

Self Supply: A Fresh Approach to Water for Rural Populations

Self supply is a demand-driven approach, built on the widespread desire of rural populations to invest in water solutions that directly benefit small groups or households. Research in Zambia has found widespread grassroots demand for small-scale water supply improvements, and has subsequently developed models by which communities could improve the quality of their supplies.



Summary

Every year, thousands of rural householders and small groups invest in traditionally dug wells and scoopholes to provide convenient water supplies which they manage and maintain themselves. These water sources number over a million in Africa alone. Many rural people value these sources for their convenience, taste, productive use and, most importantly, the sense of ownership and control bestowed. However, policymakers tend to regard them as a liability to be replaced rather than improved or augmented, and rural water supply strategies continue to concentrate on communal supplies for groups of 200 to 500 people.

Research in Zambia has found widespread grass-roots demand for small-scale water supply improvements¹, and has subsequently developed models by which communities could improve the quality of their supplies. A project, funded by the UK Department for International Development (DFID) and implemented in partnership with the government of Zambia, now incorporates these models into national rural water supply strategy guidelines as an option alongside conventional approaches.

Self supply builds on the widespread desire of the rural poor to invest in solutions that benefit their small group or household directly, rather than as members of what are often scattered or discordant communities. Its components include improved availability of water from an increased number of supplies (such as traditional sources and rainwater harvesting); improved water quality (through source protection, improved water collection and storage practices, and household water treatment); and, improved water lifting for productive use. Self supply offers choice of technology, progressive upgrading, and replicability with little (if any) dependence on outside funds, enabling rapid and significant improvements to the lives of millions of people.

Background

Progress towards achieving the Millennium Development Goal (MDG) for water supply² has been slow in rural Africa. The number of rural people without access to safe water has been increasing in the last 10 years, and investment will need to double or even treble if the number of people without access to safe water is to be halved.

Such increases in investment are unlikely, with bilateral aid to the sector having decreased since 1993, and rural water supply featuring as a low priority in most countries' poverty reduction strategies.³

¹ (Sutton, 2002)

² To halve, by 2015, the proportion of people without sustainable access to safe drinking water.

³ For a scored assessment of developing country and donor progress in poverty reduction strategy freshwater/csd12casescorecardreport.pdf.

⁴ Spot survey of project areas in seven countries, 2003.

Map of Zambia



Source: World Factbook, 2004.

At the same time, despite widespread construction and rehabilitation of communal water points, between 10 and 50 percent⁴ of these facilities may be out of service at any given time, generally due to the problem of handpump breakdown. Problems of affordability, availability of spare parts, and communal management (reflecting the lack of ownership felt by a community) are often the main culprits, especially among poorer and more remote communities. Yet strategies to reach the MDG tend to assume that all existing supplies are sustainable and continue to function.

This suggests that other strategies are needed to improve the situation, especially considering that the MDG target still leaves some 150 million rural poor without access to safe water (Figure 1).

Zambian context

In Zambia, around 3 million rural people lack access to safe water, and use springs, unlined wells, and scoopholes as drinking water sources. Subsidies for communal supplies, such as boreholes with handpumps or piped supplies, generally target larger communities, although up to 50 percent of communities in some districts are smaller than 80 people.⁵

Even when upgraded water supplies exist, the proportion of handpumps not functioning ranges from 10 to 35 per cent, depending on the province and time since installation or rehabilitation.

Recognizing this situation, the Zambian government endorsed a DFID-funded research project to look at ways to mobilize the rural poor, especially those living in scattered settlements, to improve their own water supplies sustainably and with minimal subsidies. The project covered family wells and all traditional supplies, especially scoopholes and springs.

Box 1: Self Supply Concepts

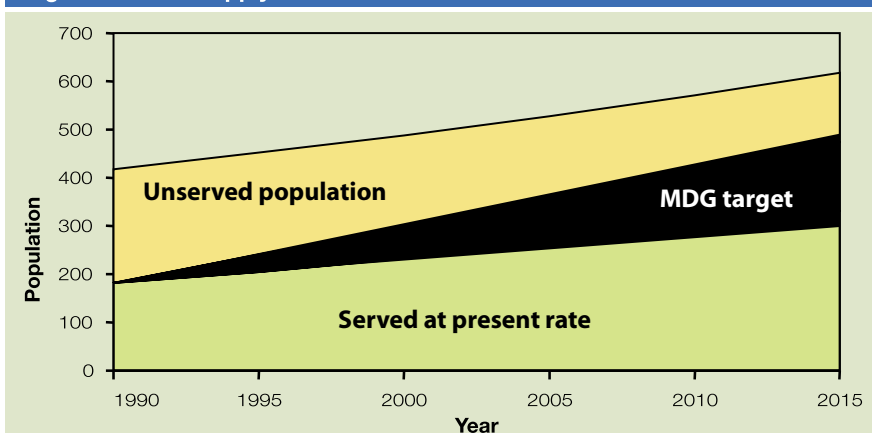
- Technologies are as far as possible replicable with minimum dependence on outside resources, encouraging local investment in systems over which investors have direct control.
- The application of minimum design standards can form the basis for phased and affordable improvements in supply, especially in areas of low population density.
- Local artisans and contractors provide safe water supplies, easier water-lifting devices and promote low-cost options.
- Where possible, linkage is made to economic and nutritional benefits as well as health benefits, increasing the perceived value (and therefore sustainability) of water supply.
- Management is maintained within naturally developed groups, usually the household or existing source user group, and has access to adequate, unbiased information, empowering them to make choices and solve problems.
- An enabling policy environment, combined with low cost and high proportion of private investment, allows rapid advance for large numbers of people, especially those in scattered communities for whom conventional protected systems may not be sustainable.

In a three-year implementation phase, the project was highly successful at stimulating local demand and identifying alternative service provision options for rural areas. The self supply concept (Box 1) combines

community empowerment with low-cost technologies to improve water quality and availability, reduce contamination risks, and improve access and ease of water lifting. The installations have proved to be popular, replicable, sustainable and affordable since they mainly use local skills, materials and technology principles. In many cases, households have reaped the benefits of both an improved domestic water supply and the productive benefits offered by access to water for small-scale economic uses.

The concerns of decision makers in African countries that have not yet considered low-cost options relate mainly to poor water quality, unreliability,

Figure 1: Water supply MDG trends in rural Africa



⁵WaterAid population distribution figures for Kazangula District, 2001.

and high per capita costs. The Zambia study data suggests that even limited protective measures can greatly improve water quality and accessibility. In addition, per capita subsidies are lower for self supply initiatives than for conventional solutions, especially where households themselves own and invest in the water sources. Government, non-governmental organizations (NGOs), and donors now support self supply initiatives within Zambia (Box 2), and other countries are starting to adapt the concept to their own requirements.

Need for wider range of technology choice

Threats to communal supply sustainability

The reasons for looking at alternatives to communal supplies stemmed partly from the recognition that conventional protected supplies were not sustainable in all situations, and partly from the apparent continued popularity of the traditional sources they were designed to replace (Box 3). Several factors have contributed to the lack of sustainability that often characterizes communal supply systems, including low population densities, low rural income levels, seasonal population movements, and ease of access to alternative sources of water.

Sustainability is further threatened by the high level of dependence on donors, generally limiting the choices for rural water supply to higher-cost options with imported spare parts and the application of unfamiliar skills.

Communities will seldom refuse such status-enhancing options, especially when they are bolstered by a high capital subsidy. The problem is that the interest is often short-lived, unless water is a very high priority and alternative sources are further away in terms of distance. Large subsidies for capital costs mask the direct relationship between capital and long-term recurrent costs, making it difficult for communities to judge what technology they can afford to maintain.

Wider application of self supply options

The natural size of social units is not always well suited to communal supply. In Zambia, the average size of a group using a single water source is about



High subsidies for communal supplies can make it difficult for communities to judge what technology they can afford to maintain.

Box 2: Short-term results of the research project

- Self supply principles are being adopted and promoted within Zambia by a number of governmental and nongovernmental organizations, including the Ministry of Health, the Ministry of Energy and Water Development, the United Nations Children's Fund (UNICEF), WaterAid, Development Co-operation Ireland, SNV Netherlands Development Organisation, the Peace Corps, and World Vision.
- National Water and Sanitation Strategy guidelines and community investment funds offer self supply as an option.
- All six districts which piloted self supply have sourced funds to continue implementation, in response to community demands.
- Manuals have been drawn up and published on facilitating low-cost changes in water sanitation and hygiene, and on low-cost water source improvement (Sutton and Nkoloma 2003; Sutton 2004).
- More than 200 groups (over 20,000 people) benefited from the pilot source and management improvements, at under US\$4 per head, and a further 1,000 supply improvements have been planned in one province alone. The future benefits will be felt more widely as the idea of self supply is disseminated among adjacent communities, and as self supply initiatives gain increased support from the government and from NGOs.

50 people for unlined wells and 80 for scoopholes. Group size appears to be determined by ease of management where water is readily available, and not by the yield of the supply (Figure 2). If the group size is over 100, there is a tendency to split off and make a new supply. This compares with the target community sizes for handpumps of 200 to 500 persons, which often means lumping together disparate groups for whom joint management may be problematic.

These figures on group sizes also suggest that individual owners commonly share their supply. The reason is that it is culturally unusual to exclude anyone and, generally, a person sinking a family well will tend to locate it for convenient use by others.

Studies show that those groups given a choice on the basis of unbiased information often prefer to remain with what they feel able to manage and afford. They then tend to

Box 3: Popularity and sustainability of traditional sources

The Monze District in Zambia's southern province has a 133 percent coverage (at 150 people per source) and most houses are within 500 meters of a protected supply. Even with this excess capacity, there are still 1,600 traditional sources in use, mainly for drinking, according to a WaterAid survey.

In the Kaoma District, a survey of supplies by the district water and sanitation health committee in 2001 found that 49 percent of the 321 communal protected wells and 80 percent of the 131 handpumps were working and in use. However, 94 percent of the 3,640 unprotected sources were also still functioning. It seems that ownership, affordability, and local skills keep traditional supplies functioning as they can even be deepened if they go dry. The continued popularity of such supplies makes it important that they be made safe.

upgrade at their own pace as more resources become available. Surveys of household-level investment in private (traditional) supplies show that individuals, even in poor communities, are often prepared to pay more towards their own supply than 40 or more households together are usually inclined to pay towards a communal supply.

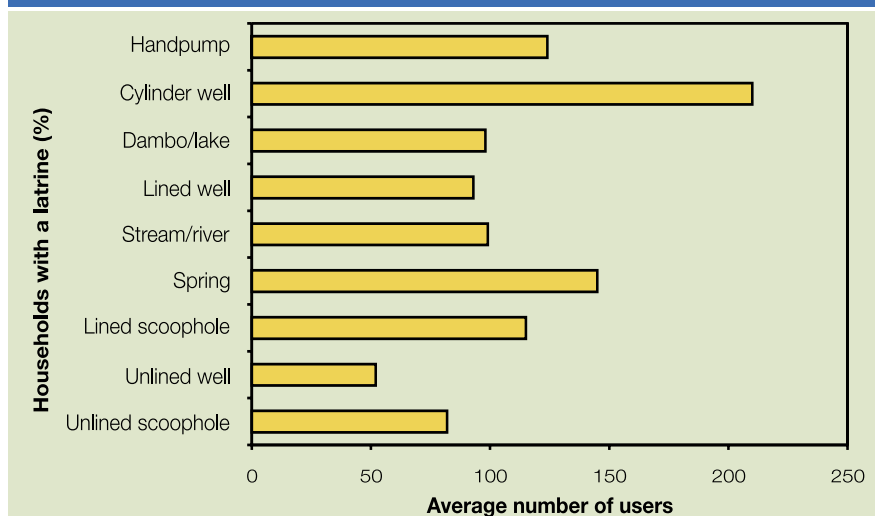
In this study, more than half of the individuals paid over US\$100 for their

own supply. Preference for ownership of and direct control over investment and its outputs, with naturally-sized units of management, appears to be a fundamental characteristic favoring self supply initiatives.

When investment is kept within a small group, and management structure and land ownership are clearly defined, water can be easily used for more than just domestic purposes. Unlike communal supplies, which are often perceived to be just a drain on the household purse, it is common for self supply systems to be net income earners. This income may come from irrigation of vegetables and seedlings, brewing, brick making, or food processing.

All of these, combined with improved family nutrition, bring clearly identifiable benefits to the household which, in turn, encourages care of and investment in the water supply. Larger communal systems rarely offer the same possibilities, and have less tangible benefits, unless the distance to the water source is markedly reduced.

Figure 2: Average number of users per source (2,214 sources)



Low-cost solutions also invigorate the rural economy. This is through the employment of local artisans in activities like well digging, masonry, and carpentry rather than bringing in remote contractors and foreign technologies.

Research methodology

The aims of the research in Zambia were to explore systematically the scope for self supply, look at pilot options, and to ensure the support of policymakers. The process was as important as the outputs. As there is often an initial reluctance to consider simpler technology options for fear of going backwards, it was therefore important that policymakers and planners were involved in both the design and undertaking of the research.

This allowed them to judge the results first hand, and see that there is a significant demand for such alternative solutions at grass-roots level. The process was divided into three phases

to allow for a continuous and ongoing assessment of progress and results:

1. Learning from what exists – qualitative and quantitative surveys
2. Piloting – monitoring changes and user satisfaction
3. Advocacy – using outputs to influence district planning and government and NGO strategies. (While this was partly a follow-up to the fieldwork, it was also a continuous process throughout the three years.)

Learning from what exists involved inventory surveys of over 2,250 water supplies, with spot water samples from 1,750 of these and a further 2,000 monitoring samples over time. The inventory and accompanying detailed qualitative studies in 22 communities took a year to complete.

After assessing the scope for improvements, pilot projects were set up. This was done mainly through

Ministry of Health extension workers, who are accustomed to working within the community. The intersectoral water, sanitation, and hygiene education committees at district level linked and integrated the technical support for water supply with risk reduction and hygiene education in health, and the advice given by agricultural block extension officers. This interdisciplinary approach maximized the benefits of the investment in water supply and sanitation, and provided long-term support to communities.

Two hundred pilot systems were established using self supply concepts (Box 1), and water quality was monitored in 80 of these. The main technologies introduced were:

- Well and scoophole lining (full or partial) with bricks or concrete rings, using portable, glass-fiber molds
- Protected wellheads (aprons, drainage, and well covers and lids)
- Cheap waterlifting devices (such as locally made windlasses and low-cost pumps)
- Handwashing devices for sources and households.

Piloted software aspects included:

- Community facilitation to encourage change, participatory planning of projects, and project self-finance with scarce cash
- Involvement of the private sector, especially local artisan well diggers, carpenters, and masons
- District-level planning to incorporate conventional and self supply options.



Low-cost solutions can invigorate the rural economy through employment of local artisans.

Small communities showing interest in improving their supply were invited to discuss the changes they felt would help, to make their own plans of the work involved. Standardized levels of upgrading were developed for different source types and communities opted for the level they felt they could reach and maintain, while being made aware of other improvements that could be made in the future.

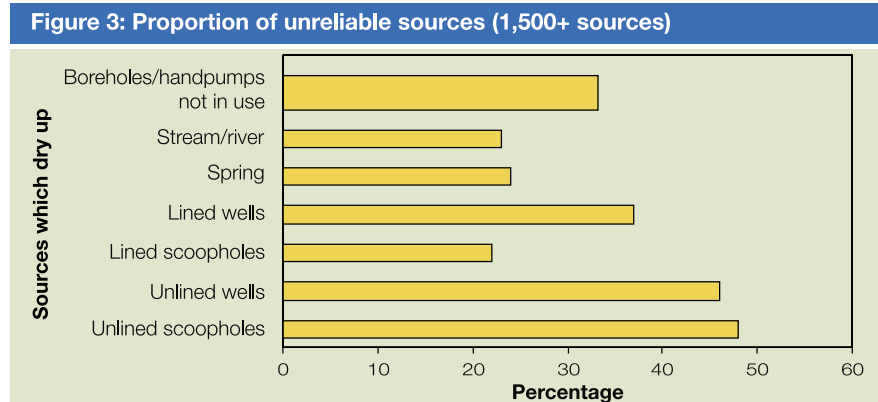
Lessons learned

Water quality and reliability

Improvements brought about by low-cost protection and improved supply management led to a significant drop in fecal coliform counts. Samples taken on a regular basis after improvement of the water sources showed 95 percent of samples with less than 10 fecal coliform colony-forming units per 100 milliliters (cfu/100ml), compared to 34 percent before the introduction of low-cost protection.

Compared to the conventionally protected wells, slightly fewer of the improved self supply sources showed no contamination at all. However, at levels which may be regarded as mildly or more severely contaminated, the low-cost improvements tended to exhibit the same or better quality than the more conventional, more expensive communal designs.

All upgraded sources were regarded by users as providing safer water than unimproved ones. Managers of improved sources remarked, in every case, on the increase in the number of users. Eighty percent of those with



unlined wells commented that they had previously travelled long distances for drinking water because their own well water was not safe. Since the introduction of partial lining and other improvements, they could use the water near their houses, which saved families much time and energy.

Dramatic reductions in faecal coliform counts were experienced in a small-scale pilot project using handwashing devices. Before the intervention, fecal contamination counts ranged from 100 cfu/100 ml to “too numerous to count”, while after the intervention, counts were usually zero and never more than 10 cfu/100 ml. Seeing such markedly positive results, some households then chose to make handwashing devices for their own use.

Although many family wells are said to dry up (Figure 3), most usually return to operation through successive redeepening. With partial (top) lining, as opposed to complete lining from top to bottom, it is easy for local well diggers to return and deepen the well at minimal cost. This leads to many more family than communal wells being kept operational since the latter require

outside labor, expensive equipment, and transport. It is only in the most intense droughts that water levels in some family wells fall below levels where they can be deepened.

Conventionally protected wells go dry slightly less often. Once they go dry, however, communities face affordability problems for the heavy equipment and skilled labor required for their redeepening. Lined scoopholes in sandy areas became more reliable than high-cost communal wells and offered better quality water.

Demand for improvements and acceptance of a step-by-step approach

Demand for improvements far exceeded the capacity of the research project. As a result, all districts which were involved in piloting successfully applied for additional funding from government, NGOs and donors so that they could continue to respond to the rising demand. All rural health centers had excess demand, with many well owners and scoophole users buying cement, making bricks, or collecting sand and

gravel in anticipation of being assisted. The idea of well owners building on their initial investment was widely accepted, and systems grew up for exchanging rice and beans for cement. Others, on seeing what improvements in supply could be achieved, started to dig their own wells, hoping that they could eventually accomplish the same.

Those who could not afford to fully improve their source in one step alone opted to make gradual improvements. An example is in Kaoma, where some farmers could not afford to line their deep wells on the proceeds of just one harvest, and just lined three or four meters a year. Most planned to add a windlass, and later ground storage, to allow more irrigation and so fund further improvements.

The same step-by-step philosophy was being adopted by communities that had

initially used cheaper local materials such as wood or clay lining as the first stages in scoophole protection; they began raising funds to upgrade to concrete in the future. Unfortunately, not everyone who embarked on progressive improvement managed to maintain the momentum to achieve higher levels of upgrading. These people could possibly have been more successful if there were a credit system allowing all improvements to be completed, with repayment scheduled over more than one harvest period.

Greater value of water

Well users remarked on being able to propagate crops (such as tomatoes) and seedlings (such as tobacco) before the rains came, giving them a head start. Others mentioned that they could now make bricks nearer to where they lived which made theft less likely. In

addition, they could make beer without having to carry water long distances. All these factors have increased the perceived value of water, encouraging the sustainability of supplies.

Low-cost pumps were in particular demand as a result of the interest in easier lifting of water for domestic use and small-scale irrigation. After demonstration pumps were installed, the remainder were auctioned for more than the market value, suggesting that those investing in wells are prepared to pay a premium to have low-cost lifting in addition to safe water. Pump costs can usually be repaid in two seasons without endangering food security.

Private sector involvement

Local artisans also market the value of water, since their livelihoods depend on it. Brick or partial lining were not known in the country before the project, and only donor-funded wells were lined. Now, an increasing number of well diggers, masons, and carpenters are making money from improving sources such as making windlasses, and lining wells and latrines.

However, the impact of the project was limited by insufficient involvement of local artisans from the start as the research concentrated initially on government personnel, whose objectives related more to preventive health measures. Government extension staff also proved reluctant to risk their allowances by passing on skills or equipment such as ring moulds to others, retarding the involvement of the private sector.



Application of minimum design standards can form the basis for phased and affordable improvements.

Taking up new ideas

There is often resistance within communities to ideas imported from other regions. For instance, there has been some reluctance in West Africa to accept windlasses, which are common in East Africa. A similar reticence is seen in East Africa to accept pulleys and inner-tube buckets common in West Africa.

The experiences of Zambia, Zimbabwe, or Nicaragua (Box 4) cannot be transferred on anecdotal evidence alone. Ideas need to be demonstrated and tested within a country before adoption can overcome resistance. The use of low-cost water-lifting devices is only slowly transferring to Africa, but even simple ideas such as lining wells are foreign to many people and were found to take time to establish. The experiences of Zambia and Zimbabwe suggest that even with demonstration and piloting, a minimum of three years will be necessary to get new concepts incorporated into national planning.

Costs

The cost of improving an unlined well, (partial concrete lining or full brick lining) or scoophole (full lining) is approximately US\$100 for materials, or US\$300 including all training of local artisans and extension workers, community and household mobilization, and purchase and delivery of materials. Low-cost pumps add a further US\$100, including installation. This compares with costs of US\$1,500 to US\$3,000 for a fully lined well (needing winches, dewatering equipment, transport, and costs of

Box 4: Income-generating potential of self supply

Studies in Zimbabwe suggest that a farmer irrigating a 0.03-hectare plot using a well with a bucket can achieve an annual return of around US\$75. The addition of a low-cost pump allows an extension of the irrigated area that can generate up to eight times the income (Water and Sanitation Program, 2002).

Studies in Nicaragua show that a well is able to increase its owner's income by 30 to 115 per cent, and that a US\$60 investment in a rope pump increases average income by US\$220 (Van der Zee, Fajardo, and Holstag, 2002).

management during construction), US\$2,500 to US\$4,500 for a borehole, and US\$250 to US\$1,000 for a communal handpump.

Per capita costs of self supply options (allowing one unit per 50 people) tend to be cheaper for groups of up to 200 (Figure 6). It is at this point that the costs of communal supplies begin to fall to similar levels. Self supply remains

cheaper for groups of up to 150 people even when using the more expensive options of up to US\$800 per unit.

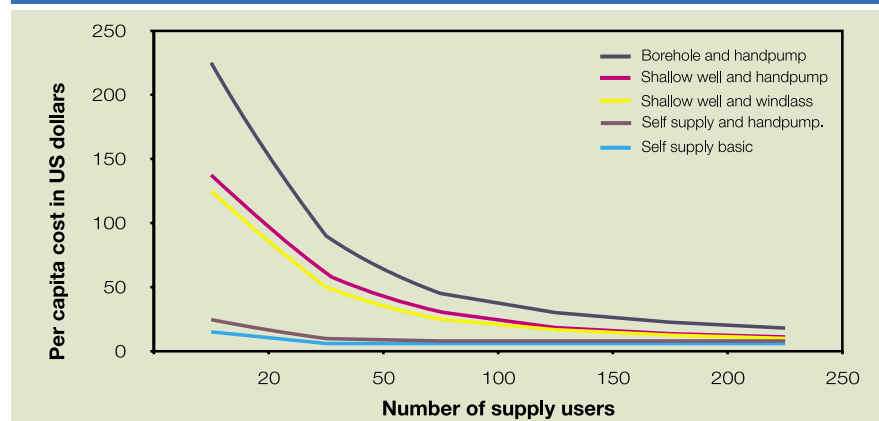
Towards self supply

Country-level initiatives

The Zambian research has taken a systematic look at some of the barriers to and effects of self supply. It has begun to create an enabling environment nationally within which families and scattered communities can invest in their own supplies, supported by any funding available to districts and NGOs.

Neighboring Zimbabwe has longer practical experience of this approach, but has concentrated almost exclusively on family well technology. In Zimbabwe, a system that is now supported by government has led to the upgrading of over 50,000 family wells over the past 15 years. As in Zambia today, it was the demand of rural families for such solutions which persuaded policymakers that there was a role

Figure 6: Per capita costs of technology options



for self supply alongside communal approaches.

Another example can be seen in Liberia where family wells supply more than a third of the rural population. The concept has been successfully piloted in Sierra Leone. In addition, the government of Benin, in response to grass-roots demand, has decided to offer household solutions and lower-cost lifting devices as an option alongside communal supplies.

Low-cost lifting devices have transformed the rural economy in several Central American countries, with Nicaragua producing over 7,500 rope pumps a year for household domestic and agricultural use, at around

US\$100 per pump. The demand for small-scale irrigation in Africa is growing fast, especially as rains become less predictable.

Rainwater harvesting is also becoming increasingly popular, especially where alternative sources of fresh water are difficult to find. However, few households in poorer rural communities have the sheet roof surfaces which maximize clean run-off.

The idea of self supply clearly has the potential to spread to other countries. However it may require specific effort to achieve political acceptability. The efforts would need to extend to incorporating pragmatic solutions alongside the existing but more narrow

engineering approaches which at present often do not recognise simpler, lower cost options.

International networks

Apart from the initiatives mentioned above, certain networks concentrate on household-level solutions and could assist countries in moving towards the MDG for drinking water supply. The Rural Water Supply Network (RWSN) encourages technical and managerial innovation, and identifies best practices for wider promotion, focusing on needs in Africa (www.rwsn.ch). In 2003, RWSN launched research- and knowledge-sharing initiatives for low-cost drilling, viable supply chains, and self supply for small communities and households.

The International Network to Promote Household Water Treatment and Safe Storage is working to improve the health of vulnerable people through domestic point-of-use water management, including household water storage and treatment.

Both organizations promote research into household solutions for water supply, treatment, and storage, and monitor the impact of these solutions. They also generate advocacy materials to support the spread of self supply practices as a long-term option.

Summary of self supply attributes

Self supply complements communal supply initiatives, and offers certain real advantages. The attributes of both systems are compared in Table 1.



Before and after: Low-cost lifting devices such as windlasses have improved water supply.

Table 1: Comparison of attributes of conventional and self supply systems

Conventional communal systems	Self supply options
Best suited to nucleated, homogeneous communities with good leadership	Suited to individual households and small groups
Technologies available for a wide variety of conditions, with greater flexibility in siting	Easily established where water is within 15 meters of surface or rainwater adequate
Focuses on outside knowledge and remote technologies	Builds on local knowledge, attitudes, and skills
Serves large numbers of people, who may or may not form a community	Serves households or small groups forming natural management units
Safety and quality of water usually assumed, not always correctly; perceived value among users may be less than assumed	Significant improvements in water quality, comparable to fully protected communal shallow wells but at much reduced cost; high perceived value among users
Generally marketed for health benefits; income generation often difficult because of communal ownership	Often generates multiple benefits including income, improved nutrition, and local employment
Depends on committee management which is not traditional and may take time to develop	Well-defined ownership and management by individual or well-established group
Provides good water within 0.5 to 1 kilometer, but households may have nearer alternative sources	Provides good water, usually within household boundary or within 100 meters
Requires large investment per unit, and very high subsidies (usually around 95 percent; typically US\$15–20 per capita)	Low unit cost means that subsidy can be less than 50 percent (Zimbabwe 20 percent) (typically US\$3–5 per capita)
Rapid construction, but construction teams not involved in maintenance	Rapid small changes, slower process to reach final product, construction teams also do maintenance
Long-term maintenance is expensive, requiring heavy equipment and transport	Regular and long-term maintenance can be carried out by local artisans, including re-deepening at low cost
Higher standards from the start but sustainability may be low	Gradual steps towards high standards, each bringing sustainable improvement
Often donor driven	Develops directly from local demand

Conclusions

Self supply is a demand-driven approach. The demand is expressed by the owner's willingness to invest significantly in improved water supply and its management. It presents a low-cost alternative to

conventional communal supplies and their associated high-cost technologies, and offers a more sustainable solution among small communities and scattered households. The enthusiastic grass-roots response in several countries suggests that it is an approach that

deserves wider application, and is capable of bringing about rapid and widespread change among the most remote of rural communities and, if recognised as a legitimate source of supply could make a substantial difference to meeting the MDGs.

References and further reading

Smith, C.C., and P. Daniels. 2004. Family Water Supply and Sanitation in Liberia. Geoscience Srl.

Sutton, S. 2002. Community-Led Improvement of Rural Drinking Water Supplies: Final Report. DFID Project KAR 7128. SWL Consultants.

Sutton, S. 2004. Low-Cost Water Source Improvements: Practical Guidelines for Fieldworkers. Teaching Aids at Low Cost (TALC). London, UK: TALC Publishing. Also on CD.

Sutton, S., and H. Nkoloma. 2003. Encouraging Change: Sustainable Steps in Water Supply, Sanitation and Hygiene. Teaching Aids at Low Cost (TALC). London, UK: TALC Publishing. Also on CD.

Water and Sanitation Program. 2001. "The Rope Pump: Private Sector Technology Transfer from Nicaragua to Ghana." Developing Private Sector Supply Chains to Deliver Rural Water Technology, Field Note 5. WSP.

Water and Sanitation Program. 2002. "Upgraded Family Wells in Zimbabwe: Household-Level Water Supplies for Multiple Uses." Blue Gold Series, Field Note 6. WSP.

Van der Zee, J., A. Fajardo, and H. Holstag. 2002. "The Impact of Farm Water Supply on Smallholders' Income along the Coast of Nicaragua." SIMI Workshop: Global Initiative for Small-Scale Irrigation, Switzerland.

Websites for further information:

CES (Centre for Ecological Sciences): www.ces.iisc.ernet.in/energy/water/paper/drinkingwater/wellsconstruction

Warwick University: www.eng.warwick.ac.uk/DTU/rwh/index.html

WaterAid: www.wateraid.org.uk/site/in_depth/technology_notes/297.asp

World Bank: www.worldbank.org/watsan/topics/tech_supply.html

Water and Sanitation Program: www.wsp.org

International Network to Promote Household Water Treatment and Safe Storage: www.who.int/householdwater/

Rural Water Supply Network: www.rwsn.ch



The Water and Sanitation Program is an international partnership for improving water and sanitation sector policies, practices, and capacities to serve poor people



The Rural Water Supply Network RWSN is a global knowledge network for promoting sound practices in rural water supply.

November 2004

Water and Sanitation Program

- Africa

World Bank
Hill Park Building
Upper Hill Road
PO Box 30577
Nairobi
Kenya

Phone: +254 20 322-6306
Fax: +254 20 322-6386
E-mail: wspaf@worldbank.org
Website: www.wsp.org

RWSN Secretariat

SKAT Foundation, Vadianstrasse 42
CH-9000 St. Gallen
Switzerland

Phone: +41 71 288 5454
Fax: +41 71 288 5455
Email: rwsn@skat.ch
Website: www.rwsn.ch

ACKNOWLEDGEMENTS:

This field note was prepared by Dr Sally Sutton. It was peer reviewed by Jon Lane (Independent consultant), Julian Jones and Erich Baumann (RWSN/SKAT). Joseph Narkevic (the Task Manager) and Piers Cross (WSP-Africa Team Leader) provided valuable ideas and guidance on the paper.

Editors: Melanie Low and Toni Sittoni.

Photo credits: Sally Sutton
Design & layout: Kul Graphics Ltd.
Publisher: WSP-Africa