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Smart technologies: New options to reduce costs of rural water supply

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Regarding water, some 84% of the un served live in rural areas (UNICEF 2008)[1]. To improve this situation the number of decentralised supply systems such as wells and hand pumps need to increase. With technologies normally chosen progress with increasing coverage is slow but by applying innovative low-cost water technologies, so called Smart tecs, access to more and safe water, especially in rural areas, could drastically increase. Recent innovations have reduced the cost of water technologies for wells, boreholes, pumps, storage, recharge, irrigation, and water treatment by 30-70% as compared to conventional options and have increased sustainability. One example is the Rope pump of which now some 80.000 are installed worldwide and used by some 3 million people. The introduction of this pump in Nicaragua started with 1 million dollars development aid, through which the yearly GNP of Nicaragua increased by 10 million dollars. The shift from piston pumps to rope pumps doubled rural water supply in less than 10 years, 3 times faster than countries with conventional hand-operated piston pumps. Surveys indicate that families that purchase a $70 Rope pump increase their annual income by $220[2]. The large scale dissemination of new small-scale technologies, has a huge potential to improve rural water supply, increase food security and reduce rural poverty.

(Currency units all in US dollars)

Background

To increase rural water supply in Africa, hand-operated piston pumps were widely disseminated in the 1980s. After technical improvements, the focus shifted from technology to the so called VLOM approach (Village Level Operation and Maintenance management) but still 20 - 50% of the hand pumps in sub-Saharan countries are not working at any given time. A major reason seems the lack of capacity of the users to manage the maintenance. Although hand piston pumps are relatively simple it seems that in many cases they are still “hi tech” for the target group. “Lo-Tech” pumps or so called Appropriate Technologies (AT) also often fail because they are not efficient or not accepted because of their “stone age” image. Another reason is the lack of the involvement of the local private sector in production, sales and maintenance. When the projects end, the activities often stop because local production and marketing (supply chain) are not developed.

Improvements

In many situations the sustainability of rural water supply could be improved by shifting from conventional hand pumps that are often imported, to simpler and locally-produced options. Box 1 summarises experiences with the Rope pumps in 3 countries.

Box 1. Rope pump experiences

Nicaragua. Some 70,000 Rope pumps have been installed since 1990. The shift from imported piston pumps costing $600 to locally produced rope pumps of costing $70 has doubled rural water supply in ten years, much faster than countries that apply piston pumps. Users do the maintenance and 95% of the pumps remain in operation[3].

Zimbabwe. The so called Elephant Rope pump model was introduced by the organisation Pump Aid in 1990. Now some 3000 pumps serve 950,000 people and more pumps will be installed before 2015 to reach 3 million more people. With this approach Zimbabwe may reach the water Millenium Development Goals (MDGs)![4]

Ghana. First experiences with Rope pumps have been discouraging. In a World Bank funded project 80% of the pumps installed in North Ghana did not function after one year because of lack of user involvement and errors in production and installation. The "wrong" introduction of the Rope pump hampered the acceptance of this option by the government for a long time and it took organisations as Water Aid a long time to repair the "image damage" with better Rope pumps and more user involvement[5].

The Rope pump was known as a low lift, home-made family pump. With new design inputs it now is a very effective pump for boreholes or hand dug wells as deep as 35 meters or even 60 meters if provided with two handles.

Worldwide some 3 million people now use Rope pumps of which some 1.4 million are in Africa and it may be the fastest growing hand pump worldwide. It is fit for family use but is also able to supply water to communities of 250 people. Because of its high pump capacity it is also popular for productive uses such as as car washing, cattle watering. irrigation etc. The Rope pump fits on hand dug wells and 2 inch (50mm) boreholes and for the same depth is 5 to 10 times cheaper than piston pumps.

Smart tecs

The Rope pump is not "Hi tech" but neither is it "Low tech" but can be considered a Smart technology (Smart tec). It is one example of innovations have taken place in the last 20 years. Other Smart tecs are in the field of wells, storage, groundwater recharge, a drip irrigation, point-of-use treatment, sanitation and hygiene. Smart tecs can be defined as innovative, simple and affordable water and sanitation solutions that in general can be produced and managed with locally-available skills and materials. Smart tecs have proven to be sustainable and reduce cost compared to conventional options. Besides the Rope pump some other examples of Smart tecs are:

- **Upgraded wells**: Simple lining systems to deepen the well in dry periods, well cover combined with EMAS pump or a Rope pump Windlass model.
- **Manual drilling (Step auger, Rota sludge, Baptist drilling)**: The drilling options are based on the Indian sludge method and can drill in semi-hard ground layers to depths of. 50m or something even 80m deep. In Tanzania a combination of a manually-drilled borehole and locally-produced Rope pump costs $600 compared to $3000 for a machine-drilled borehole and a piston pump. The Baptist drilling method is cheaper than the Rota sludge method. In Bolivia, over 2300 family wells have been drilled and combined with a simple PVC pump, for a cost of $3/m. A water point for $100!
- **Wire cement tanks**: These tanks use wire instead of construction steel for reinforcement and locally-available support material as bricks, bamboo or wood. Compared to Ferrocement tanks the cost of wire cement tanks are 30-50% lower and tanks up to 60m^3 have been made with this technique.
- **Easy drip:** A low-pressure drip irrigation system consisting of local poly pipe and imported lay flat hose. It can be coupled directly to a treadle pump or rope pump without the need for a water storage tank and irrigate at one time some 400m^2 meters of tomatoes from a 10m deep well. Time needed to pump the water is 0.5 to 1 hour per day. The cost of material for 400m^2 is $35 – 50.
- **Tube recharge**: A simple option to recharge an aquifer with rainwater that otherwise would flow away. It consists of a hand augered hole of 5 to 10m deep filled up with gravel and closed at the top with a sand filter. Experiences in Zambia indicate that hand-dug wells that before went dry at the end of the dry

season, now have water all year round. After training, these systems can be made by families themselves at a cost of $2- 5 for materials.

- **Filtron filter:** A pot shaped ceramic filter impregnated with colloidal silver, promoted by PfP (Potters for Peace). It eliminates turbidity and harmful bacteria and now is locally produced in some 20 countries.
- **Siphon filter**: A small and effective water filter that produces 30-60 litres of safe drinking water per day and costs $8-12. (see "Marketing safe water systems" www.poverty.ch).

Cost - benefits of (new) water options for nations

In general it is very cost effective to invest in improvements in water and sanitation. An example is Nicaragua. Dutch Aid invested 1 million dollar in the first dissemination of the Rope pump resulting in an . increase of the GNP of Nicaragua by 10 million dollar/year because of the increased incomes of families using the Rope pumps[6].

Cost - benefit of (new) water options for users

Benefits for users of investments in water are $5 to $28 for every dollar spent (SIWI/WHO 2004)[7]. Treatment of water at the household level can even lead to a benefit of up to $60 for every $1 invested (WHO, 2008)[8]. Surveys in Nicaragua indicate that rural families with a well generate twice the income or families without a well and a $70 rope pump on a water well generates $220 extra income per year (J van der Zee, 2000)[2]. The low cost and simplicity make Rope pumps also affordable at family level. Treadle pumps or Rope pumps have proven to be low-cost irrigation tools that generate income for smallholders. Production of cash crops can increase incomes, give food security and reduce poverty if combined with agricultural inputs and access to market (Heierli 2008)[9]. The introduction of wells and pumps has to go hand in hand with actions on water conservation.

Figure 1. Njombe, Tanzania. Training in manual drilling a 30m borehole using Baptist drilling (time 3 days, cost incl. pump, $600)

Figure 2. Training at the Smart tec centre in Tanzania in Rope pump production, well drilling, water treatment and other options

Box 2. Examples of smart technologies for multiple user services

The Money-maker in Kenya: a pedal pump called "Money-maker" is used for small-scale irrigation. This treadle pump costs $70 - 120 and can generate $200 - 500 per year extra net income per family. More than 40,000 pumps are presently in use (Heierli, undated).

The Rope pump in Zambia: After training by Connect international, the local organisation DAPP now trains other NGOs and local workshops in production. Since 2006, some 500 pumps have been produced of which some 50% are used for both domestic use and small-scale irrigation of vegetables. Cost of a pump and well improvement are $150 – 250 and families pay back credits for this investment in 6 to 12 months by selling vegetables to the local market. Similar activities are now starting in Tanzania, Mozambique and Malawi.

Dissemination of Smart technologies

One could observe that if these technologies are so promising then why aren't there many more in use in rural Africa? There are many reasons but two major ones seem to be:

- Lack of awareness: An estimated 90% of rural families in Africa have never heard or seen the new options. Although some options have been demonstrated at water events and are available on the Internet, it takes much more marketing to inform policy makers, NGOs and end users such. This requires funding. Also there are many wrong assumptions regarding Smart tecs as the Rope pump. Some remember the Rope pump from 30 years ago when it was introduced in Africa as a low-lift pump only fit for family wells. Others think that the Rope pump does not count as an improved water source since it is partly open and the well can be contaminated. Experiences indicate that both assumptions are not correct.
- Simple is not easy: A major problem with options like the Rope pump and hand drilling is that they are "too simple". If people see it, they think they can make it. Although they are indeed easy to make, some basic design rules are needed in order to avoid damage. For instance the wrong clearance in a bushing can cause the handle to break within two months. If it is well made, bushings can last for 15 years. Similar to other pumps, also Rope pumps need user involvement, so families or pump caretakers need to be trained etc.

Lessons learned

Some aspects that successes have in common are:

- Aid was is essential for introduction, training, quality control, awareness creation, and marketing.
- Involvement of local private sector and the incentive of profit are essential for "profit based sustainability".
- "Repairability" of a technology is more important than its "reliability".
- To reach water related MDGs, low-cost and locally-produced hand pumps can be more effective than high-quality imported pumps (for wells and boreholes up to 60m deep).
- Simple is not easy. The development and dissemination of simple technologies require professional knowledge transfer both on technical and social aspects.

Recommendations

- More development aid for water and sanitation is required for two reasons. Firstly, water and sanitation are essential to reach 6 out of 8 MDG's. Secondly, improvements in WASH have a "guaranteed" benefit of $5 - 60 for every dollar invested.
- Give people choices! If rural communities get a new water supply, give them the choice between a piston pump or a Rope pump! (Let people pay a percentage of the real price).
- Invest money where it is most effective. Money can only be spent once and maybe shifting investments from urban to rural water supply can be effective (84% of the MDG poverty and water target group lives in rural areas) Access to more and safe water in rural areas may also reduce migration to cities.

- Use existing subsidies for water to stimulate family wells. With the new low-cost options, a hand-drilled borehole and Rope pump may be affordable for middle and lower income families (eventually with credit).
- Replace (some of the) broken piston pumps by locally produced Rope pumps.
- Create awareness using a "Coca Cola marketing approach": All stake holders should at least be aware of new options, so they can choose between the options.
- Create "Smart Tec centres". In every region there should be place with demonstrations, real examples of upgraded wells, drilling options, hand pumps, storage tanks, irrigation systems, filters, latrines and hygiene ideas such as Tipp taps etc. These centres should have capacity to train in production, installation and maintenance.

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Note

Since 1987 the first author has been active in some 16 countries in the development and supply chain of Rope pumps and other Smart tecs. He is initiator and main author of Smart Water Solutions published by the Netherlands Water Partnership. Other smart series are on sanitation and water harvesting (see www.IRC.nl and information on rope pumps at www.ropepumps.org as well information on Smart tecs at www.AKVO.org and www.connectinternational.nl). The second author is technical Director of SHIPO which has a Smart centre in Njombe, Tanzania.

Keywords

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