

# Smart Water Solutions

Examples of innovative, low-cost technologies for wells, pumps, storage, irrigation and water treatment





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The first edition of this booklet was drafted as a contribution to the Third World Water Forum in Kyoto in March 2003 in a collaborative action of Netherlands Water Partnership, Partners for Water, PRACTICA, IRC, SIMAVI and AGROMISA. The second edition was financially supported by NCDO, Aqua for All and PRACTICA Foundation.

This third edition has been published in English, Spanish, French and Portuguese on the occasion of the Fourth World Water Forum in Mexico, and has been financially supported by Partners for Water, a programme that aims at strengthening the international position of the Dutch water sector by uniting forces (Companies, Departments, NGOs and Knowledge institutes).

Partners for Water operates under the auspices of the EVD Dutch Agency for International Business and Cooperation and NWP Netherlands Water Partnership. More information: [www.partnersforwater.nl](http://www.partnersforwater.nl)"



## Collaboration

Since the World Water Forum 2003 in Kyoto the interest in small-scale low-cost water technologies has increased and now revised versions are being published in various languages (English, Spanish, French and Portuguese). The publication is a collaborative effort by eight organisations:



**NWP**, the Netherlands Water Partnership, is an independent organisation formed by government bodies, NGOs, knowledge institutes and businesses involved in the water sector.

The main aim of the NWP is to harmonise initiatives of the Dutch water sector and worldwide promotion of Dutch water expertise. [www.nwp.nl](http://www.nwp.nl)

## PRACTICA

The **PRACTICA Foundation** facilitates the exchange of knowledge on, and the development of, innovative and low-cost water technologies. [www.practicafoundation.nl](http://www.practicafoundation.nl)



**IRC** International Water and Sanitation Centre provides news, advice, research and training on pro-poor sustainable water supply, sanitation and hygiene behaviour in developing countries. [www.irc.nl](http://www.irc.nl)



**SIMAVI** funds healthcare initiatives in developing countries with a focus on water and sanitation activities. [www.simavi.org](http://www.simavi.org)



**AGROMISA** provides information and publications on small-scale and sustainable agriculture in the tropics. [www.agromisa.org](http://www.agromisa.org)



**NCDO** is an independent Dutch organisation working to increase public support for international cooperation and the achievement of the Millennium Development Goals. [www.ncdo.nl](http://www.ncdo.nl)



**AQUA FOR ALL (A4A)** foundation supports water and sanitation projects for the poor with funds and knowledge from the Dutch public water sector. [www.aquaforall.nl](http://www.aquaforall.nl)



**PARTNERS for WATER** is a joint effort of five Dutch ministries to increase the effect of Dutch expertise in sustainable integrated water resources management internationally. [www.partnersforwater.nl](http://www.partnersforwater.nl)

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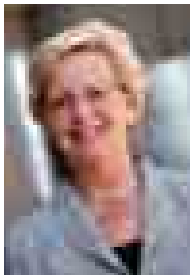
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Scepticism about achieving essential development goals and fighting poverty is fading away. Since the Millennium Development Summit in 2000, when 189 heads of state declared their full commitment to achieving the eight Millennium Development Goals (MDGs), the world has had an unprecedented opportunity to improve the living conditions of billions of people in rural and urban areas. MDG 7 is particularly relevant to this booklet. Target 10 of that goal is to halve the proportion of people without sustainable access to safe drinking water and improved sanitation by 2015. The Netherlands is ready to take concrete steps in this field and that is why I pledged in 2005 to contribute towards providing access to safe drinking water and sanitation for at least fifty million people by 2015.

The time for lengthy discussions is over. Now it is time for action. Political will, increased resources, affordable technologies and new partnerships are in place to increase access to safe drinking water and sanitation. We must realise, however, that most water facilities used by households or operated by small-scale enterprises were built without external support. This shows there are alternatives to the large centralised conventional systems. More importantly, small-scale solutions have proven to be cost effective. Implemented in large numbers, they can boost health, improve agricultural production and generate local business all at the same time. That is why large-scale dissemination of these technologies is crucial. Smart technologies like this help us to tackle poverty immediately. Capacity building in both software and hardware is equally important to success – not only for users and institutions, but also for small and medium-sized enterprises.

This booklet on water, like its counterpart Smart Sanitation Solutions, gives examples of innovations such as the use of sunlight to purify water, effective low-cost water filters, low-cost drip irrigation and locally produced hand pumps that are five times cheaper than imported pumps. By using these technologies, poor rural families can double or even triple their annual income. The technologies described are a source of inspiration.



*Finally, I would like to express my hope that sharing this information will bring "Water for All" closer to reality!*

A handwritten signature in blue ink, appearing to read 'Agnes van Ardenne'. The signature is stylized and written over a light blue background.

Agnes van Ardenne  
Minister for Development Cooperation  
The Netherlands

## For water supply and poverty alleviation, technology can make a difference

One of the obstacles to reach the millennium development goals for water supply and poverty reduction lies in the wrong technology choice, i.e. in the application of technologies unfit for the purpose. Some basic considerations are:

- Large-scale piped water systems, central water treatment systems, dams, irrigation systems, often have severe management problems.
- Low-cost options applied on a big scale face less problems, as operation and maintenance is the responsibility of the users. (New low-cost technologies are different from most so called “Appropriate Technologies”, which often failed in the past)
- Productive use of water at family level can play an important role in reducing poverty and deserves more attention.
- To produce, deliver and maintain sustainable systems for water supply, involvement of the local private sector is crucial.

### Reducing maintenance problems of hand pumps

The VLOM approach (Village Level Operation and Maintenance) reduced maintenance problems with hand pumps for rural water supply, but many of the hand pumps in Africa still remain out of order. Among other reasons, this is due to the high cost of (imported) spare parts and limited local expertise. Experiences in Latin America and Africa indicate that many of the maintenance problems can be solved by using technologies that can be produced and managed with local skills and materials.

#### The rope pump case

In Nicaragua 50,000 rope pumps have been installed since 1990. The shift from imported piston pumps to locally produced rope pumps has doubled rural water supply coverage in Nicaragua in less than 10 years. Breakdowns have decreased as users can do maintenance and repair themselves; over 90% of the rope pumps remain in operation on both communal and domestic wells.

### Reducing cost of wells

Water wells can be constructed by hand digging, hand drilling or motor drilling. Manual drilling of a tube well is cheaper and safer than making a bigger hole by hand, but using augers or bailer systems has been limited to soft soil formations. New developments are the Rota-sludge and the Stone-hammer methods, which penetrate in mediumhard soil formations. In Tanzania, 25 m- deep 4-inch wells are drilled in 2-3 days with the Rota-sludge method at a cost of around US\$ 350.

### Reducing cost of water treatment at household level

New options to treat water at the household level include solar disinfection, flocculants and Ceramic filters. These filters have elements of different shapes



(candle, disc, pot) often treated with colloidal silver. Changing from candle to pot-shaped filter elements in Nicaragua resulted in fewer problems in production and maintenance. Some 150,000 filters of this type are currently in use, in Nicaragua, Cambodia and Ghana. The cost of safe drinking water with this option is between US\$ 0.5 and 1 per person per year. Profit-based local production and sales guarantee sustainability.

### Water to alleviate poverty

Low-cost well drilling and pumps can reduce the cost of communal systems and also make water systems affordable at household level. In the past there were hardly any deep-well pump options that were affordable for poorer families. Now there is a range of pumps from US\$ 10 – 180 for wells of 10 to 90 m deep.

#### Money maker

In East Africa a treadle pump model for small-scale irrigation is called “Money maker”. It costs US\$ 60 and generates US\$ 200-500 per year net income. Around 35,000 families are using this pump at present.

### Efficiency of investments in water technology

Investments in development, training and marketing of the “right” low-cost technologies, can be highly cost-effective. Some examples:

Product	Input, US\$	Output/Year US\$
<b>Treadle pumps</b> Bangladesh 1 million installed	7 million	100 million *
<b>Rope pumps</b> Nicaragua 50,000 installed	1 million	10 million
<b>Fuel-efficient pumps</b> India Around 3,000 in use	0.1 million	1.25 million sales
<b>Latrines</b> Bangladesh 6000 private workshops produce over 1 million per year.	10 million	8 million * savings in health

\*Poverty alleviation as a business” [www.intercoop.ch/sed/product/heierli/main.html](http://www.intercoop.ch/sed/product/heierli/main.html)

### Private sector development for sustainable poverty alleviation

Successes described in this booklet have in common that the technologies are produced and sold by the private sector using local skills and materials. Development aid triggered this, by assisting in product development and promotion. Local workshops and suppliers were stimulated, jobs created and sustainability secured. Concluding it can be stated that the right technology choice, and the involvement of the local private sector is essential to reach the Millennium goals for water supply and poverty alleviation.



In Santa Cruz, Bolivia, poor rural families want their own well and are willing to pay for it. The organisation that trains people to drill low cost wells cannot cope with the demand.

Traditional wells are big and dug by hand. To reduce cost, smaller wells (boreholes) can be constructed using manual drilling techniques like augers, bailers or other techniques. For instance, millions of US\$ 10 boreholes for irrigation have been made in India with the hand-sludge method. In sandy soils wells can be made with augers.

In Bolivia both the Baptist and EMAS drilling methods are used. In Santa Cruz, families that want a well, form a "water club" and take turns to assist the well-driller. In this way, it takes 2-5 days to drill a well and install a pump. Families pay for their own water systems; demand for the Baptist wells is still growing.

With the Baptist drilling technique, clay and sand layers can be penetrated to depths of 60 m or more. With the EMAS method, wells of 90 m deep have been formed.

## Information:

Indian hand sludge:	<a href="http://www.hrwallingford.co.uk">www.hrwallingford.co.uk</a>
EMAS:	<a href="http://www.emas-international.de">www.emas-international.de</a>
Baptist:	<a href="http://www.geocities.com/hzoclubs">www.geocities.com/hzoclubs</a>

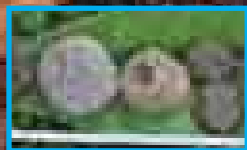
**Numbers:** 20,000 in Bolivia, 5,000 in Nicaragua, Honduras and other countries.

**Cost of wells:** US\$ 40\* for 20 m deep well, incl. casing.

**Cost of introduction:** Variable, US\$ 2,000-5,000 per project, including hands-on training, drawings and drill set.

\* Cost of BAPTIST wells in Bolivia.

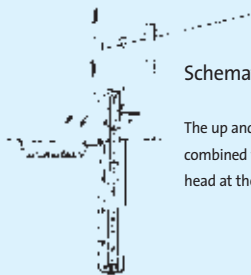
◀ **Santa Cruz, Bolivia. Drilling of a 30 m deep well in 3 days, using the Baptist method.**



"Last year, digging a well by hand in this hard soil took 20 days. With the Rota-sludge we made a well in just 3 days".

*Andres Meza, well driller in Nicaragua.*

The Rota-sludge method is an adaptation of the Indian hand sludge method. The hardened drill bit is turned 90 degrees during drilling thus chiselling the bottom of the hole. This technology can be used to drill 2-5 inch wells in layers with sand, clay, gravel, tuff stone or weathered rock.



Schematic drawing of Rota-sludge

The up and down movement of the drilling tube is combined with a rotating movement of the drill-head at the moment of touching the bottom.

## Information:

[www.practicafoundation.nl](http://www.practicafoundation.nl)

[www.rwsn.org](http://www.rwsn.org) (general information on well drilling)

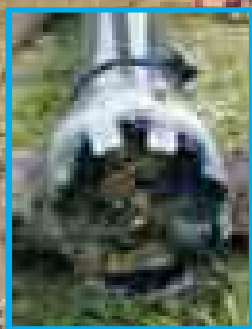
**Cost of wells: (20 m)** US\$ 30 India.  
US\$ 80 - 400 Nicaragua.

**Cost of introduction:** Variable US\$ 5,000 - 20,000 per project, including hands-on training, drill set and drilling of test wells.

## ◀ Drilling a 20 m deep well in Chinandega, Nicaragua, with the Rota-sludge method.

*Insert left:* Rota-sludge drilling head.

*Insert right:* Stones extracted with Rota-sludge.



**"The Stone-hammer is slow but does not give us the headache of the cost and maintenance of motorized drilling rigs".**

*A. Fajardo, Director of the Nicaraguan NGO Cesade .*

The previous drilling methods are not suitable for hard soil formations, so ongoing development led to the Stone-hammer. This method consists of a heavy hammer hitting directly on a hollow drill-head. Although it does not penetrate very hard stone such as basalt, it is a tougher option than the Rota-sludge method. This technology is being refined further in India and Nicaragua.

The Stone-hammer method has won a competition for innovative irrigation technologies organized by the World Bank, Winrock and IDE (International Development Enterprises).

## Information:

[www.worldbank.org](http://www.worldbank.org)

[www.practicafoundation.nl](http://www.practicafoundation.nl)

## Capacity:

2-5 inch wells to 40 m.

## Cost:

20-60% less than hand dug wells.

## Cost of introduction:

Variable US\$ 15,000 - 30,000 per project, including: production drill set, drawings, hands-on training, first wells.

## ◀ The Stone-hammer in India, drilling a 20 m deep well in a stony layer.

*Insert:* Drill-head Stone-hammer.





**“The fuel consumption of irrigation pumps was decreased by 40% through the use of improved bamboo screens”.**

*F. v. Steenbergen, Arcadis / Euroconsult.*

Small-scale irrigation in India usually involves the use of diesel or electric-powered suction pumps, drawing water from water tables down to 7 m deep. The India-North Bengal Terai Development Project carried out pump energy analysis, which showed that tube well screens excessively restricted water flow, resulting in low overall pumping efficiency. Improving these screens resulted in a reduction of fuel consumption of over 40%. Since publication of this innovation, thousands of wells have been fitted with the new screens, with benefits for the profitability of farming and for reducing CO<sub>2</sub> emissions.

## Information:

[www.practicafoundation.nl](http://www.practicafoundation.nl)

[www.teriin.org](http://www.teriin.org)

(In 2002, TERI published a book on the subject, entitled *Technology innovation and promotion in practice: pumps, channels and wells.*)

## Numbers:

3,000 in India.

## Yield:

15 Litres/sec (3 inch well, length of screen 4 m).

## Initial cost:

New screen is 20% of the cost of conventional model.

## Application:

Mainly irrigation.

## ◀ Low-cost bamboo screens that improve pumping efficiency.

*Insert:* 4-m-long bamboo screen.



**One million treadle pumps generate US\$ 100 million per year.**

The treadle pump for irrigation was developed in the late 1970's in Bangladesh. After wide-scale promotion by IDE International Development Enterprise, they are now being produced in 300 local workshops and used by more than one million poor rural families that otherwise could not have afforded an irrigation pump. With this technology, many families have increased their income. Some farmers who started with this pedal pump have now bought a motorized pump.

The treadle pump is cost effective; it cost US\$ 20 in Bangladesh and generates US\$ 100 or more per year. Together, these pumps add over US\$ 100 million every year to the GNP of Bangladesh. Production and sales are now sustainable without any external aid.

The treadle pump is also being promoted in Africa where it is installed by organisations like Kickstart (former Approtec) and EW Enterprise Works. Models of the treadle pump like the Moneymaker and the Soka-pump are now widely used for small-scale "spray" irrigation.

## Information:

Asia	<a href="http://www.ideorg.org">www.ideorg.org</a>
Africa	<a href="http://www.fao.org/iptrid">www.fao.org/iptrid</a>
East Africa	<a href="http://www.kickstart.org">www.kickstart.org</a>
East and West Africa	<a href="http://www.enterpriseworks.org">www.enterpriseworks.org</a>

<b>Numbers:</b>	1.3 million in Asia, 35,000 in Eastern Africa.
<b>Yield:</b>	100 litres/min (from 4 m deep).
<b>Initial cost:</b>	US\$ 20 in Bangladesh. US\$ 50 – 80 in Africa.
<b>Cost of introduction:</b>	Variable. US\$ 20,000 per project, including training, engineering and first production.
<b>Application:</b>	Mainly irrigation from wells 1-7 m deep.

## ◀ The bamboo version of the treadle pump used in Bangladesh.

*Insert:* The "Moneymaker" used for vegetable irrigation generating US\$ 200 – 500 additional income per year.



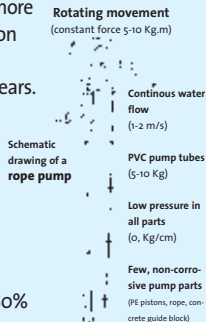
**“The shift from piston pumps to rope pumps has doubled rural water supply coverage in Nicaragua in less than ten years”.**

*Henk Holtslag, technical adviser in low-cost water technologies.*

For wells down to 35 m, rope pumps are often 5 times cheaper and more sustainable than piston pumps. Evaluations show that rope pumps on communal wells are being maintained by the users, if introduced properly. 90% Of rope pumps remain operational, even after many years. Because of its low cost, the pump is also popular for domestic use.

A survey among 5,025 rural families in Nicaragua indicates that a rope pump increases income, even if used for domestic purposes only. Families with a pump earn US\$ 220 per year more than families without a pump. In Nicaragua the pumps are now being produced commercially by 20 workshops.

Different models of Rope pumps were introduced in Africa. This introduction has not always been successful: in some projects over 80% of the pumps do *NOT* work! However, with the “right” models and the “right” user training, also 90 % remain in operation in Africa, as the Victory model in Ghana and the Elephant model in Zimbabwe have proved.



## Information:

Evaluations

[www.irc.nl](http://www.irc.nl)

Africa

[www.pumpaid.org](http://www.pumpaid.org)

General

[www.ropepump.com](http://www.ropepump.com), [www.ropepumps.org](http://www.ropepumps.org)

## Numbers:

50,000 in Nicaragua, 20,000 in Mexico, Guatemala, Honduras, Ghana, Zimbabwe, Tanzania, Senegal.

## Yield:

40 litres/min from 10 m depth.

## Range of depth:

1-35 m (60 m with 2 cranks).

## Application:

Communal wells, households, irrigation.

## Initial cost:

US\$ 20 – 120 depending on model.

## Cost of introduction:

US\$ 10,000 - 20,000 per project, including 20 pumps, engineering and hands-on training. US\$ 60,000 - 100,000 per project, including 1,000 pumps, production workshop and hands-on training.

## ◀ Rope pump (Victory model) on a hand-dug of 20 m deep well, made in a local workshop in northern Ghana.

*Insert:*

Rope pump (Model AB for boreholes) Minimum borehole diameter 2”.



**“A complete domestic water system costs US\$ 90, including a 15 m deep well, a PVC pump and a water tank in the kitchen”.**

*Wolfgang Buchner: Escuela Movil Agua y Sanamiento, Bolivia.*

Most direct action pumps such as the Blair pump are not fit to pump water higher than a few meters above ground level. New models such as the EMAS pump can pump up water to tanks as high as 30 m. These pumps are very popular for domestic use, as shown by 20,000 water systems in Bolivia.

The pumps are made from local available PVC tubing and the valves are made with marbles. PVC pumps are used in Malawi and Brazil and many other countries in combination with water storage tanks.

## Deepwell pumps

In general handpumps for rural water supply are piston pumps such as Indian MarkII, Afridef, Volanta, Nira and others. Information on these pumps can be found on the website [www.rwsn.org](http://www.rwsn.org). New developments can be seen at [www.handpumps.org](http://www.handpumps.org) and [www.watsan.org](http://www.watsan.org).

### Information:

EMAS:	<a href="http://www.emas-international.de">www.emas-international.de</a>
Baptist:	<a href="http://www.geocities.com/h2oclubs">www.geocities.com/h2oclubs</a>
Deepwell pumps:	<a href="http://www.rwsn.org">www.rwsn.org</a> <a href="http://www.handpumps.org">www.handpumps.org</a> <a href="http://www.watsan.org">www.watsan.org</a>

<b>Numbers:</b>	20,000 in Bolivia, hundreds in Malawi.
<b>Yield:</b>	25 l/min (10 m well).
<b>Range of depth:</b>	2 - 90 m.
<b>Costs, Baptist:</b>	US\$ 2 / m, incl. drilling, casing and pump.
EMAS	US\$ 6/ m, incl. drilling, casing, pump, installation tubing, storage tank in kitchen.
<b>Cost of introduction:</b>	US\$ 1,500 - 2,000 2 week hands-on training in Bolivia.
Baptist	

## ◀ EMAS type pump produced and used in Malawi.

*Insert:* Filling up a 6 m-high-tank.





**“Improved motor pumps of 2.5 HP yield as much water as traditional 5 HP pumps, for half the fuel consumption”.**

*Gert Jan Bom, technical advisor in India-Terai project.*

In India there are more than 6 million diesel pumps. The efficiency of these pumps was investigated as part of the India-Terai development project. Technical adaptation resulted in a smaller engine that consumes 50% less fuel and is easier to transport. Improved motor pumps of 2.5 HP could yield as much water as traditional 5 HP pumps. Local industry has started to produce these new pumps.

Proper pump selection reduces fuel consumption and new cost-efficient irrigation pumps are available in countries such as China and India.

Chinese 4HP diesel pumps can irrigate 5 ha up to heads of 6 m, consuming 0.45 litres of fuel an hour. Chinese petrol pumps of 1.5 HP pump 3 litres per second and consume less than 0.3 litres of gasoline per hour.

## Information:

[www.hipponet.nl](http://www.hipponet.nl)

[www.terrin.org](http://www.terrin.org)

See also TERI publication *Technology innovation and promotion in practice: pumps, channels and wells*.

## Numbers:

Approx. 3,000 Improved diesel pumps in India.

Approx. 30,000 1.5 HP petrol pumps in China.

## Yield:

4 HP set 20-30 l/s. 1.5 HP pump-set 2-4 l/s.

## Initial cost: (off-factory)

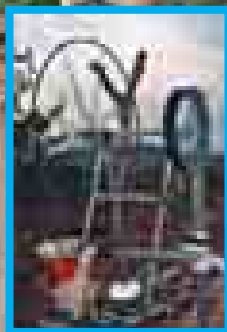
4 HP diesel pump US\$ 400.

1.5 HP petrol pump US\$ 75.

## ◀ Transporting the improved pump that weights 50% less than the conventional model.

*Insert left:* Right, conventional model.  
Left, improved model.

*Insert right:* Fuel efficient 1.5 HP Chinese petrol pump.



**Costs of motorized water pumping from deep wells reduced from US\$ 800 to US\$ 450.**

Most common diesel and petrol pumps are suction pumps that can pump from shallow wells down to 7 m. deep. Pumping from deeper wells requires generator pump sets or long-shaft diesel pumps costing US\$ 800 or more. Where there is electricity, submersible pumps can be used but many small farmers do not have electricity.

Motorised rope pumps can pump from deep wells. This model combines a rope pump with an electric motor or petrol engine. Pump parts and other elements of the structure can be produced in local workshops, the engines are often imported.

If combined with a locally available small petrol engine the cost of a motorised deep-well pump can be US\$ 450. This is far cheaper than long-shaft diesel pumps or submersible pumps and this cost can even be less when Chinese engines are used.

Similar to hand rope pumps, the pump part can be maintained and repaired by the users. The motorised rope pump is being tested in Columbia and Nicaragua.

## Information:

[www.practicafoundation.nl](http://www.practicafoundation.nl)

[www.ropepumps.org](http://www.ropepumps.org)

<b>Yield:</b>	120 – 150 Litres/min (10 m). 60 Litres/min (20 m).
<b>Range of depth:</b>	1 - 60 m.
<b>Initial cost:</b>	Around US\$ 350.

## ◀ Electric rope pump lifting water from a 25 m well.

*Insert:* Rope pump powered by a 1.5 HP engine on 20-m deep well with option to lift water another 5 m.



**“A horse-powered pump can lift 60 litres per minute from a depth of 20 m”.**  
*Luis Roman, rope pump factory AMEC. Nicaragua.*

Renewable energy sources such as animal power and wind power can be used to extract water from wells.

## Wind powered pumps

In several countries, low-cost windmills are used to power piston pumps. Examples include the Miramar mills in Peru, the Poldaw mills in Africa and Baptist mills in Bolivia.

In Nicaragua, windmills are combined with a rope pump. The wind rope pump has features of a modern wind pump of Dutch design (CWD 2000) and there are 300 units installed in Nicaragua, produced locally and maintained by the users. They are used for cattle watering, domestic water supply and irrigation. A recent survey indicates that the investment in a wind rope pump for irrigation can be recovered within 2-3 years.

## Rural electricity

As an option, wind rope pumps can be combined with a permanent magnet generator to charge batteries for a few light bulbs and a television. There are also small wind generators based on the design of the wind rope pump.

### Information:

[www.ropepumps.org](http://www.ropepumps.org)

[www.arrakis.nl](http://www.arrakis.nl)

[www.gamos.org](http://www.gamos.org)

**Yield:** Horse rope pump: 120 litres/min (10 m head).

Wind rope pump: 60 litres/min (10 m head).

**Costs:** Horse rope pump: US\$ 350.

(AMEC, Nicaragua) Wind rope pump: US\$ 450 - 800.

## ◀ Wind powered rope pump in Nicaragua used for irrigation of 1 ha of fruit trees and vegetables.

*Insert:* Horse-powered rope pump on a 20 m deep well.

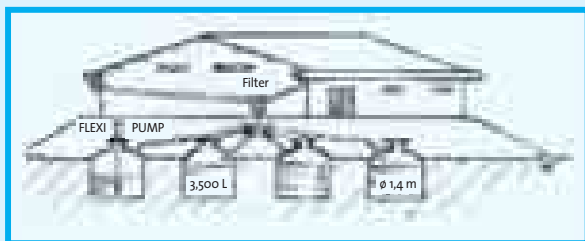


**EMAS underground water storage costs one bag of cement per cubic metre.**

Where access to groundwater is limited, rainwater harvesting in underground tanks can be an effective and low-cost solution. Water stored in the rainy season can be used in the dry season and lifted from the tank with a rope pump or with a Flexi-Emas pump (see [PVC pumps](#)), which can elevate water up to 30 m.

The government, with support from organisations such as UNICEF and IRCSA (International Rainwater Catchment Systems Association) started a programme to construct one million rainwatertanks in Brazil.

Practica foundation is testing various options for low-cost storage and groundwater recharge like the “Reed cement tank” and the “Tube recharge”.



## Information:

General:	<a href="http://www.rainwaterharvesting.org">www.rainwaterharvesting.org</a> <a href="http://www.unep.or.jp">www.unep.or.jp</a> <a href="http://www.rainfoundation.org">www.rainfoundation.org</a>
Recharge:	<a href="http://www.practicafoundation.nl">www.practicafoundation.nl</a>
Storage:	<a href="http://www.emas-international.de">www.emas-international.de</a>

**Capacity tanks:** 3500 litre each (example).

## Cost:

EMAS tanks (Material) Sand and four 50 kg bags of cement for each tank.





**Farmers construct 60 m<sup>3</sup> tanks in 3 days, using stones, cement and steel wire.**

Nowadays, most storage tanks have a cylindrical shape, which is much stronger and uses less material than square or rectangular tanks. In Nicaragua short “hands-on” training courses teach users how to make their own storage tank for irrigation.

Bricks are used to make smaller tanks of 0.5-3 m<sup>3</sup> and natural stones are used for tanks of 3 to 120 m<sup>3</sup>. The construction starts by laying 2 PVC tubes on the ground (for the outlet and drain). Then stones are placed in a circle and secured with steel wire. The inside and outside of the tank is then plastered with cement. No steel bars are needed since the wire functions as reinforcement. Leaks are repaired with cement.

**Information:** Water storage, Rainwater harvesting.

General:

[www.unep.org](http://www.unep.org)  
[www.rainfoundation.org](http://www.rainfoundation.org)  
[www.hrwallingford.co.uk](http://www.hrwallingford.co.uk)  
[www.rainwaterharvesting.org](http://www.rainwaterharvesting.org)

Austra-Nica tanks

[www.ropepumps.org](http://www.ropepumps.org)  
[www.practicafoundation.nl](http://www.practicafoundation.nl)

**Capacity:**

0.5 m<sup>3</sup> - 120 m<sup>3</sup>

**Cost:**

120 construction bricks, sand, 50 kg cement and 1 kg of

Material for a tank of 1 m<sup>3</sup>

steel wire.

◀ **Filling a tank of 1 m<sup>3</sup> made of bricks, wire and cement.**

*Insert:*

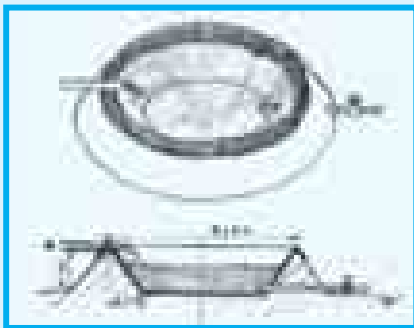
Construction of an Austra-Nica storage tank of 60 m<sup>3</sup>.



Plastic lined tanks can be a low cost alternative to metal or ferro-cement tanks.

The organisation IDE in Asia is developing several models of plastic-lined tanks. One model consists of a 1500-litre reinforced plastic bag that fits inside a cylinder of sheet metal. Another model is a plastic liner reinforced with a 10 m<sup>3</sup> plastic bag and installed in a hole in the ground.

Open storage tanks can be made of earth. If clay is not available, a plastic lining is needed to stop water from leaking away. Linings can be made of standard plastic sheet glued together with the tar normally used to repair roofs. The plastic must be covered with earth to prevent it from being exposed to the sun.



### Information:

[www.ideorg.org](http://www.ideorg.org)

[www.practicafoundation.org](http://www.practicafoundation.org)

**Capacity:** 5 m<sup>3</sup>.

**Material needed:** 12 m<sup>2</sup> of plastic sheet, 3 m of PVC tube and labour.

◀ In Nicaragua earth is used to construct open storage tanks.

*Insert:* Plastic-lined (IDE) and conventional tanks, Bangladesh.



## Lay-flat hoses for low cost water transport.

Irrigation sometimes involves transporting water over a long distance. Cement or clay canals are relatively costly, inflexible and cannot elevate water. PVC tubing or polypropylene (PP) hose is relatively expensive. In India, farmers started to use locally made plastic hose, called the lay-flat hose because the hose is flat when not in use. This hose is so cheap that even very low-income farmers can buy or rent it and irrigate their crops. It is often used for supplementary irrigation in unexpected dry periods in the rainy season. An additional advantage of lay-flat hose is that rolls are easy to transport and do not occupy valuable cropland as is the case with field channels.

### Information:

[www.practicafoundation.nl](http://www.practicafoundation.nl)

[www.teriin.org](http://www.teriin.org)

(Lay-flat hoses are also mentioned in the book in *technology innovation and promotion in practice: pumps, channels and wells*.)

**Cost/100 m:**  
(Yemen prices)

US\$ 20 - 30 (40 mm diameter).  
US\$ 40 - 60 (80 mm diameter).

### ◀ Lay-flat hoses for sale in a shop in Yemen.

*Insert:* Pump set with lay-flat hose attached (India).



**“In West Africa this technology is "self promoting" without the intervention of outside organizations”.**

*Sjon van het Hof, documentalist, Tropical Institute, The Netherlands.*

Spray-head irrigation requires pressure from pedal or motor pumps. In West Africa, the spray-head is mounted on a lay-flat hose connected to a small petrol pump.

Due to its simplicity, spray irrigation technology has spread spontaneously from farmer to farmer in West-African countries such as Mali, Niger and Togo. A recent survey in Bamako, Mali, among 80 market gardeners showed that more than 60% used this method.

Spray irrigation is an intermediate option between a watering can and more sophisticated sprinkler or drip irrigation. It has high water use efficiency and saves energy and labour.

Treadle pumps combined with spray-heads are promoted by Approtec in East Africa and Enterprise Works in West Africa.

## Information:

[www.enterpriseworks.org](http://www.enterpriseworks.org)

[www.hipponet.nl](http://www.hipponet.nl)

[www.approtec.org](http://www.approtec.org)

## Costs:

US\$ 2 - 5 for a spray-head.

US\$ 300 - 600 for a unit with petrol pumps.

## Location:

West Africa.

## ◀ Spray irrigation for urban market gardening in Mali.

*Insert:* Money-maker pump with a spray-head.





**Pepsi drip is made of plastic hose used for ice-lollies and costs US\$ 60 per ha.**

Drip irrigation reduces water consumption but conventional drip technology is “high-tech” and expensive. To make drip irrigation affordable for small farmers, the Chapin bucket or IDE bucket and drum kits were developed and are now being promoted in many countries. A bucket kit costing US\$ 5 can irrigate 25 m<sup>2</sup> and a drum kit five times as much. Based on this principle, farmers in India started to make their own drip system, made of plastic hose that is normally used to package ice-lollies. Hoses can only be used for one growing season (generating plastic waste) but investment costs are so low that it is not a risk for poor families to invest in it. This technology now more or less promotes itself.

## **Easy drip irrigation**

An improvement of Pepsi drip is the so-called Easy drip that consists of sun resistant lay-flat hoses and micro tubes that have a lifetime of 1-2 years. This option is being developed by IDE and applied in Asia. Practica foundation is testing different options in Nicaragua, Tanzania, Zambia and Ghana.

### **Information:**

[www.cgiar.org/iwmi](http://www.cgiar.org/iwmi)

[www.ideorg.org](http://www.ideorg.org)

[www.practicafoundation.nl](http://www.practicafoundation.nl)

### **Numbers**

Pepsi drip 2,000 systems.

Easy drip 20 – 40,000 in Asia.

### **Capacity:**

0.1-2 ha.

### **Cost/ha:**

Pepsi drip: US\$ 60 (plastic hose only).

Easy drip: US\$ 200 – 400.

## ◀ **low cost plastic hose, used for drip irrigation.**

*Insert:* Pepsi drip irrigating 1 Ha of vegetables in India.



**A drip system for flat land that works with a pressure of 0.5 to 1 metre of water column.**

The Pepsi and Easy drip method needs water pressure from a 1.5 - 3 m-high water tank or can be directly coupled to a pump. Drip systems such as the bucket and drum kit work with lower pressures of 1 - 1.5 m. The Nica drip systems can be used on flat land and need only 0.5 - 1 m head of water.

The advantage of this system is that storage tanks do not have to be elevated. Systems are made of locally produced hoses and are being field tested in Nicaragua by Cesade/Amec and the FAO. Through demonstrations, farmers learn how to make the drip holes and hose connections and so can build the system that fits their situation best.



**Information:**

[www.praticafoundation.nl](http://www.praticafoundation.nl)

[www.ropepumps.org](http://www.ropepumps.org)

[www.ideorg.org](http://www.ideorg.org) (easy-drip)

**Initial cost/ha:** US\$ 300 – 600, depending on crop and material used.  
(Nicaragua)

**Useful life:** 3-5 years.

◀ **Nica drip system working with 1 m pressure and made of local produced plastic hose.**

*Insert:* Dripper made of the same hose.



**Using the sun to improve the quality of drinking water at household level.**

SODIS uses sunlight to inactivate harmful micro organisms in water almost completely. Transparent plastic (PET) or glass bottles filled with contaminated, but clear, water are exposed to the sun for six hours in sunny weather or two days in cloudy weather. If a temperature of 50 degrees Celsius is reached, an exposure time of one hour is sufficient.

This technology was awarded a price by Simavi and organisations such as SANDEC are promoting it in many developing countries.

**Information:**

[www.sodis.ch](http://www.sodis.ch)

[www.simavi.org](http://www.simavi.org)

**Numbers:**

Used by more than 1,000,000 in Asia, Africa and Latin America.

**Initial cost:**

Very low, re-use of plastic bottles.

◀ **Plastic bottles filled with contaminated water are placed in the sunlight.**



**“A filter for family use that provides clean and bacteria-free water at a cost of US\$ 3-5 per family per year”.**

*Ron Rivera of the NGO Potters for Peace.*

A new alternative to conventional ceramic candle filters is the CSP filter. This model has a pot-shaped ceramic filtering element that is treated with colloidal silver. It has a bigger capacity and is easier to produce locally than candle filters. Also leakages are easier to detect than in candle filters so there is less risk in use.

Evaluations, including a USAID-funded test in Nicaragua, indicate that CSP filters remove turbidity and harmful bacteria that cause diarrhoea, cholera and other waterborne diseases. Maintenance consists of cleaning with a brush and changing the ceramic element every 2-3 years. If filled twice a day the filter produces enough for a family of six.

Field studies have shown that investment in a filter is “paid back” within 3 to 6 months because of savings on expenses for medicines, fuel wood and labour. In Nicaragua, Guatemala and Cambodia the production of this filter is a commercial activity and production is starting up in six other countries.

## Information:

[www.who.org](http://www.who.org)

[www.potpaz.org](http://www.potpaz.org)

[www.elfiltron.com](http://www.elfiltron.com)

**Numbers:** 150,000 in Central America, Asia and Africa.

**Applied by:** CARE, UNICEF, Red Cross and others

**Capacity:** 10-20 litres/day.

**Cost complete filter:**  
(off-factory): US\$ 8 in Cambodia

US\$ 10-15 in Nicaragua.

**Cost of introduction:** US\$ 15,000 - 30,000 for project incl. training, machinery and a first production of 500 filters.

US\$ 50,000 - 100,000 for project incl. production shop, training, first promotion, and 5,000 filters

## ◀ Family using a CSP filter in Zapatera, Nicaragua.

*Insert:* Manual press to produce the filtering element.





Safe Water Systems is a water quality intervention that utilises chlorine treatment combined with safe storage to make drinking water safe. The intervention has three steps:

1. Point-of-use treatment with chlorine, purchased and produced locally.
2. Safe water storage in locally produced plastic or ceramic containers with a narrow lid and spigot to avoid recontamination.
3. Behaviour-change techniques including social marketing, community mobilisation, motivational interviewing and education.

These activities increase awareness of the link between contaminated water and diseases. The SWS has been implemented in 19 countries and research has shown a consistent reduction of diarrhoea in users of approximately 50 %.

## Information:

General

[www.cdc.gov/safewater](http://www.cdc.gov/safewater)

“point of use” options [www.who.int/entity/household\\_water/en](http://www.who.int/entity/household_water/en)

Numbers:

1 million families reached in 2002.

Cost Chlorine:

US\$ 0.1 - 0.3 to treat 2,000 litres (1 monthly supply for 1 family).

Cost storage vessel:

US\$ 3 - 5.

## ◀ Kenyan boy using SWS in his home.

Insert: SWS products in 7 countries.

The examples in this booklet indicate that *the "right" technology, introduced in the "right" way, can make a difference\**. Low-cost technology can substantially reduce poverty as proven in Bangladesh where the introduction of the treadle pump resulted in higher farm income, more workshops and more sales centres.

A question one may ask is "Since these options work so well, why are these low-cost technologies not disseminated worldwide?" Regarding development, for obvious reasons the private sector in industrialised countries is unlikely to be interested in "patent-less" technologies that can easily be copied in local workshops. Development agencies may be reluctant to support these options because of failures with many an *Appropriate Technology* in the past. The lack of wide-scale dissemination appears to be caused by lack of awareness of new options. Hence the importance of publication and promotion.

The private sector in developing countries often lack capacity and resources for R&D and marketing. So therefore governments and donors should invest in capacity building, promotion and marketing.

Promising is that, apart from organisations such as ITDG, IPTRID, TERI or CSE, also WHO, World bank, Unicef, EU Water Initiative and others have become interested in low-cost technologies. The RWSN Rural Water Supply Network ([www.rwsn.ch](http://www.rwsn.ch)) is now active in the field of well drilling and hand pumps. IRC recently published a comprehensive overview of small community water supply technologies Technical Paper nr.40 ([www.irc.nl/content/view/full/1917](http://www.irc.nl/content/view/full/1917)).

The dissemination of "best practices" requires information that is objective, up-to-date and easily accessible, for policymakers, local industries and other stakeholders. For this reason the organisations mentioned on pages 2 and 3 intend to go on publishing more on smart technologies. Technology is regarded as "smart" if it can be easily manufactured and repaired in local conditions and -most of all- is affordable. If you want to share experiences that fits this concept, you are invited to contact NWP or the PRACTICA foundation.

\* See page 7 "Poverty alleviation as a business"

[www.intercoop.ch/sed/product/heierli/main.html](http://www.intercoop.ch/sed/product/heierli/main.html)





**PRACTICA**

PROTECTING FOOD FROM WATER



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**AGRIALIS**

