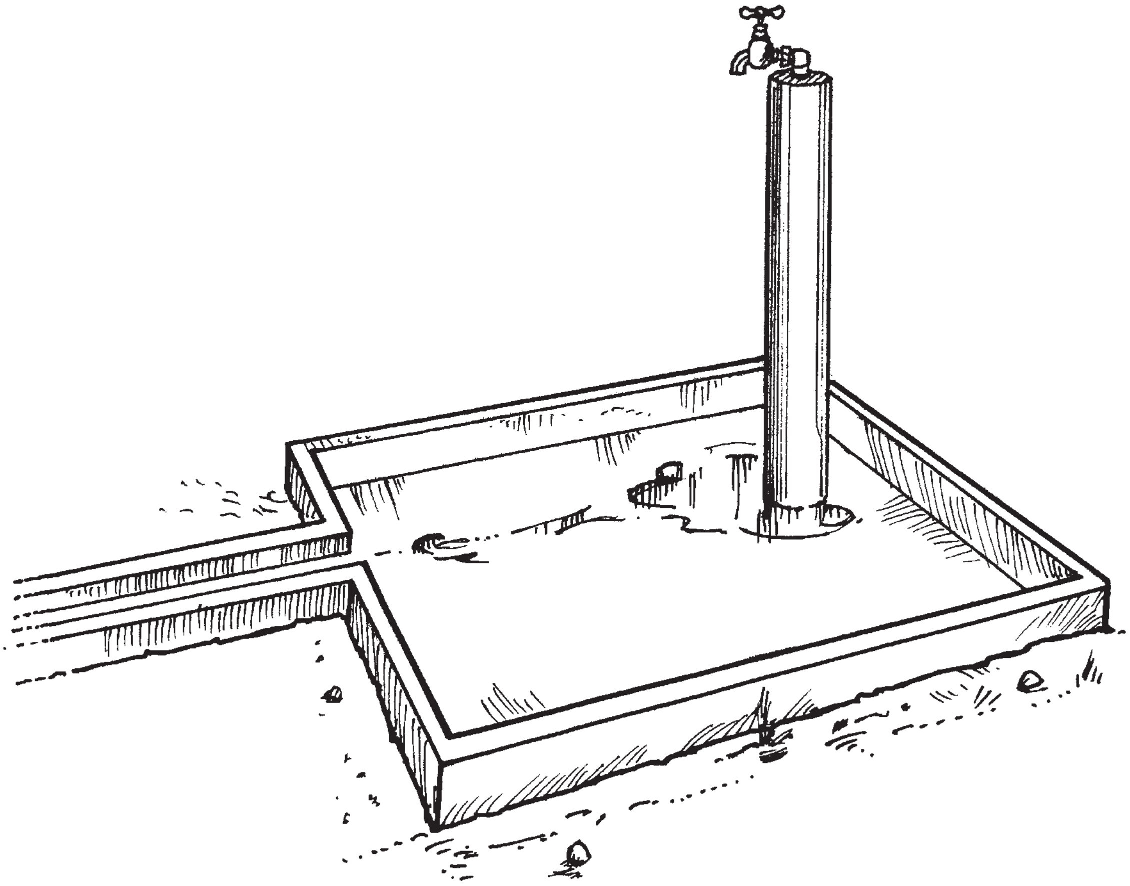
Factors to consider when selecting a borehole water supply

- What training will be provided for maintaining the pump?
- What tools and materials are required for maintenance?
- What tools and materials are provided by the outside agency?
- What tools and materials must be purchased by the community?
- How much do these tools and materials cost?
- Where can spare parts be purchased?
- How much do spare parts cost?
- How often do spares need to be purchased and what is their shelf-life?

3.2.4 **Piped water supply**

Many villages may have piped water systems that supply communal taps or yard taps. These piped water systems are often small and rely on community management, and many use untreated groundwater sources. Small piped water systems are usually fed by gravity, either from protected springs or from surface water above the village, although some may be supplied from boreholes fitted with motorized pumps. Most piped water supplies include storage tanks so that water is always available, even when demand is heaviest. Such tanks are usually necessary because the rate of water use at peak times of the day (often early morning and early evening) is greater than the average rate of use throughout the day. The tanks also provide emergency storage in the event of a breakdown. When planning a piped system, community members should consider carefully where to locate the taps, so that everyone has relatively easy access. However, the design of piped systems can be quite complicated and it may not be possible to place taps where people would prefer.

Figure 3.4 ***Single standpost with surround***



As with boreholes and handpumps, piped systems require regular maintenance. Pipe leaks need to be repaired rapidly to prevent water loss, and to prevent surface water from entering the pipes and contaminating the supply. Also, communal taps are likely to be used heavily and users may not be as careful as they would with their own taps. As a result, the taps are more likely to break and will need frequent replacement. One way of dealing with these issues is to give someone in the community responsibility for checking communal taps and making repairs. To prevent the accumulation of stagnant water around community taps, which could become mosquito breeding sites, community members could build a concrete "apron" at the base of the taps and include a drain and a soakage pit. An example of a standpost is shown in Figure 3.4.

Another problem with piped systems is that users do not consider the impact of how much water they use, and may not think it is important to turn off the tap after use. When there is a lot of water, this may not have negative consequences. However, where the amount of water available is limited, if users at the high end of the system leave taps running, users lower down may suffer shortages or intermittent service. This can force them to use less safe sources of water. Moreover, if the pipes are dry or have very low flow rates, surface water may enter the pipes and contaminate the piped water. Users of piped water systems should thus be aware of the impact of their water use on others and good water use should be promoted. This could be supported through village regulations or by-laws that penalize people who persistently abuse the system.

3.2.5 **Rainwater harvesting**

Although rainwater can be a good source of water for drinking and domestic use, it may be seasonal, and it is often difficult for a community to rely on rainwater alone. Collecting sufficient rainwater for an entire community also requires relatively large roofs and tanks, and the supply may still not be sufficient. Instead, rainwater is usually collected by households for their own use. If the rainwater is to be used for drinking it is better to collect it from a roof, rather than from a ground catchment where it may become contaminated. Ground catchments are more appropriate for agricultural use.

Using roofs to collect rainwater is relatively easy and a lot of water can be collected. For example, 50 mm of rainfall on a 4 m^2 roof yields 200 litres of water. All that is required are gutters around the roof that discharge into a collection tank. The roofing material is important and hard surfaces, such as iron sheets or tiles, allow more rain to be collected than softer surfaces such as thatch and grass, which absorb water. Hard surfaces are also easier to keep clean and are less likely to have insects and animals living in them.

Any roof used to collect rainwater for human consumption must be thoroughly cleaned at the start of the rainy period. Birds and animals may leave faeces on the roof and these can be a source of pathogens. There should be a system for diverting the flow of water in gutters away from the tank, so that the first rains (which are more likely to pick up contamination from the roof) are not collected. A small filter may be added to the top of the collection tank as an added protection. The tank should also be cleaned every year and any silt or algal matter removed. After cleaning and before use, the tank should be scrubbed using a chlorine solution (bleach).

Water should be drawn from a tap at the base of the tank, rather than with a bucket, which may contaminate the water. It is better not to bury the collection tank, even partially, since contaminated water from the soil can enter the tank. Covering the tank is also essential for preventing contamination of the water and for reducing opportunities for disease vectors to breed.

3.2.6 **Ponds, lakes and water treatment**

Ponds and lakes have traditionally been used as sources of drinking-water. Although they are easily contaminated, the water quality can be improved by careful use. For example, if platform steps or ramps are constructed at the water edge, people can be encouraged not to walk into the pond or lake when collecting water. This rapidly stops the discharge of guinea-worm eggs into the water, thus interrupting transmission. Preventing urination and defecation close to or in the pond may reduce schistosomiasis. Even so, dirt deposited on these structures can enter the pond, especially when it rains. Pumps mounted on the banks of ponds can also supply water to people away from the pond, but these may be difficult to maintain. Alternatively, a protected intake with a layer of sand as filter can be constructed in the pond or lake and be connected to a handpump. Whichever method is used, however, domestic water drawn from ponds and lakes must always be treated before consumption. Although water treatment can be complicated, communities do operate and maintain simple water-treatment plants. Some simple technologies are robust and have been community-managed in Latin America and parts of Asia. They are usually based on several filtration stages and tend not to use expensive chemicals and dosing equipment.

Pond or lake water is easily contaminated and should be treated with a disinfectant as a minimum. The most commonly used disinfectant is chlorine, although others can be used. Chlorine can be added as a solution of calcium hypochlorite, as chlorine gas or as other chlorine compounds. Achieving the correct ratio of chlorine and water is complicated, however; using too little chlorine will not kill the pathogens, while using too much will make the water taste unpleasant.

Some treatment systems, called package plants, come ready constructed. Package plants have been promoted on the basis of their low operational requirements; however, when package plants fail they usually require specialist repairs and equipment beyond the means of a small community. This should be taken into consideration when deciding whether to use a package plant.

3.3 **Household water treatment**

Sometimes the best option for improving water quality is to treat water in the home, by boiling, filtering, chlorinating or leaving the water to settle. These options are discussed in more detail in the following sections.

3.3.1 **Boiling**

Bringing water to a rolling boil will destroy pathogens in the water and make it safe to drink. Boiled water tastes “flat”, but if it is left for a few hours in a partly filled, covered container, it will absorb air and lose its flat taste.

3.3.2 **Canvas filters**

Canvas bags are the simplest type of home filter. The bag is filled with water and the water collected as it seeps out of the bag. This makes the water cleaner and, although it does not remove all pathogens, is particularly useful for removing *Cyclops* containing guinea-worm eggs. Bags that have been specially treated to prevent them from rotting are available.

3.3.3 **Candle filters**

Candle filters are hollow, porous ceramic cartridges. Although they do not filter out all pathogens, they should remove the larger ones such as protozoa, worms and bacteria (but not viruses). Ceramic candles need careful maintenance and should be cleaned and boiled at least once a week, even if they are not clogged. If a candle filter becomes clogged, it should be scrubbed under running water with a stiff brush free of soap, grease or oil. To reduce the risk that water will pass through a candle without being filtered, such as through a small crack, candle filters should be regularly inspected and replaced if necessary. In some countries it is common to both filter and boil water. Where this is done, the water should be filtered first and then boiled. Some filters incorporate silver into the candle, but this does not disinfect the water and the candle acts simply as a normal filter.

3.3.4 **Disinfection**

One method of treating water in households is to add chlorine. This will kill most bacteria and some viruses. Since the taste of chlorine disappears when water is left in open containers, a very small lump of bleaching powder or one drop of household bleach can be added to a 20-litre water container and the mix left to stand for at least 30 minutes. After this time, if a faint smell of chlorine can be detected in the water, it should be low-risk and palatable to drink. Chlorine should only be added to clear water otherwise it will be absorbed by the dirt in the water. Moreover, chlorine that has been stored for some time will lose potency. The use of disinfectants as a household treatment system has been successfully implemented in Latin America and Asia.

Other disinfection systems have been developed for treating household water, particularly the use of solar radiation. There are some simple methods of solar disinfection (e.g. SODIS), which can effectively treat water, although this may take longer than chlorine disinfection.

Household water treatment

In Bolivia, household water treatment was introduced into two communities where water quality was generally poor. The treatment used mixed oxidants (including chlorine) and a container fitted with a tap. After the treatment was introduced, faecal contamination of water samples was reduced by over 90% and the incidence of diarrhoea dropped by almost 50%. Similar improvements have been observed in other countries, such as Bangladesh, demonstrating that household treatments can be effective.

Source: Quick RE et al. Diarrhoea prevention in Bolivia through point-of-use water treatment and safe storage: a promising new strategy. *Epidemiology and Infection*, 1999 122:83–90.

3.3.5 **Settling**

Where water is cloudy or muddy, a simple treatment is to allow particulates in the water to settle overnight. Clear water at the top of the container is then poured into a clean container. Adding certain chemicals can help settling, such as a pinch of aluminium sulfate (alum), or powder from the ground seeds of *Moringa oleifera* (horseradish tree) and *Moringa stenopetala*, sprinkled onto the water surface.

It should be stressed that settling does NOT remove all pathogens, silt or clay. The settling of particles may reduce pathogens but some will remain, and water should be boiled or disinfected before it is consumed.

3.4 **Safe handling of water**

Frequently, water collected from a communal point and transported back to houses for use becomes contaminated because of poor handling. Community members should therefore be aware of the risks of contaminating the water and how it can be prevented.

All water containers should be clean, especially inside. It is always best to clean the insides of storage containers with either detergent or chlorine. Leaving a capful of bleach in a sealed plastic or metal container full of water for 30 minutes will kill most pathogens. If detergent or chlorine is not available, the insides of clay pots can be cleaned with ash. Plastic or metal containers should be cleaned weekly by putting clean sand and water inside them and shaking for a few minutes. The top of the water container should be covered to stop dust and other contaminants falling into the drinking-water. It is best for water to be poured from the container to prevent contact with dirty fingers and hands. An example of a good storage container is shown in Figure 3.5.

When scoops are used to take water out of the storage container they should be clean and kept inside the water storage jar. They should never be placed on the floor.

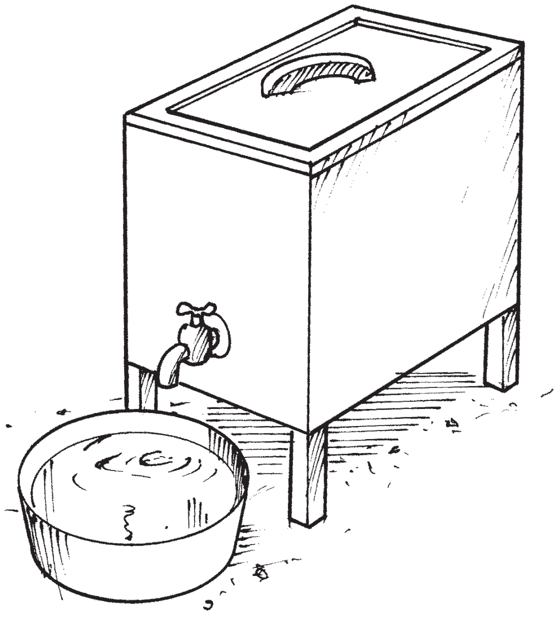
3.5 **Monitoring water quality**

Water of poor microbial quality can have a significant impact on the health of community members by causing disease and contributing to the spread of epidemics. Water quality should therefore be monitored on a regular basis. Ideally, it should be tested by staff working with local and national government in support of the Healthy Villages programme. The community should request that such support is given by the local authorities, particularly if it suspected that the community water supply is contaminated. The test results should be provided to the community and if any problems arise, the community should request recommendations for solutions.

3.5.1 **Microbial quality**

The major concern of microbiological testing is whether faeces have contaminated the water supply, as most of the infectious water-related diseases, such as cholera and dysentery, are caused by faecal contamination. Although these diseases can also be transmitted through poor hygiene and inadequate

Figure 3.5 ***Household storage container***



sanitation, control of drinking-water quality is one of the main ways of preventing their spread.

Using surveillance to promote better management of water quality

Environmental health staff from local councils in Uganda used water quality tests as a way of working with communities to identify problems. The staff took water samples from sources and households, and then left the water testing kit overnight so that community members could perform the tests themselves. The next day the results were discussed with community members. The discussions were always lively and the approach helped to improve both the management of protected springs and water handling and hygiene practices. Discussing the results of water quality tests with communities was an effective way of promoting improvements.

The principal method of assessing the microbial quality of water is to test for bacteria whose presence indicates that faeces may be in the water. An analysis of the test results is usually beyond the resources of communities and will be carried out by health or water officials. However, community members can request that officials regularly test the water supply and inform the community of the results and recommendations. Some kits have been developed for community use, but the results of these tests should be analysed with caution.

3.5.2 **Sanitary inspection**

An analysis of water quality usually also includes a sanitary inspection. This is a visual assessment of the water supply, using standard forms to record information, to see whether faecal pollution exists and whether such pollution could reach the water source. Sanitary inspections can be undertaken by communities on a regular basis as part of operation and maintenance, and forms have been developed in several countries to help communities undertake these inspections. Many of the risks to the water supply relate to improper operation and maintenance activities in the area around the water source, and sanitary inspection can be used to ensure that these tasks are carried out to keep the water supplies safe. Examples of sanitary inspection forms for community use are available in a number of the documents listed in Annex 2.

3.5.3 **Chemical quality**

It may also be necessary to test community water supplies for harmful chemicals. Certain chemicals, such as fluoride, nitrate and arsenic, represent a health risk, whereas others, for example iron, manganese and sulfate, may cause consumers to reject the water because it is unpleasant to drink or stains clothes and causes other problems. Testing is usually done by health or water officials, but community members can play a key role by demanding that such analyses are carried out, and by informing officials of any developments that may cause contamination of the water supply. When a water supply is first developed, a full water quality analysis should be carried out. The community should request feedback regarding this analysis and ask for guidance concerning the suitability of the water source for drinking.

3.6 **Managing community water resources**

Communities need to conserve water resources for future generations; ways in which this can be accomplished are discussed in the following sections.

3.6.1 **Preventing over-pumping of groundwater**

Communities should discuss with outside agencies the short- and long-term impacts of water supply improvement on water resources. For example, sinking too many tubewells for irrigation may cause serious depletion of water held underground and even cause water sources to dry up. This can also lead to deteriorating water quality: as the water table falls, domestic tubewells must be sunk deeper into underground water that may contain harmful chemicals such as fluoride or arsenic. Because community members are the principal stakeholders of local water resources, they should always ask planning agencies to assess the longer-term effects of water pumping on the environment and should be actively involved in evaluating the risks.

3.6.2 **Water conservation**

Although it is important that people use enough water for good hygiene, in areas where water is scarce it is also important not to waste water. Piped water supplies are particularly vulnerable to wastage; if they are not properly managed, the community as a whole may suffer water shortages and people will have to wait longer to collect water. Most piped water systems leak and need to be checked regularly and repaired as soon as faults are discovered. Taps should also be turned off immediately after use and children discouraged from playing with taps.

Questions to ask in areas prone to water shortages

- Does the main water source dry up?
- If so, where will water be collected?

- How far away are alternative sources of water and how long does it take to collect the water?
- Who collects the water and how often do they have to go to the source?
- How much water do families collect each day?
- Does the source provide sufficient water?
- Are there problems with water quality?
- Would rain failure next season bring a drought?
- What would be the effect on pasture, vegetation and crops?
- What would be the traditional response to drought?

3.6.3 **Managing water for agriculture**

Farmers can protect their lands by building small stone dykes or growing hedges along the edges of fields. These prevent rainwater from running down slopes too fast and reduce erosion. Some of the rainwater infiltrates the soil, and crops near the dykes have a higher survival rate in times of water stress and produce yields about 40% higher than crops further from the dykes. The amount of water that goes into the groundwater is also higher in these areas.

The introduction or expansion of irrigated agriculture will cause important changes in the local hydrology, land use patterns and ecology. Such changes may introduce new health risks into the area, although there are ways to manage these risks. Some examples of health risks and how they may be managed are listed below.

- When irrigation is permanently introduced into arid areas, habitats for disease vectors, such as the malaria-carrying anopheline mosquitoes, can also be created. This is particularly a problem in low-lying areas where drainage is poor and pools of stagnant water appear. Also, if the local drinking-water wells become saline, the community may use irrigation channels as a source of drinking-water, increasing the risk of diarrhoeal disease, of schistosomiasis (from contact with the water) and of exposure to agrochemical residues. To help counter these risks, the community can take measures such as maintaining proper drainage, ensuring water systems are well-maintained and filling ground depressions.
- Water storage facilities are an essential part of many irrigation systems, but small dams/reservoirs and tanks can pose health risks by acting as breeding habitats for disease vectors, and as foci for transmitting schistosomiasis and guinea-worm infections. Options for a Healthy Village approach include fencing off reservoirs, varying the water reservoir levels, removing weeds and flushing the surrounding areas.
- Mosquitoes often breed in areas flooded for rice production, but the

breeding cycle can be interrupted by alternately flooding and drying the rice plots (as opposed to continuous flooding). A well-designed regime will also save water and may even increase rice yield.

- Irrigation water demands can be reduced by recycling treated wastewater. Recycled wastewater can be used productively to irrigate fruit, such as papaya and banana, or for irrigating vegetable gardens. Eucalyptus and papyrus should be avoided, since they are “water-hungry” plants. Safe use of wastewater is discussed further in section 4.2.