

# Ashden technology

## Water pumping: treadle pumps and ram pumps

Pumps are used to supply water to where is needed for drinking, washing, and irrigation. The water can come from different sources, such as rivers, reservoirs and underground aquifers. The pumped water usually passes through a pipe, sometimes covering a long distance and going uphill. Mains electricity, diesel engines, solar photovoltaics and wind turbines are all used for water pumping. Treadle pumps and ram pumps are two other sustainable energy solutions, both of which are easy to construct and maintain.

- Treadle pumps used by individual families to pump from shallow wells, and cost around US\$20 to US\$30 installed.
- Ram pumps pump water from valleys up 100 metres or more to whole communities, and cost around US\$4,000 to US\$ 5,000 installed.
- Over 750,000 treadle pumps and several thousand ram pumps in use.

Read on for more information about treadle pumps and ram pumps, or [go to our database](#) for films and case studies of Ashden Award winners who use water pumps.

### Treadle pumps

#### How treadle pumps work

A treadle pump is foot-operated, with the user driving a pair of pistons to pump the water. Most treadle pumps in use are suction pumps, which can raise water from several metres below ground up to the level of the pump. Some treadle pumps are also able to produce water under pressure, and this allows it to be sent uphill or through long horizontal pipes. The user stands on two treadles, which can be made of bamboo, wood or metal, and pedals them, alternately raising and lowering pistons in two metal cylinders. The treadles extend beyond the piston rods, to act as counterweights to push the pistons back down. A non-return valve is used in each piston and at the base of each cylinder to ensure the water only flows in one direction. For pumps delivering water under pressure an extra non-return valve is required for each cylinder.

The pair of cylinders is connected to a tube-well, or to a surface level pond. A tube-well is a robust, flexible plastic pipe, sunk into the ground until it reaches an aquifer, with a filter on the end to prevent silt entering the tube. Before first use, water is poured into the cylinders to 'prime' the pump. When the user pedals, water is lifted up onto the field, or into a pond or irrigation canal.

#### How treadle pumps are used

Treadle pumps can raise water from up to seven metres below ground, so are suited to areas where the water table is high. Many areas in India and Africa have a rainy season, during which a single crop can be grown without irrigation, but during the rest of the year they are dry. By using the treadle pump, the user can bring sufficient water back to the surface to grow one or two additional crops during the dry season.



Children around the air chamber of their village ram pump



Treadle pump India showing bamboo treadles and metal cylinders. On each stroke, the piston in one of the cylinders drives water into an irrigation canal



It is possible to have several tube-wells and move a single pump between them, keeping costs down for the user. The only parts of the pump that need regular replacement are the non-return valves and washers, which last for a year.

One of the biggest organisations distributing treadle pumps is International Development Enterprises India (IDDI), who won Ashden Awards for its work in 2006 and 2009.

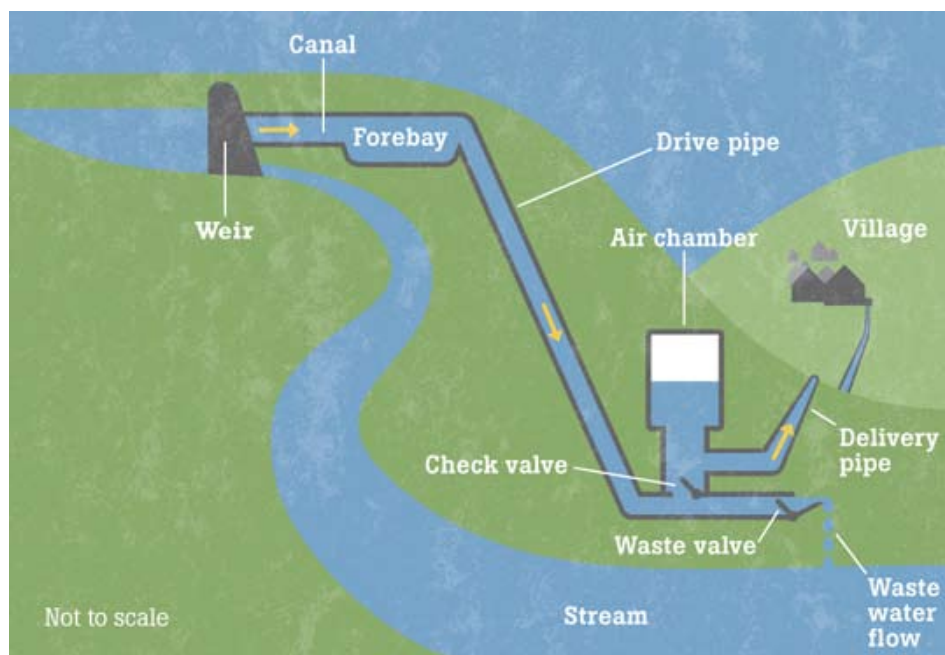
### Ram pumps

Ram pumps were first developed in 1772. Modern designs have been refined to improve performance and reliability, and are finding applications all over the world.

#### How ram pumps work

Ram pumps use the power available in water flowing down through a drop of a few meters to lift a small percentage of that water to a much greater height. Ram pumps can be made in a range of sizes, delivering flow rates from just a few tens of litres per day to thousands of litres, and pumping the water by up to 200 metres uphill.

The ram pump is installed well below the intake, where water is taken from the stream. The intake has a catchment tank and is used to ensure a smooth supply and eliminate any debris, and then feeds water down the drive pipe. The delivery pipe is routed from the ram pump to where the water is needed.



#### How ram pumps are used

A ram pump can be used whenever there is a stream with sufficient flow and head (the distance dropped between the intake and the pump). The biggest growth in their use today is in developing countries, where supplying water is often a challenge.

A ram pump will typically be set up to pump water from a stream to a village that is up a hill or some distance away. As the pump operates continuously, the delivery pipe usually empties into a reservoir, which will be sized to allow it to fill up at night and then run down during the day, as the water is used. If the demand for water is more than can be supplied by a single ram pump, then several pumps can be operated in parallel, each with its own drive pipe and delivery pipe.

For use in remote rural areas, it is important that a ram pump is reliable and easy to repair. One organisation that has made significant progress on both of these fronts is the [AID Foundation](#) in the Philippines, which won an Ashden Award for its work in 2007. It has since been working with partners to install ram pumps in Afghanistan, Cambodia, Costa Rica, Malaysia, Nepal, Peru, Thailand and West Timor.



Neighbours can chat as they pump water to irrigate their fields in the evening

#### The principle of operation of a ram pump is as follows, and shown in the diagram below left:

1. Water is allowed to flow down the drive pipe and out of the waste valve.
2. As the flow of water accelerates, the waste valve is forced shut, causing a pressure surge (or "water hammer") as the moving water is suddenly brought to a halt.
3. The pressure surge causes the check valve to open, allowing high-pressure water to enter the air chamber and delivery pipe. The pressurised air in the air chamber helps to smooth out the pressure surges from the ram pump and ensure a continuous flow through the delivery pipe.
4. As the pressure surge subsides, the pressurised air in the air chamber causes the check valve to close, and forces water up the delivery pipe. The closure of the check valve reduces the pressure in the ram body, so that the waste valve opens under its own weight, and the pump is returned to the start of its operation cycle.



Checking the ram pump intake



### What are the benefits?

Treadle pumps are designed to be used by individual families. By allowing a poor farming family to grow two or three crops per year instead of one, a treadle pump can improve food supply and increase their income significantly.

Farmers who previously hired diesel pumps for irrigation save money, because the annual cost of hiring and fuel is usually far more than the cost of a treadle pump – and the treadle pump is available whenever it is needed. A detailed study has estimated that a treadle pump which replaces diesel pumping saves about half a tonne of CO<sub>2</sub> each year.

While treadle pumps are aimed at family use, ram pumps are more suited to supplying water to small communities that otherwise have to collect water by hand or rely on diesel or electric pumps. Installing a ram pump provides a village with a cheap and reliable supply of water for both domestic and agricultural use, allowing improved hygiene, irrigation of crops and sometimes new uses, such as fish farming or animal husbandry.

### Cost

Treadle pumps sold by [IDEI](#) cost between US\$20 and US\$32 including installation, with an additional US\$11 for a tube well. This cost is easily recouped by the increased income from one extra irrigated harvest. The annual cost of maintenance for a treadle pump is less than US\$1, and the pump will last for at least eight years, although some have operated for much longer than this.

Ram pumps are more expensive, but they supply water up a high head and for a large number of people, and do not require the physical effort that a treadle pump needs. A ram pump to supply a community of 300 people in the Philippines costs typically US\$4,000 to US\$5,000, which is often very cost-effective compared to the alternatives. For reliable operation, a ram pump needs to be checked daily, with maintenance and replacement of valves every three to six months. The [AID Foundation](#) trains community members as pump technicians, and families receiving water are charged a small monthly fee to pay the technicians and the cost of replacement parts.

### Numbers

In February 2009, there were 750,000 [IDEI](#) treadle pumps in operation in India alone, with a further 50,000 being sold every year. Other countries including Kenya are also using treadle pumps.

At the start of 2010, [AID Foundation](#) had installed 160 ram pumps, supplying water to over 50,000 people. Globally, there are estimated to be several thousand ram pumps in use.

### The future

The main technological developments in treadle and ram pumps over the last few years have related to improving their durability and making them easier to maintain, while keeping their cost low; this is expected to continue. [IDEI](#) is expanding its operations rapidly in India, and has set up a separate business to sell treadle pumps and other low-cost irrigation technologies in other countries. For [AID Foundation](#) the next step is to spread the use of their ram pumps to other countries, and make people aware of this old technology that has been brought up-to-date.

### Useful links

View our water pumping photo collection on [flickr](#)

If you've found this interesting, then you might want to read some of the other technology papers on our website [www.ashdenawards.org](http://www.ashdenawards.org)

Lead author: Dr Mike Pepler



Air chambers and delivery pipes for six ram pumps that are used in parallel to supply more water at this site 'I'll like the third shot of this the best'



Water on tap for the first time promotes hygiene and reduces illness



Irrigation with water from a ram pump can transform the crop production in a village