Technologies for multiple use of water; experiences from Zimbabwe

Working paper

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Executive summary

The need for an approach to water supply which aims to cover for both people's domestic and productive water (the multiple use services, mus, approach) needs has gained recognition over the last few years in Zimbabwe. A range of organisations, especially NGOs are pioneering such approach in their programmes and projects.

In following such a mus approach, these organisations have started to use a range of technologies which enable multiple uses in different degrees. These range from household-based options such as family wells and rainwater harvesting devices to community-based boreholes with bush pumps; and, from drip irrigation kits to associated head works for cattle watering and laundry. These technologies differ in their functioning, their costs and especially their implications for water use.

This paper attempts to systematically document these different technologies. It does so by first providing a typology of the technologies that are being used. This typology is based upon whether technologies are typical household solutions, or communal ones. A further distinction is made along the chain of water sources, extracting and lifting devices, and then distribution devices. Each of the technologies is described in detail, especially in terms of its implications for multiple use of water.

It shows that there is not one single "best" technology for multiple uses. The household-based family wells are more expensive (in per capita costs) than the conventional boreholes with bush pumps, but allow for much higher consumption levels, which can be turned into productive use. This doesn't mean that family wells can now spread all over the country, as they can only be applied in areas with shallow groundwater. Other technologies such as rainwater harvesting and farm ponds are complementary technology to the family wells or bush pumps, as they cannot guarantee year-round water supply. Finally, a number of technologies can be applied to save water, and reduce labour requirements in putting available water to use, ranging from cattle troughs to drip kits. To what extent these are feasible, depends mainly on the availability of water. When it is easily and readily available, the need for such technologies is less than when more effort is needed to collect water.

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Acknowledgements

The Mvuramanzi Trust and IRC International Water and Sanitation Centre would like to acknowledge the financial support from the MUS (Multiple Use Systems) project, part of the Challenge Programme on Water and Food.

A number of organisations, such as UNICEF, Mvuramanzi Trust, World Vision International, Pump Aid Zimbabwe and the Rainwater Harvesting Association of Zimbabwe (RHAZ) have been developing, piloting and promoting many of the technologies described in this report. This was done together with many communities in Zimbabwe, particularly in UMP district, Zvishavane district, Marondera district, and Murewa district. Our thanks go out to them as well for providing the basis for this report.

Introduction

Traditional water sources in Zimbabwe have always provided water for a number of uses. Archaeological surveys carried out at the monumental sites such as Great Zimbabwe, the Chinhoyi curves and Matopos, revealed that water sources at these early settlements were used to provide water for both domestic needs such as drinking, washing, cooking, and animal watering.

Still, people in Zimbabwe use water for a wide range of livelihoods activities, as shown for example in studies by Robinson *et al.* (2004) and Katsi (2006) show the range of livelihood activities that people are engaged in, many of these posing particular demands on water. Partially due to the political and economic crisis, which Zimbabwe is currently going through, a number of the small-scale livelihoods activities have gained even more importance. The collapse of the formal economy has resulted to a situation in which part of the rural population (and even part of the peri-urban population) has resorted to small scale market gardening as the only source of livelihood. Observations by Mvuramanzi Trust staff in the field, seems to indicate that the majority of these gardens are being managed by women and girls.

Despite the importance of water in rural livelihoods, in many countries most formal water services do not meet these demands in an integrated way. “Domestic” water supply services are not usually planned to take account of small-scale productive uses, or managers prohibit such practices. In irrigation schemes, even other productive uses such as livestock watering are not considered. This limits the potential benefits that water services can have upon the users. In addition, putting such limitations to use can have a negative impact on sustainability.

In response to this situation, a so-called multiple use services (mus) approach is proposed. Van Koppen *et al.* (2006) define this approach as “*a participatory, integrated and poverty-reduction focused approach in poor rural and peri-urban areas, which takes people’s multiple water needs as a starting point for providing integrated services, moving beyond the conventional sectoral barriers of the domestic and productive sectors*”.

This makes mus both a new and old concept; old in the sense that the practice has been around since times immemorial; new in the sense that only recently this practice is being recognised in water services delivery programmes.

In Zimbabwe, we see a mixed picture of on the one hand water services, originally planned for one specific use only, but *de facto* used for multiple purposes, and on the other hand, services specifically developed to meet people’s multiple water needs. An example of the first categories are the boreholes with bush pumps in the dry district of Tsholotsho, where humans and cattle are forced to share the boreholes, by lack of other sources of water.

But, Zimbabwe is also rich in terms of existing experiences with the implementation of water services for multiple purposes (see for example, Lovell, 2000; Robinson *et al.*, 2004; Makoni and Smits, 2005; PumpAid, 2006). Especially, NGOs have been at the forefront of developing innovative approaches to providing water for multiple uses. In this, the approaches and technologies used are quite different among them. Robinson *et al.* (2004) for example discuss different water delivery technologies that enable (or not) multiple uses of water. However, many of the experiences are not systematically documented or shared, leading to sub-optimal use of the existing experiences and no further mainstreaming in the sector (Makoni and Smits, 2005).

The objective of this report is to contribute to gaining further insights into the technologies available for multiple uses, by looking at the experiences with those in rural areas of Zimbabwe, especially in terms of their implications for water use, and looking into an overview of those with most potential for multiple uses.

Methodology and structure of the report

As mentioned, only few formal reports have been written on multiple use services in Zimbabwe. Most of these are isolated case studies. A wider body of literature exists on specific technologies, but often not focused on the element of water use for multiple purposes.

The report has been written on the basis of the review of the few documented experiences with the technologies in the countries. Most information was sourced from grey literature and project documents from implementing organisations such as Mvuramanzi Trust and Pump Aid. Additional inputs were provided on the basis of the knowledge of some experts in rural water technologies in Zimbabwe.

In the review it appeared that little information exist on actual water consumption for different uses in relation to the various technologies. In general terms, indications are given about which technologies allow for certain consumption levels, but no specifics exist. Therefore, additional field work has been done in three districts (Marondera, Murehwa and Uzumba Maramba Pfungwe), especially looking at implications of having certain technologies on levels of water use. Water use diaries were kept by selected families, representing a range of technologies in different zones of water availability (see Katsi, 2006). Although these families had been briefed and trained in the keeping of the diaries, the actual registration didn’t work out as expected, and didn’t deliver reliable results. The figures for water use in this report are based on the experiences and insights of water professionals in the sector, not on actual measurements.

The review of experiences gave us a variety of technologies being applied in quite a diverse set of circumstances, complicating the possibility to compare them. At the time of writing no typology for technologies for multiple uses was available. Therefore, we developed a typology of water technologies, and classifying the most common technologies in Zimbabwe accordingly. This will be introduced in the next chapter.

Having such a typology in the back of our mind, each of the technologies was described and analysed. We didn’t want to provide a detailed account of each technology’s design and functioning, as often general and Zimbabwe-specific reference documents already exist. The analysis focuses mainly on the implications of each technology on multiple use of water.

After this description of technologies, the report ends by providing a comparative analysis between the different technologies. It does not aim to promote one single specific technology, but rather focusing on the conditions for success.

Technology typology

There is a range of handbooks and technology guidelines available (see for example Smet and van Wijk, 2002; NWP *et al.*, 2006; Brikké and Bredero, 2003), which cover the range of technologies in use in rural water supply across the globe. These guidelines provide some classification or typology, as well as detailed descriptions of the technologies. However, many of these documents lack specific reference to the implications for multiple uses of water, the objective of this report.

For the sake of consistency, this document will follow a similar typology as the ones mentioned above, and make it specific to the context of multiple use of water in Zimbabwe. A common element in the typologies, given in the references above, is the chain of water supply:

Water source -> water lifting devices -> water treatment –> storage, distribution and application

In each step along the chain, different technologies are needed. Differences between each step are not always that clear. For example, a bucket can be used to lift the water from a well, and at the same time to apply water to the field. Rainwater harvesting devices typically combine the function of harnessing the water source and storing water. Whereas the water source and water extraction or lifting device are often closely linked and determined often by the physical context, in the storage, distribution and application more variations are possible.

A second element found of relevance in Zimbabwe is the level at which the technology is located: family or community level. The study by Katsi (2006) clearly highlighted important differences in water use between these two types of options. For many technologies, this is assumed implicitly. For this report, it is deemed important to make that distinction more explicit.

These two elements can be taken together and put in a matrix as below. The most common technologies in Zimbabwe have been included here. Other technologies may exist, but are not found to be relevant in Zimbabwe. For example, in the country there are many small-holder irrigation systems, often fed through small dams, which could have the potential for multiple use of water. That, however, is not a common practice yet, and more detailed research and development in this area would be needed. Therefore, smallholder irrigation technologies are not included here. Also note that the treatment step is not included in this table, as limited attention has been given to this topic in Zimbabwe, as groundwater is the most common source of water for domestic purposes.

Table 1: typology of technologies for multiple use of water in Zimbabwe

Level	Water source	Water extraction or lifting	Storage, distribution and application
Family	Family well	Windlass and bucket Rope pump Motorised pump	Buckets Drip kit
	Perennial stream or spring	Spring protection	Family water scheme
	Farm ponds	Buckets	Buckets Drip kits
	Rainwater	Rooftop harvesting	Storage tanks Buckets
Community	Borehole or tubewell	Bush pump Motorised pump	Associated head works Drip kit Buckets
	Perennial stream or spring	Spring protection	Small piped water scheme

As can be appreciated from this table, there is a number of combinations possible with each step along the chain. For example, a family well (as water source) can be either be equipped with a windlass and bucket, or a rope pump as lifting device, and water can then be distributed either through buckets or drip kits. Other combinations are more or less inseparable; for example the windlass and bucket always goes with a family well.

Many of the technologies are well known and will not be discussed here in detail; a short introduction is given and then reference is made to more elaborate technology guidelines for full details. Rather, the sections below focus on the implications for water use for multiple purposes. Those combinations which are more or less inseperable will be discussed together, so as to show their integratedness.

Water sources

Family wells

Introduction and description of the technology

The development of the family well in Zimbabwe was achieved in a number of stages. Initially it started in areas with relatively high water table like Gutu, Chirumanzu and Marondera. The initiative started by families with a desire to have water closer home. Originally, these were shallow dug wells without any form of protection. Some of the wells were even dug along perennial river beds where water was within easy reach throughout the dry season. At this stage the main issue was quantity with very little emphasis on quality. The common feature was that the wells were not lined from the bottom and therefore unprotected. There was also risk of contamination through surface water run-off.

With the coming of professional hygiene educators, more emphasis was placed on protection of the shallow well, including:

- Lining the bottom of the well with stones up to one metre to allow for good infiltration
- Backfilling the top one metre with anthill soil to avoid contamination from the surface

- Raising the collar to at least one foot above the general ground level again to avoid surface contamination
- Provide a simple concrete cover

During the early 1990s the Ministry of Health, through the Blair Research Institute (then called Blair Research Laboratory), developed a simple technique of protecting family wells called Family Well Upgrading. This technique had a number of features including (see also Figure 1):

- A well head raised above ground with brick pillars for holding a simple windlass
- A windlass which enabled families to raise water in a hygienic way using rope or chain and bucket
- A removable metal lid cover on top of a concrete slab to avoid contamination when wells are not in use
- A hygienic apron around the well head with a short drainage slab

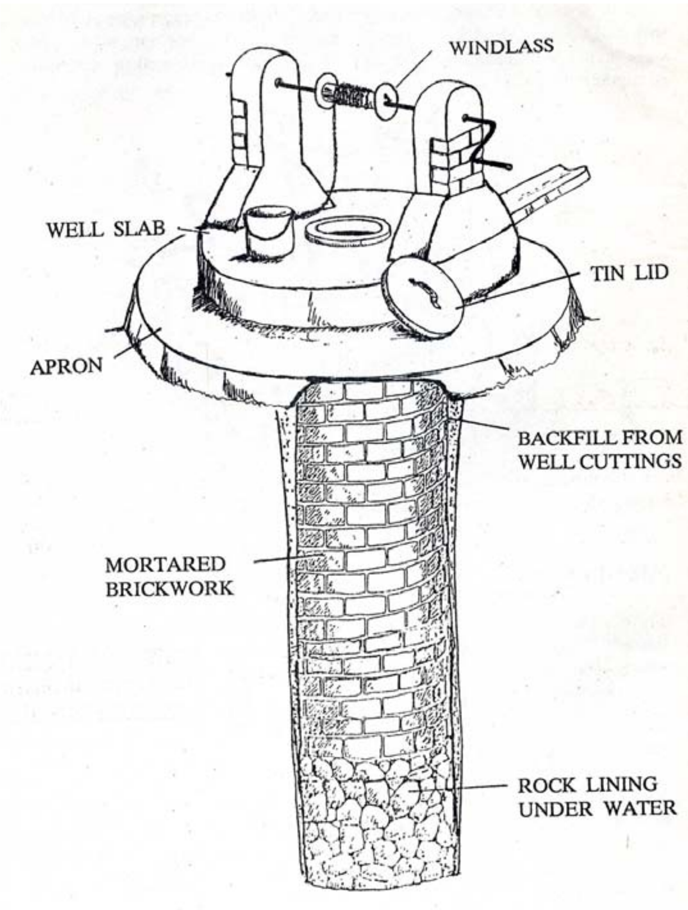

Figure 1: Cross-section through upgraded family well (Mvuramanzi Trust, 1995)

With those simple upgrading techniques, family wells have spread over many parts of the country, mainly in the shallow groundwater areas, but even into areas that were considered traditionally “dry” territory where only boreholes would be feasible such as in Matabeleland North and Matabeleland South. Some of the family well programmes have been promoted by NGOs such as Mvuramanzi Trust, Plan International, Christian Care and Save the Children Fund (UK), as well as by the Government of Zimbabwe through its Integrated Water and Sanitation Programme. In addition, individual families develop and finance their own wells. Local entrepreneurs, such as welders and tin smiths have started involving themselves in adapting the design and scaling up this technology.

Its main advantage lies in the low operation and maintenance (O&M) requirements. Besides, it has household ownership, avoiding more complicated forms of community management. Another advantage is that it combines low distance with good quality water (in the case of upgraded family wells). However, its spread is limited to those areas where groundwater levels are high, as the maximum depth is 15 m.

Figure 2: A typical upgraded family well with windlass and bucket in Marondera district
Picture: Stef Smits

The windlass and bucket system is very common on this kind of wells. This is a cheap and simple way of extracting water from the well, is that it may limit water use. Abstracting large quantities of water will be time consuming, and further distribution would have to take place through buckets (see more on that in the section on buckets). Therefore, family wells are increasingly being upgraded by lifting devices such as the rope pump (see section on those devices for more details).

For more technical information about family wells, see Morgan and Chimbunde (1991), Mvuramanzi Trust (1995) and Morgan (2003).

Implications for water use

Family wells have a simple advantage over many other sources in terms of the implications for water use: they are mostly constructed close to the homestead where productive activities take place. There is little need to transport water over large distances and in that way does not limit water use. Besides, the wells don't have to be shared by a larger number of users and all water can be applied within the family's activities.

This is reflected in the large number of productive activities around family wells. A survey carried out by the Mvuramanzi Trust in 1998 and 1999 in Guruve district revealed that 75% of the families they had assisted were using the water for a wider variety of uses. Families have taken the opportunity to develop small vegetable gardens for home consumption with any excess sold to generate income. Some of the water is also used for watering poultry, pigs, chickens, cattle and domestic animals. Home industries such as welding, brick moulding construction work and pottery have also been identified to be benefiting from family wells, though at a small scale. Estimates of average daily consumption rates are as follows:

Table 2: Average consumption patterns for family wells with windlass and bucket

Activity	Consumption (lpcd)
Drinking and cooking	5
Bathing and cleaning	25
Livestock	7.5
Gardening	30
Total	**67.5**

Total amounts differ a lot, depending on family size, number of cattle that a family has, and the size of the garden. The figure given in the table above is more or less the maximum a family can do with only windlass and bucket. For bigger gardens normally other lifting devices such as rope pumps are used, which allow for higher abstraction levels (see below).

Although water levels in wells fluctuate between seasons in most areas, only in few areas they completely dry up. In areas such as Buhera district, where family wells do dry up, only few people have developed such wells, and they resort to the bush pump as source of domestic supply in the dry winter. On the other hand, in Marondera district, groundwater levels are so high that people often have a protected well for domestic uses, and an unprotected well close to their gardens for irrigation.

Costs

The upgrading of the family well, including the top structure of windlass and bucket costs around 300 US$. This excludes the digging of the well, as these existed in most cases. This comes down to a per capita cost of anywhere between 6 and 30 US$, depending on the number of families using one well.

Tubewells and boreholes

Introduction

Tubewells and boreholes are small-diameter wells, which are driven, bored or jetted. Although not by definition, these are mainly used in deep groundwater areas, as opposed to dug family wells which are in shallow groundwater zones.

In Zimbabwe, deep tubewells and boreholes are usually equipped with hand pumps, such as the bush pump, which will be discussed later.

Implications for water use

The key issue from a multiple use perspective is the yield of boreholes, in relation to the use of the water. This is the intrinsic amount of water which can be extracted from the borehole, until overdraft occurs. This may be different from the yield of a hand pump. For example, a borehole may have a high potential yield (i.e. high water resources availability) but be limited by the extraction capacity of the pump. This will be discussed further in the section on bush pumps.

An important study into the potential of different boreholes and wells in Zimbabwe has been done by Lovell (2000). According to his work, a borehole or well should supply at least between 10.000 – 20.000 l/day for a community of around 200 persons (i.e. around 75 lpcd). However, half of the conventional boreholes in Masvingo were supplying less than the required 0.3 l/s or were even dry during parts of the year. A number of innovative borehole and well development methods have been mentioned there to increase yields. These include for example screened regolith boreholes, large diameter wells and collector wells. More information about these particular technologies can be found in Lovell (2000). Often yields can also be improved by better siting and development of the boreholes, which is a strong limitation at the moment.

Small stream and spring systems

In Zimbabwe, surface water from (perennial) streams and springs is being captured through small piped systems for domestic supply or irrigation. These are either at community level, or even individually owned systems. Because of water resources availability, these systems are mainly limited to the wetter mountainous area in the eastern part of the country. We couldn't find systematic documentation of these systems, and their use. Occasional references to such systems are made. Katsi (2006) mentions that in the three study districts only one case was found where an individual farmer had captured a spring.

Rooftop water harvesting systems

Rainwater harvesting is the concentration of precipitation and includes collection delivery to tanks through gutters and storage after rainfall events. Water can be harvested from different types of surfaces such as roof-tops, rocks or from fields themselves. Here we consider the rooftop and rock surface systems as the ones being most relevant for multiple use systems.

Description of the technology

In rooftop rainwater harvesting, precipitation falling on the roof surface is concentred through a gutter system and then stored for use. The entire system consists of the following components:

- hard roof catchment surface, usually corrugated iron or asbestos
- stainless steel guttering system which directs the water to the storage system
- storage tank, often made out of bricks, ferro-cement or in some cases plastic. It needs to be fitted with foul flash system, a floor cleaning outlet and gate valve or outlet pipe.

Figure 3: Roof top rainwater harvester under construction in Tsholotsho district
Picture: Mvuramanzi Trust

Implications for water use

The amount of water that can be used through rainwater harvesting systems depends on the amount of rainfall, the rooftop and the storage capacity. Typically, rainwater systems provide water for household use for a period of 3 months at an average use rate of 15 lpcd. They are also being placed at schools and clinics. In Tsholothso for example, district schools have been equipped with harvesters, with a storage size of $35m^3$, serving around 400 pupils each, which is equivalent to 88l/person. If only used for drinking, this can take the school around 1-2 months into the dry season.

Rainwater harvesting systems are generally limited by the storage size. In order to take a family through the entire dry season, too big a storage tank would be needed. This means that rainwater harvesting systems cannot fully replace others sources of water supply for the entire duration of the dry season but can complement other sources or even replace the need to develop those. In this ways, they can fit into an approach of multiple sources for multiple uses. Especially at institutions such as clinics and schools they seem to provide a welcome additional source. In Zvishavane (Midlands province) the critically had their access to water for hygiene drinking, small animal watering and even nutrition gardening watering improved as a result of rooftop water harvesting (RHAZ, 2004).

Farm ponds

Another form of rainwater harvesting are the farm ponds. These are small dams which capture run-off from the field. These can then be used for mitigating against mid season dry spells during summer or for supporting small scale irrigation during winter. These provide mainly water for productive uses, as their quality is often not sufficient for drinking or other domestic uses. They fit in with a strategy of multiple sources for multiple uses, rather than a stand-alone technology.

Figure 4: farm pond in UMP district
Picture: Luckson Katsi

Like spring systems, this type of technology is not systematically applied, and few documented cases exist to provide details on implications for water. .

Water lifting devices

Bush pumps

Introduction

The bush pumps are the most widely used type of hand pump in Zimbabwe. They can be distinguished between type A and type B. The original type A was difficult to handle for children and women. The type B was further developed in response to this as an initiative by the NAC (National Action Committee) technical sub-committee in 1997 and combined effort of the District Development Fund (DDF), the Ministry of Energy, Water Resources and Development and the Ministry of Health and Child Welfare. It is now adopted as the national hand pump of choice in Zimbabwe

Description of the technology

The bush pump is a conventional lever action pump. The upward and downward movement of the handle moves the piston in the cylinder up and down in water. The piston is fitted with a non return foot valve which allows water into the cylinder during every downward stroke. The water thus captured inside the cylinder continues to be pushed up the rising main until some amount reaches the sprout into the containers. See diagramme below, and more technical details can be found in Erpf (1997).

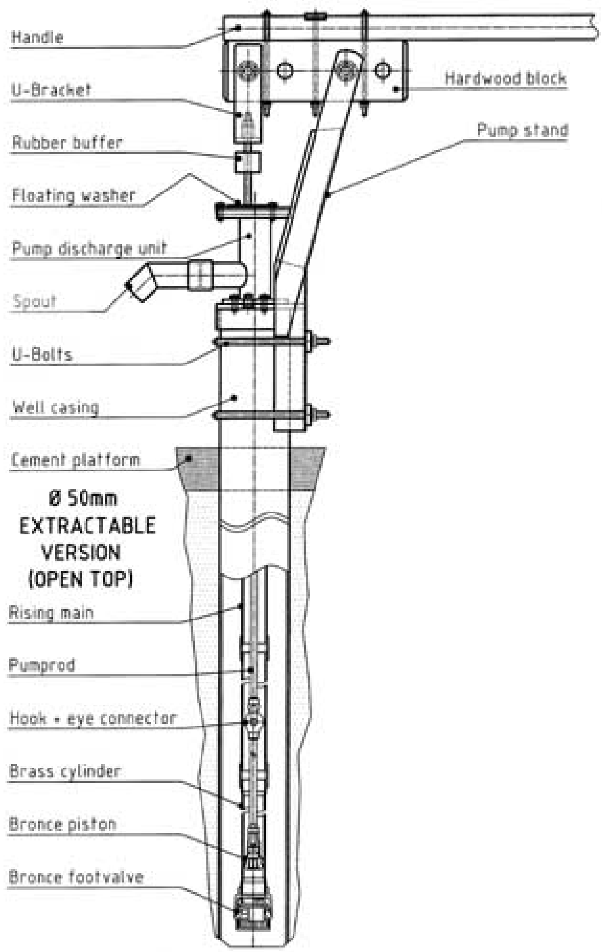

Figure 5: cross-section of bush pump (Erpf, 1997)

Bush pumps can take water from a depth up of between 18 and 100 m. In deep groundwater table areas, it is often the only type of manual pump which can be used. It is designed for heavy duty and endurance.

References to more detailed technical documents, include Blair Research Laboratory (1991) and Erpf (1997).

Implications for water use

The amounts of water use that can be extracted from a bush pump depend on a number of factors. First of all the depth of the pump determines the discharge which can be pumped under normal use. Typical yields range from 3 l/min in drier parts of the country where boreholes may be as deep as 100 meters to 15 l/min in the wetter parts of the country, where there is shallow groundwater.

The second factor is the number of people sharing it. Bush pumps are normally fitted to communal boreholes or deep wells, which are typically shared between 25 households (around 250 users) per pump.

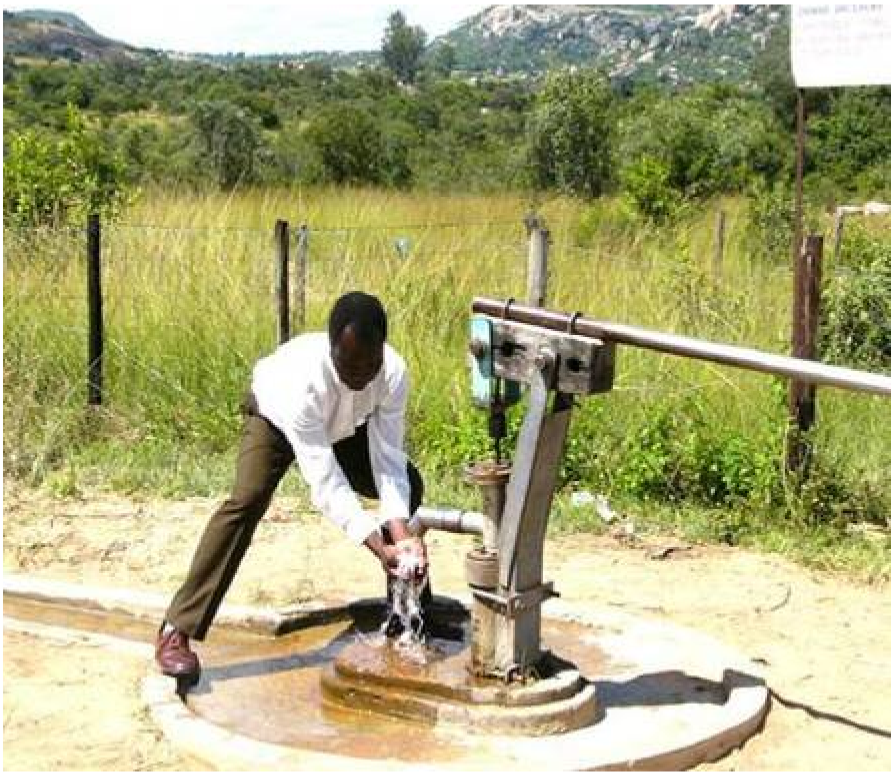

Figure 6: bush pump in Murehwa district; the sign board indicates that doing the laundry and watering cattle are prohibited.
Picture: Luckson Katsi

In regions like Tsholotsho district, hardly any surface water is available and groundwater levels are low. This means that boreholes with bush pumps are *de facto* the only source of water and are used for all people's uses. The yield of 3 l/min in those areas then starts to pose limits on what the water can be used for. Using the water then for multiple purposes, may lead to rapid wearing of parts such as oil rings, leather cups and the cylinder. Walking distances and time required to collect water will then also pose limits on the actual use of water. In the most extreme cases, water consumption levels may be as low as an estimated 10 – 15 lpcd. Under such scenarios, people may only have one or two goats. Larger livestock, such as cattle, is then only limited to few people, or those living close to cattle dams.

Figure 7: Women and children spending as long 8 hours waiting for their supply of water for household and animal watering from a bushpump in Tsholothso district
Picture: Mvuramanzi Trust

If other sources of water are easily available for productive purposes, often borehole water is only used for domestic consumption. This is for example the case in UMP district, where streams and dams are used for bathing and laundry, and cattle watering while the bush pumps are only used for drinking and cooking purposes. When streams and dams dry up in the winter, extra demands are placed on bush pumps to account for cattle watering.

Costs

The costs of the bush pump have gone up dramatically in recent years as some parts need to be imported, against the official exchange rate, which is much lower than the one of the parallel market. That makes comparison of prices difficult. Before the hyper-inflation, the costs of boreholes with bush pumps was in total around 2200 US$, of which up to 1500 US$ for the drilling of the borehole and the casing (depending on depth of groundwater), and the remainder for the head works and the pipes. This amounts to around 10 US$/person. At current costs, it may cost up to 5000 US$, including drilling and casing.

Rope and washer pump

Introduction

The rope and washer pump (or rope pump) is a simple hand operated pump that was developed in Nicaragua, where its development and use has been well documented (see Alberts and van der Zee, 2004). It was brought to Zimbabwe from the UK in the 1980s and was adopted and further developed in the 90s. The pump was tried on a small scale in UMP district where a total of 278 pumps were installed. It could not be developed further because of the low water table in that district and design complications. Further development of the technology by organisations such as Mvuramanzi Trust overcame some of the problems and allowed for further scaling up. Mvuramanzi Trust has installed more than 600 rope pumps to date. Also, other organisations such as PumpAid have embraced the rope pump. They further adapted it, and branded it as the Elephant pump (PumpAid, 2006), making this technology central to their water supply programme. Recently, the rope pump is experiencing a boom in Zimbabwe. This is partially due to the economic crisis which makes the import of spare parts for bush pumps to expensive, partially due to the realization that rope pumps have a big potential in providing water for multiple uses (see below). In response, a broader range of organisations are embracing the rope pump in areas where it is technical feasible.

The acceptability of the rope pump is high in areas where it has been introduced. There are a number of reasons for that.

- Both manufacturing and repair and maintenance can be done for the largest part uf the users themselves, and they can use locally available materials
- It has a comparatively low cost when compared with other lifting hand pumps such as the bush pump, both for installation and for maintenance
- The delivery rate is far above the yield form bush pumps, and hence enables productive uses of water (see next section)

However, its application is limited to areas with surface water or shallow groundwater. It can not extract water from the same depths as bush pumps.

Technology description

The key technological principles of rope and washer pumps have been described in a number of publications (Alberts and van der Zee, 2004; NWP *et al.*, 2006). The typical Nicaraguan design is given in the figure below.

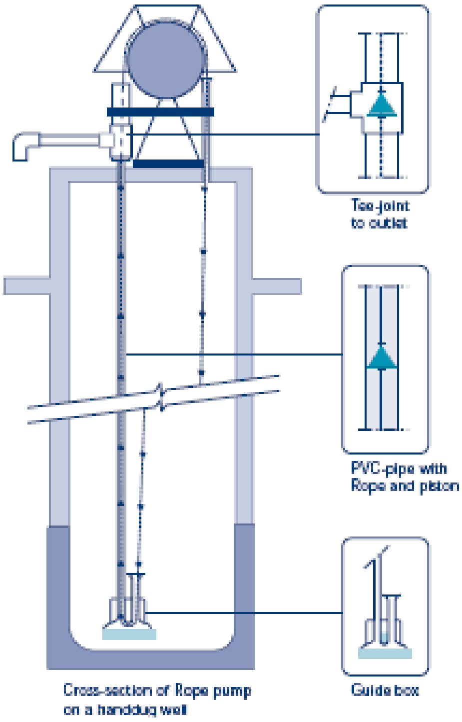

Figure 8: technical drawing of rope pump (Source: Alberts and van der Zee, 2004)

In Zimbabwe, adaptations of the technology have been made. It started as a rudimentary hand pump with wooden axel and honge in which the wooden axel rotates. This caused much friction, making operation difficult. The adapted rope pump now consists of a metallic axel and rubber honges which can be greased, improving the easiness of operation. Various organisations, including World Vision, Pump Aid (see PumpAid, 2006) and Mvuramanzi Trust, have further refined the pump, leading to slight differences in the design and materials used, as can be appreciated in the figure below. Efforts are currently underway to evaluate the different design standards.

Figure 9: different designs of the rope pump by World Vision, Mvuramanzi Trust and Pump Aid respectively

Pictures by World Vision, Luckon Katsi and Pump Aid

The rope pump can be used to abstract water from different sources, including traditional family wells, rivers or small ponds. For these sources, design implications hold as described in the previous sections. For family wells which are used both for domestic and productive purposes, avoiding contamination is key. The lining is raised approximately 30 cm above ground to avoid surface contamination and a concrete cover slab is placed on top of the well. The cover slab is made in two sections to facilitate fitting of rising main and rope and also so that the well can be accessed more easily for maintenance.

Figure 10: Rope pump extracting water from shallow well for irrigation
Picture: Stef Smits

Implications for water use

The yield of the rope pump depends on the speed at which the wheel is turned, which in turn depends on the strength of the person operating it, and the height over which it needs to be lifted. As an average figure, the rope pump delivers 200 litres of water every 4 or 5 minutes (i.e. 40-50 l/min) from a depth of 20-30 m.

At such a rate, it becomes easier to lift enough water to use water for garden irrigation. And indeed this has happened in many places. But also, rope pumps can be connected to in-house distribution schemes, so that water can be used for bathing, laundry and even showering. An example of a pump with different outlets is given in the picture below.

Figure 11: Rope pump with several outlets, potentially for in-house connections, Marondera district
Picture: Stef Smits

As can be seen in the typology in the beginning of this report, once water is lifted, there are various ways of further distributing it: by just letting the water flow through the fields through furrows, by putting it in a drip kit, by pumping it into buckets and then sprinkling the water over the crop, etc. These distribution mechanisms further determine the amount of water which can be applied, and hence the uses which are possible.

Evaluations of the rope pump done in Zimbabwe have shown large appreciation by the users. A number of households who have adopted the technique have reportedly marked increases in area of production. Figures are difficult to generalise. Some farmers have been able to increase their area under irrigation from 0.5 to 1 ha. In Marondera district, farmers report reduction in time spent on irrigation from 8 hours to less than 3 hours, and an increase of water consumption from 300 liters/day (lifting water through windlass and buckets) to 500 liters/day (lifting through rope pumps) as it means a reduced physical burden.

Box 1: Mr Chausa and the miracle pump

Mr Chausa, a married man with two wives and fourteen children, lives in UMP district. He used to irrigate 1 ha of land using buckets and watering cans, taking advantage of his big family to provide the labour. However, the limited area resulted in the production of green vegetable, tomatoes and maize only. When Mr Chausa acquired a rope pump in 1992 he managed to increase his hecterage to 2.5 ha in only three years time. He also managed to acquire another rope pump in 1996 and manage to increase his hecterage to more than 5 ha. Not only did he increase the acreage but also the variety of crops grown, producing a more varied diet and reduced vulnerability in case one crop would fail. He now grows tomatoes, beans, okra, butternuts, sugar cane, cucumber, green leaf vegetables, carrots, ground nuts and fruit trees. With the increased area cultivated, Mr Chausa's income has increased five fold. By the year 2000 he commented: "the rope pump is a miracle pump. Through it I have acquired four cattle, a scotch cart, sent children to school, built a new four bedroom house, and above all, married a third wife who is already pregnant".

Costs

The costs of the installation of the rope pump was around 300 US$ in 2006 (Katsi, 2006). This is only the costs of the pump itself, not of the digging and lining of the well, if this is to be done.

Access and distribution

Buckets and watering cans

The most common form of backyard irrigation (as the main form of irrigation concerned in this report is the use of buckets and watering cans. A survey carried out by the Mvuramanzi Trust in 1999 revealed that almost 90% of the irrigators are using buckets and watering cans. This leads to relatively a large amount of time spent on collecting water from the source and in applying it to the land at relatively high water losses. This limits the amount of land to be cultivated. But as can already be seen from the previous sections, having additional lifting devices may help reduce time spent. But, there are other technologies which enable the distribution from the point of water collection to the point of use.

Figure 12: Gardener irrigating using a can in Guruve district
Picture: Mvuramanzi Trust

Associated head works

A first set of aides, for storing and distributing water, are so-called associated headworks. These are complements to handpumps, such as bush pumps and rope pumps.

- For example, in Uzumba Maramba Pfungwe (UMP) district in the Mashonaland East province, overhead tanks have been added to bush pump-equipped boreholes. This allows people to store water and then guide water through small pipes systems for irrigation, animal watering and brick moulding.
- In Marondera district (Mashonaland East province), the construction of washing slabs at a water point has resulted in women having improved access to laundry water. This relieved them of having to walk 2 kms to the river for laundry and also at the same time spared of the risk of contracting schistosomiasis or bilharzia.
- Finally, cattle troughs sometimes are added to bush pumps. In fact in the past this used to be part of the standard design. However, in communities where people don't have cattle, these troughs were not used. As a result, now communities need to express whether they want such troughs or not and have to bear the additional costs.

Associated head works thus do not make more water available, but facilitate its access and use for various purposes. But there also have additional costs which have to be borne.

Drip irrigation kits

Introduction and technology description

Drip irrigation kits can be used in combination with many of the previously mentioned technologies. Their main aim is to reduce labour and to save water. It has been piloted in Zimbabwe since the 1990s. The most common system consists of the following:

- The stand; is an elevation on which the containers can be placed to create sufficient head of water. It can be made of concrete, wood, or just stones.
- The water tanks; these vary from one system to another. Some systems have two tanks, whereas some just have one. In systems with two tanks the first one acts as a primary filter where water-borne sediments are given enough time to settle. In the system with one tank, there is no primary filtration but one can put filtering material on top when pouring water into the tank.

- Secondary filter; this is a finely meshed cylindrical filter at the inlet to the main pipe. Dirt may accumulate at the meshes, thus there is need to regularly clean it.
- Stopcock; this is to regulate the flow or to turn it completely off.
- Main pipe; to distribute the water towards the laterals. It lies straight on the levelled ground.
- Laterals; these are connected to the main pipe. They lie transversal to the main pipe. The area covered by the laterals depends on the type of system.
- Emitters; these are very fine pores found on the laterals through which water drips directly onto the soil, infiltrating into the root zone.

Figure 13: Drip kits in Marondera districts: water gets pumped into the tanks from the rope pump, and distributed to the plot via the laterals with emitters
Picture: Stef Smits

Implications for water use

The main implications of combining a drip kit with some of the technologies mentioned in the previous section are reduction in labour and water savings.

The labour required for a drip irrigation system goes into filling the containers and the cleaning of filters and emitters. Once the drip kit is filled, it runs of its own. If no drip kit is available, labour needs to be spent on carrying and pouring water from buckets and water cans. Besides, as drip irrigation is more efficient than water cans, less water needs to be pumped and hence time can be saved. Which of the two in absolute terms requires most labour differs from case to case. If water is available close to the garden (e.g. through family wells) then actually carrying buckets may need least time. But when a drip kit can be connected to a rope pump, hardly any labour goes into filling the containers and the drip kit may be a preferred technology. Of course, it also depends on the size of the area being irrigated.

As with any irrigation system, the water savings that are happening depend on how the system is used. These systems have the potential of reaching very high irrigation efficiencies of up to 90% compared to using watering cans, which have an estimated efficiency of 50%. This is because little water is lost through evaporation, deep infiltration or surface run-off.

However, there are also some disadvantages related to the system.
- Plants are more sensitive to drip systems which are not precisely enough installed. If well installed, only a small patch of soil is wet. Especially young plants may suffere when they are outside this wet area.

- During the rainy season the soil may get compacted, and water from the drip system cannot infiltrate.
- Salt formations or dirt accumulating at the emitters may cause the emitter to plug and the flow to stop.
- There are cases of theft of the kits from gardens. Farmers have also faced problems of theft when the kits are left in the field.
- Rodents may eat the plastic lateral and rubber main lines.

Uptake by farmers depends on water availability. If water is easily and plentiful available, farmers are less likely to resort to drip irrigation. In Chipinge district, which has moderate water availability, the uptake of drip kits by farmers was relatively high at 64% in a project developed by Plan International. In Chihota communal lands in Marondera district, where the groundwater level is only 2-3 m deep, the drip kits are not used at all. Users find it easier to carry the water and apply it directly to their land rather than first put it into the container to go into the drip lines. Water conservation is not an issue in these areas either.

In conclusion, drip kits can be an important component of a mus approach, to save water and time, but will mainly be relevant, where water is scarce, and cannot easily be applied to the land.

Costs

At current exchange rates, the costs of drip kits are around 25 US$ per 100 m^2.

Conclusions

The sections above have shown a range of technologies in use in Zimbabwe that enable to certain extent the practice of mus. These technologies can be classified according to where they fit in the water chain: water sources, lifting devices and distribution technologies. In addition, the fact whether these are employed at family or communal level is an important point of classification. It determines amongst others the time spent on collecting water and the distance between the water point and its application, and hence water consumption possibilities.

We have seen three main types of (combinations of) technology which can stand on their own and provide water all year round, being family wells with windlass and bucket, family wells with rope pumps and boreholes with bush pumps. Small streams and spring systems could be included here as well, but too little information on these is available. There three systems compare as follows in terms of their costs, and benefits (in terms of the typical water consumption figures).

Table 3: costs and benefits of main types of technology

Type of system	**Capital costs**	**Typical water consumption for all uses (lpcd)**
Upgraded family wells with bucket and windlass	US$ 30/person	60-70 lpcd
Upgraded family well with rope pump	US$ 50/person	80-90 lpcd
Borehole and bush	US$ 10/person	10-15 lpcd

pump		

Even though family wells, either with windlass and bucket or rope pump, are more expensive in terms of capital costs required, their benefits are much higher in terms of water consumption. How these water consumption figures translate into financial benefits for the users depends on the type of use these are put to, and the value generated with it. Under the current hyper-inflation context getting such figures has proved to be tricky. Past research, however, has indicated that in general the benefits in terms of livelihoods outweigh the costs. Unfortunately, the family well technology cannot easily be applied in all parts of the country, because it required shallow groundwater.

Next to these main types of technologies, more water may be made available at household level, through complementary sources of water. Rooftop water harvesting is an example of that. It cannot fulfil domestic needs throughout the year but complements water from boreholes and reduces dependency on these. The same goes for farm ponds, and streams. These are generally used as complement to bush pumps, especially for those uses which do not require high quality water such as livestock and laundry.

Finally, a number of add-ons exist to facilitate access and distribution of water, such as watering cans, associated head-works to bush pumps and drip irrigation kits. Giving exact cost-benefit figures is difficult as their main benefit is in terms of saving time or saving water, both benefits to which no easy value can be put. Practice in the field shows the cost-benefit ratio that users give it. Drip kits, for example, are taken up in the drier areas of the country, where it takes more effort to collect water, while in the shallow groundwater areas, they are not taken up at all.

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