Rural Water Supply Network

Field Note No 2011-3

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Handpump Technologies

Low Cost Hand Pumps

Executive Summary

Groundwater supplies provide a significant proportion of rural dwellers in the developing world with access to a safe drinking water supply and will continue to do so in the near future. With the emergence of Self Supply and its increasing acceptance, low-cost handpumps have a role to play. Twenty five years ago the emphasis was on completely enclosed pumps (for drinking water only) to avoid the contamination of the well. Over the last 10 years, cheaper and simpler pump designs have become more acceptable. This development has been strongly influenced by the general recognition of the self-supply approach.

There are three possible ways to produce low-cost pumps:

- **Do-it yourself:** building the pump by the owner, one-off handpump production using locally available materials and tools
- **Artisan workshop**: small scale production of handpumps in small workshops with few tools using locally available materials
- **Industrial production**: large scale production in local or foreign industrial units

This guidance note points out the strengths and limitations of a number of low cost pumps. It provides an overview of the application, technical details, materials used, installation and maintenance, manufacturing requirements and costs of several low cost pumps, including information on the numbers installed and locations.

Contents

Abbreviations and Glossary

Ø	diameter
ABS	Plastics based on acrylonitrile-butadiene-styrene copolymers.
Ergonomics	Equipment design which maximises productivity by reducing operator fatigue and discomfort.
Jig	A device for guiding a tool or for holding machine work in place.
Fixture	A device to secure a work-piece in a machine-tool.
Piston	A solid cylinder or disk that fits snugly into a hollow cylinder and moves back and forth to lift or pressurise fluid.
PVC	Polyvinyl Chloride; a type of plastic.
Roboscreen	Continuous slot screen for a tube well or used as a filter with a fine slot size and high open area to allow water to flow through
Specification	A detailed, exact statement that prescribes the materials, dimensions, and quality of work for something to be built, installed, or manufactured.
Suction pump	A pump for raising fluids by suction.
Tolerance	The allowable deviation from a specified value of a structural dimension, often expressed as a percent.
Tube-well	A water well or hole which is drilled in the ground and partially or fully lined for the abstraction of groundwater.
uPVC	Unplasticised Polyvinyl Chloride, a type of plastic.
VLOM	Village Level Operation and Maintenance) pumps

Introduction

Rural people need water not only for domestic uses such as drinking, washing, cooking, hygiene, and, sanitation. A wide range of other purposes are also important to their livelihoods. Productive uses, such as small-scale irrigation, livestock watering, post-harvest processing or micro-enterprises are also of value. Indigenous water supply systems normally cater for the multiple needs and are often multi-purpose. Quite often multiple sources are used to meet the demands requirements of different uses and users, e.g. rainwater harvesting combined with a handpump drawing ground water.

Most drinking water projects are designed to cater for domestic uses only. The provision of services is based on the availability of financial resources from the government, donor funded projects or NGOs. Many households are not willing to wait a long time for government services to arrive, so they decide to help themselves. Therefore many households decide to use a Self Supply approach whereby they upgrade their own water supplies. The family invests in water treatment, constructs wells or up-grades them, or collects rainwater. Usually the improvements to water supplies are incremental. The steps are easily replicable, with technologies affordable to users. Thus self supply at household level generally implies strong ownership. Low-cost pumps are often used in Self Supply.

With the emergence of Self Supply and its increasing acceptance, low-cost handpumps have a role to play. Twenty five years ago the emphasis was on completely enclosed pumps (for drinking water only) to avoid the contamination of the well. Over the last 10 years, cheaper and simpler pump designs have become more acceptable. This development has been strongly influenced by the general recognition of the self-supply approach.

This field note points out the strengths and limitations of a number of simple pumps.

Characteristics of low-cost pumps

As the name, "low cost pump" implies the relatively small investment lends these pumps to the purchase by individuals.

All low-cost pumps have several features in common:

- light weight and easy to transport
- easy to install.

The pumps described in this paper are generally family pumps which are designed to pump a few hundred litres of water a day from depths of less than 25 metres. In contrast community pumps serve 200 to 500 people and pump 4,000 to 10,000 litres per day from often more than 30 metres.

People often ask the question: "*Is the rope pump now a good pump or not?*" Unfortunately there is no definitive answer; neither "yes" nor "no". Low-cost pumps are a little bit like the weather: *"There is no bad weather; there is only the wrong clothing"*.

Many promoters of low-cost handpumps claim that their design can do all kind of marvellous things:

- There are promoters of rope pumps that will tell you that the pump can lift water in excess of 30 metres. In theory this is clearly true, and under controlled conditions this can be achieved. However, the practical normal working conditions are much less.
- Similarly the claim that low cost pumps can serve large user groups comes up quite often. Most pumps that are presented in this paper were not designed for large communities but for small families.

To use with the allegory related to cars; it is clearly understood that a Mini would break down soon if it had to carry a load of one ton, driven over gruelling terrain. The Landrover, however, could cope with this requirement. This similarity should be kept in mind when low-cost technologies are promoted. It is very important to consider the operating conditions carefully before a selecting a pump type.

Small Scale Irrigation

Drinking Water

Categorising low-cost pumps

Because of the lesser performance requirement, low-cost pumps can use readily available materials that do not need any sophisticated machining. The tolerances[1] that are required are quite lenient, thus these pumps can be produced with fewer skills and less investment into the production facilities.

Categorising by pump use

It is also possible to classify the low-cost pumps by the intended use that the designers had in mind when the pump was developed. Basically two different types of pumps are presently on the market:

1. Pumps **for small scale irrigation** and limited use for drinking water. These pumps were designed to have an ergonomically favourable operating position allowing prolonged use.
2. Pumps **for drinking water** and limited use for irrigating gardens. These pumps are designed to allow easy collection of water.

Categorising by method of pump production

There are three possible ways to produce low-cost pumps:

- **Do-it yourself:** building the pump by the owner, one-off handpump production using locally available materials and tools
- **Artisan workshop**: small scale production of handpumps in small workshops with few tools using locally available materials
- **Industrial production**: large scale production in local or foreign industrial units

Owner-built pumps

This production process is the traditional way of making a pump for personal use. It is clearly a self help approach. Generally this type of approach depends on the initiative by the owner to build a pump for his use. The person who decides to build his own pump needs technical know-how and access to tools and materials for building the pump. Thus, this approach can be supported and assistance can be given to the owner. Box 1 gives and an example of this process in Mali some years ago.

Box 1 Owner-built pumps in Mali

The catholic mission in Segou had a small workshop, equipped with the very basic tools to carry out some maintenance work. The workshop employed only a semi-skilled mechanic. In this workshop the "*Pompe Malienne*" was produced by farmers who lived around the area. The main purpose of the *Pompe Malienne* was to lift water for small scale irrigation; they were however also used for the provision of drinking water.

The design was an adaptation of the Pompe Sahorès, which was initially developed in France for village production. The technology used for manufacturing this pump was very straightforward and the final product was a crude handpump. All materials were indigenously available (PVC pipe, construction steel bars, wood, leather, and rubber from bicycle inner-tubes).

The pump was not specified by drawings. Materials were not defined by bills of quantities and there were no production manuals.

Production of the pumps took place as follows: the farmer came to the workshop and manufactured the pump by himself under the guidance and supervision of the workshop mechanic. The pump owner/producer bought the necessary materials and started to make the pump. The production process took about two days. This was possible because the design of the pump was so simple that no special skills were necessary for its production. No handling of machine tools or welding was necessary.

The results from this production processes were homespun pumps; each a single customised model, somewhat different from each other. None of the components were interchangeable.

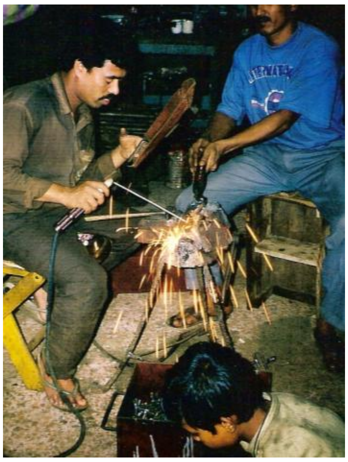
The performance of these homemade pumps was also quite restricted; they could be used for a maximum lift of about 12 metres. The cost of the pump was approximately US$ 60 (including the installation in a dug well).

The system of the owners producing their own pump worked well, especially since these pumps were in the true sense VLOM (Village Level Operation and Maintenance) pumps:

- Every owner himself had built his pump so he knew exactly how it worked and, in case of a breakdown, how to repair it.
- Because of the basic design, the pumps experienced frequent breakdowns during operation.
- Because of the multiple uses of the water, and the potential to gain some income from the pump, the owners fixed their pumps whenever necessary.

[1] See Glossary

Building pumps by the owner



Producing pumps in artisan workshops

Industrial Production of handpumps

The limitations of owner-built pumps:

- Distribution has to be limited to the vicinity of the workshop. The purchasers who make their own pump in the workshop cannot come from very far away. He needs to return to his house in the evening. In case of a repair that requires tools he does not have in his homestead, he has to go back to the workshop to borrow the tools.
- The system with the owner making and maintaining his own pump prevents community ownership. The Pompe Malienne, for example is not designed for heavy use. However, it is useful as a pump that lifts water for a single household and garden irrigation.
- The design needs to be constantly adapted to the changing materials available in the local markets.
- Because of the private ownership this type of pump is only feasible where groundwater is fairly shallow, abundantly available and can easily be accessed. It is only feasible where drilling of boreholes or digging of wells is easy and cheap. Such conditions often occur along rivers and in their deltas.
- Such pumps generally do not fulfil the World Health Organisation (WHO) hygienic standards as the wells and the pump are not sealed and can thus be easily contaminated. However, this is not such a problem when the pumps are used as household pumps and not as community pumps.
- In order to maintain continuity of such an approach the workshop and its management need to be available for the customers over a long time. The workshop needs to be maintained and furnished with other work as the pump production only in its own is not necessarily economically feasible. Such workshops will therefore not be in the private sector. Missions or other altruistic organisations might be the owner of such workshops, as they stay with the communities and guarantee availability in the long term. NGOs and development projects with rapidly changing management are not suitable for this approach.

Producing pumps in artisan workshops

Not every person can be expected to produce their own pump. Also it is not always appropriate as the designs of some pumps are too complicated for the manufacture by untrained persons. The low-cost pumps like the *Rope pump* or the *Canzee pump* are such examples.

The quality of the locally produced pumps needs to be considered carefully. At first glance, it appears that many small local workshops can easily produce low-cost pumps. However, no matter how simple the mechanism looks and how easy and cheap production processes are, these pumps are still complex machines. To produce an adequate product and provide a reliable service to the users, manufacturing of such pumps requires relatively high quality standards. Such quality levels can be achieved in well-managed workshops when the direct contact to the customer/user establishes a sense of accountability for the product.

As a first step, it is necessary to establish the technical feasibility and economic viability of the pump technology under the prevailing conditions. It is important to study the potential market carefully. Once the market has been established, it is crucial to keep in mind that launching a new product needs careful planning, strategic marketing and adequate time. Pilot projects to establish the low-cost pumps in a new market should concentrate on areas where a big potential is present, e.g. a high density of dug wells in the area.

Normally the artisanal workshops that could produce the pumps are in cities. In order to minimise transportation costs down, the potential area where the first pumps are used should be nearby. Once the technology has established itself, more remote areas can be targeted.

The selection of a partner for the production is important. It could be a small engineering plant. Street side workshops might not have technical or financial capacity to invest in developing a market for the product. Similarly, government-owned training schools might have the equipment for production but not the flexibility to engage in successful marketing.

In the long term, private sector producers have a crucial role to play in the development, manufacturing, promotion, and provision of pumps and services to users. Marketing of the product and its application (also for small-scale irrigation) has to be left to the producer and his sales organization. These low-cost pumps should be sold directly to the users. Bulk procurement by government or NGO projects is detrimental to the establishing of supply chains.

Financial and technical assistance should be designed carefully, so that it helps to introduce the technology. Once the pumps have become established, support from outside should be phased out. Procurement and supply mechanisms need to be adapted to enable users to select and purchase their handpumps themselves and take over full ownership.

Industrial Production of handpumps

High production volumes provide economies of scale that help to keep down the manufacturing costs. This results in low sales prices.

In the case of large scale production, the pumps are not produced one by one. Instead single components are manufactured in the factory or are purchased from an outside supplier and eventually assembled to an end product. This means that all components have to be according to specification, so that they are completely interchangeable and of uniform quality. The organised and managed production process requires that all components of the pump need to be clearly defined with drawings and material specifications. Production processes need to be defined and jig and fixtures are needed to achieve uniform quality. The components need to be checked for their dimensional accuracy and their material properties.

Each single component is manufactured and checked through a Quality Control System. In order to avoid rejects during the end inspection, the manufacturer has to check the production at all stages. It is necessary to keep records of the inspection. This Quality Control Management gives the manufacturer the advantage of being constantly informed about the quality of production and about the performance of personnel. The final inspection of all pumps is to be carried out by the manufacturer, including performance tests.

Such a production process can only be handled by manufacturers with the financial capacity, infrastructure of workshop as well as suitable machines and equipment. The manufacturer also requires personnel which has the necessary technical and administrative ability. Such suppliers depend on large orders from projects and government programmes.

Low-cost pumps on low-cost wells

Low-cost pumps only make sense in areas where the ground conditions allow the construction of low-cost wells. Very few users could pay for the construction of the well and the pump if the pump costs US$ 100 and the well or borehole costs US$ 2,000. In areas where low-cost pumps have been successfully used the drilling or digging is cheap. Bangladesh is a case in point where a pump might cost US$ 30 and the tube-well costs US$ 50.

A US$ 50 dollar pump on a US$ 10,000 well would be a clear mismatch.

Geological conditions that lend themselves for the use of low-cost pumps are:

- **For boreholes**: alluvial deposits in river deltas or with sand or clay underground materials, or
- **For dug wells:** firm overburden material and high water tables that allow easy digging.

Limitations of low-cost handpumps

The pumps that are presented in this paper are low-cost options. It should however be kept in mind that these pumps, because of the simple technologies used, have limitations.

All these pumps were designed as a family pump with the objectives to serve small user groups, thus the pumps are generally simple and cheap.

The conditions under which handpumps are used determine largely the selection of the type used. In general, the critical factors for selection are:

- Size of User Group
- Lift (Shallow or Deep Well Applications)
- Ground Water conditions (corrosion)

Operating Conditions

The number of users (or quantity of water pumped) and the pumping lift are the most important factors for the stress on a pump. Both of these factors increase the load on the pump exponentially. As a rule of thumb it can be said that:

Stress $\approx f[(\text{Nos. of users})^2 \times (\text{Pumping lift})^2]$

Corrosion resistance

In many countries the water is very aggressive. Under these conditions, handpumps that are not fully corrosion resistant are faced with serious corrosion problems.

User Preference

Users prefer pumps that have a high yield; they do not like pumps that have a small output and are hard to operate. This is even more important for pumps that are used for productive purposes with prolonged pumping times. The pumps need to be ergonomically right. Pumps that corrode, producing iron tainted water that tastes bad and stains food and clothing are generally not accepted. In addition, the look and feel of a pump can affect its acceptability. In some countries, socio-cultural non-acceptance of the pumping position when operating direct action pumps has proved an important factor in users' preference.

Pump Types and Details

The following section of this field note provides an overview of the application, technical details, materials used, installation and maintenance, manufacturing requirements and costs of several low cost pumps, including information on the numbers installed and locations.

Extra strength rope pump

Madagascar type rope pump

Vietnam type rope pump

Rope Pump

Application

A pump for drinking water but well suited for irrigation of family gardens.

The rope pump is also known as the **chain and washer pump** or **bomba de mecate**. The design was known in ancient China. The main features of this pump are (i) the wheel made of old tires and (ii) a rope loop with plastic pistons that fit into a PVC pipe. The rope pump is a household level pump for drinking water and small scale productive use in areas with water tables up to 30m. Despite the fact that the familiar model exposes sections of rope and pistons, when correctly installed on a sealed well, this pump delivers water of much better quality than do the traditional open wells.

Technical details

Pumping depth (Lift):	0 to 30m
Cylinder diameter:	28 mm to 42 mm, depending on depth
Piston:	Plastic pistons spaced at 1 m
Yield:	(75 watt input, at 5 m head) ~ 4.5 m^3/hour
Population served:	0.25 hectare
Type of well:	dug well or borehole

Materials used

The frame is welded from mild steel; The handle axle is a mild steel pipe (some design use bearings, either ball bearings or wooden bearings, other employ a steel bush; The pulley wheel is assembled by fitting the cut off sides of a tyre on a rim; The rope are made of Polyethylene, Polypropylene, or Polyamide fibres varying from Ø 4 to Ø 8 mm; The pistons are injection moulded plastic with no seal; The rising main are PVC pipes ranging from ND20 to ND50 (depending on lift); The guide box is made of concrete with a ceramic insert (some designs use cast in glass bottles; Screens are not used, only coarse filters.

Installation and Maintenance

The installation of the Rope pump is easy and does not need any lifting equipment or special tools. The pumps are generally installed in dug wells but also versions that fit into boreholes are available.

This pump has an excellent potential for maintenance by the users. All repairs can be done with few tools.

Manufacturing

The rope pump can be produced with locally available standard materials and local skills. Artisan workshop: small scale production of handpumps in small workshops with few tools using locally available materials

Costs

Approx US$ 100-200 excluding the borehole tube well (depending on installation depth, local material and labour costs)

Numbers

At least 35,000 rope pumps have been installed in Central America, and in many African and Asian countries several thousand have been installed.

Variations

Three models are sold for different populations. The familiar model is appropriate for single family use. The extra strength model is recommended for public service because it is of more robust assembly and parts and includes a metal cover to better protect water quality. In Madagascar a fully enclosed version is produced.

Treadle Pump

Steel pedals

Wooden Pedals

Concrete pump body

Treadle Pump

Application

A pump for small scale irrigation and only limited use for drinking water.

The treadle pump was developed as a simple foot operated pump for small scale irrigation. The pump is a suction pump in which the two pistons are activated via a pedal. The extended pedal acts as a counterpoise to push the piston back. The treadle pump is a simple and reliable pump with very few moving parts thus wear is reduced. It is easy to repair and maintain The stepping movement of the operator is ergonomically favourable and makes it easy to pump for prolonged periods, thus well suited for irrigation. The pump has limited use for drinking water as the spout is at ground level. Typically, Treadle pumps are installed in collapsible tube wells with the screen extending to the coarse sand aquifer.

Technical details

Pumping depth (Lift):	0 to 6 m
Cylinder dia:	3.5 inch and 5 inch
Stroke:	Variable
Yield:	(75 watt input, at 5 m head) ~ 4.5 m^3/hour
Population served:	0.25 hectare
Type of well:	collapsible tube well or dug well

Materials used

All components (or junction box): are made from mild steel; Piston-mild steel with plastic seal (cup Seal); foot valve-leather flap; rising main-PVC pipe or bamboo; various types of screens are used.

Installation and Maintenance

The installation of the Treadle pump is easy and does not need any lifting equipment or special tools. The drillers who sink the tube well with the sludger method also install the pump. This pump has an excellent potential for maintenance by the users. All repairs can be done without the use of tools.

Manufacturing

Artisan workshop: small scale production of handpumps in small workshops with few tools using locally available materials

Costs

Approx USD 100-200 including tube well (depending on installation depth and drilling method)

Numbers

About 2,000,000 treadle pumps were sold Bangladesh and about the same number in India


Money Maker Pump

Money Maker Pump

Application

A pump for small scale irrigation and limited use for drinking water.

The Money Maker pump is a further development of the treadle pump also intended as a foot operated pump for small scale irrigation. The Pump sucks the water to the cylinder, then pressurizes it, sending it through a crude sprinkler over the crop. It is easy to repair and maintain The stepping movement of the operator is ergonomically favourable and makes it easy to pump for prolonged periods, thus well suited for irrigation. Typically, Money Makers Treadle placed near a river or pond and a suction hose reaches into the source. The pump installation is not fixed and the pump can be moved around. The pump is not intended for drinking water use as it takes the unprotected water from ponds or rivers.

Technical details		Materials used
Pumping depth (Lift):	max 9 m	Pump cylinders: (or junction box): Pump Manifold: fabricated from 2.5mm steel sheet; Non-return Valves: two pairs of non-return valves, one on the inlet side of the pump and another on the outlet. The valve type is flapper type, made of circular rubber; Piston Assembly: Piston-mild steel with plastic seal (cup Seal); The piston assembly constitutes the piston rod made of 25mm x 6mm and 5.5mm thick rubber seals (cups); Treadles: are made of box section steel.
Cylinder dia:	121mm	
Stroke:	Variable about 120 mm	
Yield:	(75 watt input, at 5 m head) ~ 3 m^3/hour	
Population served:	0.1 hectare	
Type of well:	River or pond	

Installation and Maintenance

The installation of the Money Maker pump is easy and does not need any lifting equipment or special tools. This pump has an excellent potential for maintenance by the users. All repairs can be done without the use of tools.

Manufacturing

Industrial production: large scale production in local or foreign industrial units. The cast iron design required foundry equipment and skills

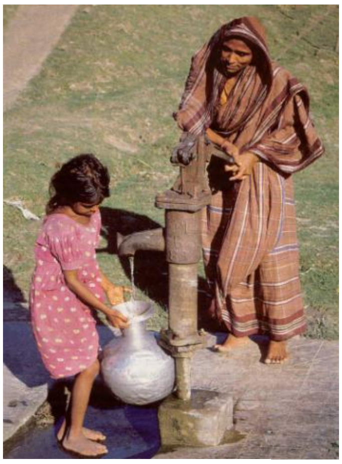
Costs

Approx USD 200 No tube-well cost for installations in rivers and ponds

Numbers

About 70,000 Money Makers were sold in Kenya, Tanzania, Zambia

No. 6 Pump Vietnam



No. 6 Pump Bangladesh

No. 6 Pump

Application

A pump for drinking water and limited use for irrigating gardens.

In the whole Indian subcontinent cast iron suction pumps were traditionally used for the provision of drinking water and small scale irrigation. The No 6 is a suction pump that is simple and robust. It is made almost entirely of cast iron. It has the advantage that all moving parts are above ground, which makes the pump easy to repair and maintain. Typically, No. 6 pumps are installed in collapsible tube wells with the screen extending to the coarse sand aquifer. The No. 6 pump is suitable for providing drinking water for a family or small community. It has a limited use for irrigation. The pump has no bearings, thus the wear is considerable when heavily used.

Technical details		Materials used
Pumping depth (Lift):	0 to 7 m	Pump head and handle are made from cast iron; Piston is welded mild steel with plastic seal (Cup Seal); Foot valve is a leather flap valve; Rising main is made from PVC pipe with top section made from galvanised steel pipe; Filter various designs (robo screens, brass mesh)
Cylinder dia:	89.0 mm	
Stroke:	215 mm	
Yield:	(75 watt input, at 5 m head) ~ 4.5 m^3/hour	
Population served:	50 to 100 people	
Type of well:	collapsible tube well or dug well	

Installation and Maintenance

The installation of the No. 6 pump is easy and does not need any lifting equipment or special tools. The drillers who sink the tube well with the sludger method also install the pump.

This pump has an excellent potential for maintenance by the users. Only two spanners are needed to repair plunger or foot valve.

Manufacturing

Industrial production: large scale production in local or foreign industrial units. The cast iron design required foundry equipment and skills

Costs

Approx USD 100-200 including tube well (depending on installation depth and drilling method)

Numbers

About 6 million No. 6 pumps are used as drinking water pumps in Bangladesh. Many derivatives are available throughout Asia.

Canzee Pump

Canzee Pump

Application

A pump for drinking water and limited use for irrigating gardens.

The Canzee pump is a direct action pump initially developed in New Zealand. It uses a simple pumping principle. It consists of two pipes, one slightly larger than the other. At the bottom of each pipe is a non-return valve. The pumping movement raises and lowers the inner pipe. The outer pipe remains still. When the inner pipe is raised it lifts the water contained within it. The atmospheric pressure pushes more water into the outer pipe. Each stroke lifts the water in the inner pipe to the top until it runs out through the spout. The pump is self-priming. A thin film of water between the two pipes ensures they do not touch: the pump lubricates itself. The Canzee pump is designed as family pump for serving user groups of about 100 to 150 people. It can be used for irrigation of family gardens. Like all direct action pump the operation is not ergonomically favourable, therefore prolonged pumping is not possible.

Technical details

Pumping depth (Lift):	0 to 10m
Cylinder dia:	28 mm to 42 mm, depending on depth
Stroke:	variable
Yield:	(75 watt input, at 5 m head) ~ 2.5 m^3/hour
Population served:	100
Type of well:	dug well or borehole

Materials used

The above-ground components (pump head and pump body) are designed for easy dismantling; the material is ABS, a material that is Ultra-Violet resistant.

The down hole components like rising main and pump rod pipes are made of standard uPVC pipes; The plunger and foot valves are machined from Polyamide; The only non-plastic components are the pump rod (stainless steel) the pump handle (local hardwood) and a number of bolts, nuts and washers (galvanized steel), which are not in direct contact with the water pumped, thus Pump is corrosion resistant.

Installation and Maintenance

The installation of the Canzee pump is easy and does not need any lifting equipment or special tools. The pumps are generally installed in dug wells or boreholes. This pump has an excellent potential for maintenance by the users. All repairs can be done with few tools. Only one spanner and one nail are required to dismantle the whole pump.

Manufacturing

Artisan workshop: small scale production of handpumps in small workshops with few tools using locally available materials. The Canzee Pump has been designed so that the majority of plastic materials used are readily available on the market and only few machining operations are needed for finishing the pump components. Therefore simple manufacturing equipment is required (small lathe machine and a number of tools and fixtures).

Costs

Approx USD 100-200 excluding the borehole tube well (depending on installation depth, local material and labour costs)

Numbers

About 500 – 1,000 Canzee pumps have been installed in Madagascar. Canzee pumps have also been used in Kenya, Tanzania, Zimbabwe and Angola.


EMAS Flexi Pump

EMAS Flexi Pump

<table>
<tr><th colspan="2">Application</th></tr>
<tr><td colspan="2">A pump for drinking water and limited use for irrigating gardens.

The EMAS Flexi-pump is a direct action pump initially developed in Bolivia. It uses a simple pumping principle. It consists of two PE-pipes (diameter approx. 5 cm) put into one another, one slightly larger than the other. At the bottom of each pipe is a non-return valve (glass ball). A metal pipe with a T-fitting serves as handle of the pump. One side of the T has a blind nipple and the other has a discharge nipple with elbow downward. A hose can be attached to this outlet so that water can be transported away from the pump up to 300m. The pumping movement raises and lowers the inner pipe. The outer pipe remains still. When the inner pipe is raised it lifts the water contained within it. Each stroke lifts the water in the inner pipe to the top until it runs out through the T-handle. The pump is self-priming. The EMAS Flexi pump is less resistant to very intensive use and mistreatment than metal pumps. It is designed as family pump for serving user groups of about 20 to 50 people. It can be used for irrigation of family gardens. Like all direct action pump the operation is not ergonomically favourable, therefore prolonged pumping is not possible.</td></tr>
<tr><th>Technical details</th><th>Materials used</th></tr>
<tr><td>Pumping depth (Lift): up to 20m lift and a further 20m
Cylinder dia: 28 mm to 42 mm, depending on depth
Stroke: variable
Yield: (75 watt input, at 5 m head) ~ 2.5 m³/hour
Population served: 20-50
Type of well: dug well or borehole</td><td>All components are made from commercially available materials, using two (glass) marbles, simple PVC pipes, thread adapters and (galvanized) iron pipe, available in any hardware store.</td></tr>
<tr><th colspan="2">Installation and Maintenance</th></tr>
<tr><td colspan="2">The installation of the EMAS Flexi pump is easy and does not need any lifting equipment or special tools. The pumps are generally installed in boreholes drilled with the EMAS-Concept of drilling.

Can be built and repaired by users themselves. Very cheap (less than one tenth of a rope pump in Nicaragua)</td></tr>
<tr><th colspan="2">Manufacturing</th></tr>
<tr><td colspan="2">Rural people are easily taught to build their own, Having built their own pump, people are able to maintain it forever. Only basic hand tools required.

The building of a pump takes approx. 3 hours and costs for materials are approx. USD 20 for a 10 meter pump.</td></tr>
<tr><th colspan="2">Costs</th></tr>
<tr><td colspan="2">Approx USD 20 -30 excluding the borehole tube well (depending on installation depth, local material and labour costs)</td></tr>
<tr><th colspan="2">Numbers</th></tr>
<tr><td colspan="2">Some 20,000 EMAS pumps are in use in Bolivia and some 10,000 in Brazil. It is used in Peru, Equator and Nicaragua. In Asia and Africa, hundreds are in use.</td></tr>
</table>

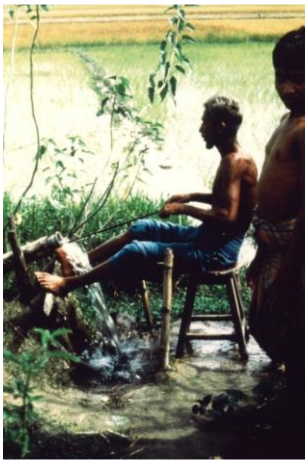

Tara Pump

Tara Pump

Application
A pump for drinking water and limited use for irrigating gardens. The Tara is a direct action pump initially developed in Bangladesh as a measure to counteract the dropping water table that exceeded the range for suction pumps. The Tara Direct Action is one of the most successful medium lifts pumps. Is has been included into the Indian standards. The pump is fully corrosion resistant since all underground parts are made of non-corrosive materials like PVC or stainless steel. Tara pumps are designed for lifting water from bore wells with static water level not exceeding 15 m. The hermetically sealed pump rod, of a relatively large diameter, is buoyant. It displaces water in both the upward and downward stroke and the buoyancy of the pump rod makes pumping operation easy. It is designed as family pump for serving user groups of about 20 to 100 people. It can be used for irrigation of family gardens. Like all direct action pump the operation is not ergonomically favourable, therefore prolonged pumping is not possible

Technical details		**Materials used**
Pumping depth (Lift):	up to 15m lift	The down hole components like rising main and pump rod pipes are made of standard up pipes; the pump rod is buoyant. The plunger and foot valves are injection moulded plastic; The only non-plastic components are made of stainless steel, thus the pump is corrosion resistant.
Cylinder dia:	50 mm	
Stroke:	variable	
Yield:	(75 watt input, at 5 m head) ~ 3 m^3/hour	
Population served:	20-100	
Type of well:	bore well drilled with Sludger Method	

Installation and Maintenance
The direct action handpump is designed for easy installation. No lifting equipment or special tools are needed. The pumps are generally installed in collapsible boreholes drilled with the sludger method.
Manufacturing
Industrial production: large scale production in local industrial units. The plastic moulding requires specific equipment and skills.
Costs
Approx USD 100 excluding the borehole tube well (depending on installation depth, local material and labour costs).
Numbers
These pumps are used very extensively in India , Bangladesh, Laos, other parts of East Asia and Africa



Rower Pump

Rower Pump

Application	
A pump for small scale irrigation and limited use for drinking. The Rower pump was developed as a simple manually operated pump for small scale irrigation. The Rower Pump is a suction pump in which the piston is directly activated. A surge chamber (an air vessel just downstream of the foot valve, makes the pumping operation is smoother). It is a simple and reliable pump with very few moving parts thus wear is reduced. It is easy to repair and maintain The sitting position of the operator is ergonomically favourable and makes it easy to pump for prolonged periods, thus well suited for irrigation. The pump has limited use for drinking water as the spout is relatively low. Typically, Rower Pumps are installed in collapsible tube wells with the screen extending to the coarse sand aquifer.	
Technical details	**Materials used**
Pumping depth (Lift): 0 to 8 m Cylinder dia: 54.4 mm Stroke: Variable Yield: (75 watt input, at 5 m head) ~ 4.5 m^3/hour Population served: 0.1 hectare or 50 to 100 people Type of well: collapsible tube well or dug well	All components are made from plastic; Surge chamber-blow moulded plastic, plunger and foot valve have rubber flap valves; rising main-PVC pipe with a Robo screen filter.
Installation and Maintenance	
The installation of the Rower 6 pump is easy and does not need any lifting equipment or special tools. The drillers who sink the tube well with the sludger method also install the pump. This pump has an excellent potential for maintenance by the users. All repairs can be done without the use of tools.	
Manufacturing	
Industrial production: large scale production in local or foreign industrial units. The cast iron design required foundry equipment and skills.	
Costs	
Approx USD 100-200 including tube well (depending on installation depth and drilling method).	
Numbers	
About 200,000 pumps have been made in Bangladesh.	

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About the author

Erich Baumann is an internationally recognized technical expert in the field of rural water supply with 30 year of experience in Rural Water Supply. His expertise includes institution building, contract management, supply chains and procurement procedures, operation and maintenance systems and community management, cost recovery concepts, private sector participation, financial issues, and capacity building and training.

Erich Baumann headed the secretariat of RWSN (formerly the Handpump Technology Network HTN) from 1992 to 2008. He was instrumental in establishing the network in supply chains, low cost drilling, self-supply household solutions, handpump research and development, capacity building in local production, technology transfer, quality control and quality assurance, and training.

He has initiated the preparation and publication of the RWSN handpump standard specifications such as Afridev, India MKII/III, and Walimi pumps.

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