

## **Local manufacture and installation of hydraulic ram pumps, for village water supply**

### **Summary**

Many people living in villages on the hillsides in the Philippines do not have easy access to fresh water, and have to make a difficult journey down steep slopes to collect what they require for their basic needs from springs, streams or rivers in the valleys. Lack of water leads to poor hygiene and sanitation, and limits agricultural activities. The Alternative Indigenous Development Foundation Inc (AIDFI) installs ram pumps to provide a good supply of water from the rivers to the hillside villages. The ram pumps use the power of the water flowing in the spring, stream or river to lift a small fraction of the water up to 200 metres vertically, and sometimes pump it over a kilometre to where it is needed. Government bodies, NGOs and development agencies pay for the installations, but local people are trained as technicians to maintain the pumps and the villagers pay for this maintenance themselves.

When a ram pump is installed, the local people benefit from having sufficient water for personal hygiene, sanitation and washing clothes, rather than just enough for eating and drinking. They also have a surplus for growing more food and can significantly increase their income.

Ram pump technology was developed over 200 years ago, and has great potential for supplying water without the need for electricity or fossil fuels, but many installations in the Philippines and elsewhere have not been successful. AIDFI developed a durable ram pump design, with cheap and locally-available options for the moving parts which need regular replacement, and it also emphasises the critical importance of regular maintenance to keep the pump working properly. Over the past 10 years AIDFI has installed 98 pumps in 68 communities in the Philippines, and there are probably another 10,000 sites where the pumps could be used.

### **The organisation**

AIDFI was started in 1990 to help people who had lost their employment on sugar plantations and had no land to provide them with an income. It was registered as an NGO in 1992 and now employs 21 people. In addition to the ram-pumps, AIDFI has also been working to provide poor communities with micro-hydro for battery charging, biogas plants, hand and foot pumps, solar water heating and micro wind-power.

**Address:** Auke Idzenga  
AIDFI Bldg.  
Murcia Road  
Brgy. Mansilingan  
6100 Bacolod City  
Philippines

**Telephone:** +63 34 4463629

**Email:** [auke\\_idzenga@yahoo.com](mailto:auke_idzenga@yahoo.com)

**Website:** [www.aidfi.org](http://www.aidfi.org)

## Context

Statistical information	
Population (2004)	81.6million
Urban population (2004)	61.9%
GDP per capita US\$ (2004)	\$ 1,036
- at purchasing power parity	\$ 4,614
Population living on less than \$1 a day (2004)	15.5%
Population living on less than \$2 a day (2004)	47.5%
Population with access to grid electricity (2000)	87.4%
Annual electricity consumption per person (2003)	655 kWh
Annual CO <sub>2</sub> emissions per person (2003)	1 tonne
Population undernourished (2001-03)	19%
Population with access to an improved water supply (2004)	85%

Sources: UNDP, World Resources Institute

Much of the island of Negros in the Philippines was formerly covered with sugar plantations, but after the sugar price crashed in the 1980s many people lost their livelihoods, and a climate of conflict arose in the area. Since then there has been some land reform, although conflict continues at a low level. Many people reap only one harvest a year from their land, and this is mostly rice for their own use, although some maize and sugar cane is grown for sale. Dry season vegetables are grown where there is a water supply available. However, deforestation has led to increasing droughts in the hotter months, causing problems for farmers and leading to the abandonment of some land.

Although access to mains electricity in the Philippines is in theory widespread, in practice only a few buildings in each community are connected.

The terrain in Negros is hilly, and many villagers must scramble for a hundred metres down a steep slope, twice a day, to collect fresh water, which is carried back in jerry cans on a shoulder yoke. This is dangerous and time-consuming, and means that water is often used only for essential purposes like drinking and cooking, with little spare for hygiene, sanitation or agriculture. Wells are sometimes available, but these supplies may become contaminated by agricultural or industrial run-off. This is where the ram pumps supplied by AIDFI are helping people, by providing an adequate supply of clean water to the villages.

## Technology and use

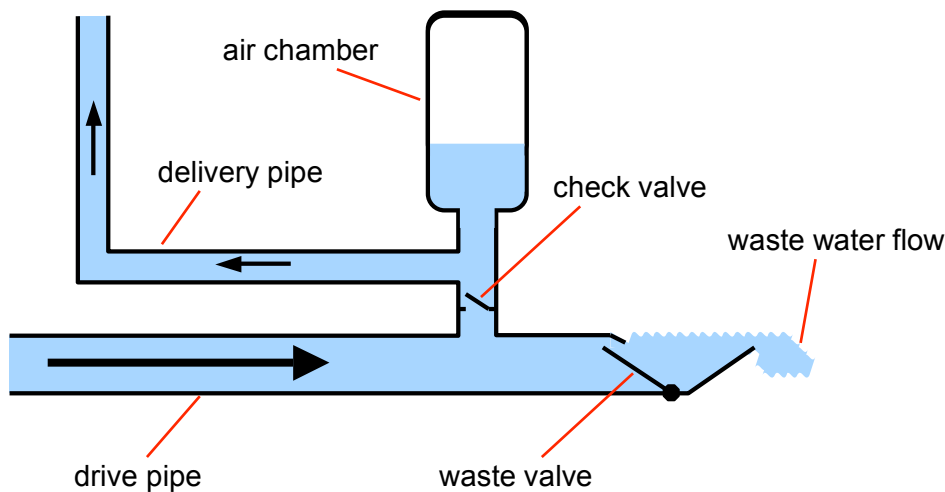
Ram pumps use the power available in water flowing down through drop of a few metres to lift a small percentage of that water through a much greater height, to where it is needed. The range of ram pump sizes used by AIDFI can pump between 1,500 and 72,000 litres of water a day, lifting it up to 200 metres.

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

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 sudden closure of the check valve reduces the pressure in the ram body, so that waste valve opens under its own weight, and the pump is returned to the start of its operation cycle.

The ram pump is installed well below the intake, where water is taken from the source. 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 pipes – one per ram pump. The delivery pipe is routed from the ram pump up to the village, where it fills a concrete reservoir for people to draw water from. The pump and reservoir are sized so that the reservoir level falls gradually during the day, and is refilled at night, as the pump can run continuously without any intervention most of the time.



**Simplified diagram of the ram pump**

The ram pump is not new technology; a manually operated version was developed in the UK in 1772 by John Whitehurst, and a self-acting version was developed in France by Joseph Michel Montgolfier in 1796. Although apparently an attractive option for rural energy supply, many implementations of the ram pump in developing countries, including the Philippines, have not been successful due to poor design, and lack of maintenance and spare parts. Before starting the AIDFI ram pump programme, Auke Idzenga made a survey of all the ram pump installations that he could find in the Philippines, to learn what design factors were crucial to successful operation, and also find out how to reduce the cost.

The design developed by AIDFI uses mild steel for the body of the ram pump itself, including the final section of the drive pipe and air reservoir. Some critical parts are made from stainless steel to ensure they last throughout the expected lifetime of over 20 years. All construction materials are sourced locally, although the stainless steel is imported from Japan by Philippine steel companies. The pumps are made in the AIDFI workshop, where high quality manufacture and good working practices are required; workers must wear steel capped shoes, safety goggles and protective gloves as needed.

The AIDFI ram pump design is patented, and its most novel feature is the use of a door hinge for the waste valve, which creates a steel-to-steel seal. This avoids the use of a gasket, which would

quickly wear out in this high-impact valve. A further feature that helps improve the reliability of the pump is a submersible box around the outflow of the waste valve, which prevents air entering the pump at the end of each cycle. This is important as if air enters the ram body it reduces the efficiency of the pump.

The AIDFI ram pumps are specially designed for use in the setting of Negros, where maintenance is carried out by trained villagers with limited access to tools and spare parts. Some parts need regular (three to six months) replacement and are therefore made from cheap, locally available materials: the waste valve is made from a door hinge, and the check valve can be made from an old car tyre. Local people are often innovative with the maintenance – plywood has been used to make replacement gaskets, and has worked well because the wood expands when it is wet, ensuring a good seal.

AIDFI supplies five different sizes of ram pump with intake rates ranging from 10 to 800 litres per minute, allowing them to cater for different heads, flow rates and delivery heights. For small schemes an individual pump is used, but for larger schemes multiple pumps are connected in parallel or in series (depending on the head and flow rate). The pumps operate continuously and deliver water to a reservoir of 1,000 to 50,000 litres at the village, which will typically be filled up overnight and then drained down through the day.

AIDFI has installed 98 ram pumps so far at 68 sites.

## **How users pay**

£1 = P91 (Philippine Pesos) [April 2007]

A typical ram pump installation for 50 households or 300 people costs P200,000 - 250,000 (£2,200 - 2,700), although the largest system installed which included extensive civil works and distribution networks for households and irrigation, cost P1.8 million (£19,800). The capital cost of all ram pumps installed so far has been met by local authorities, government development departments, NGOs or international development agencies. For local authorities the funding of a ram pump system can be a very cost-effective way of meeting their obligation to supply water. In future there is the possibility of community co-operatives using micro-finance to purchase ram pumps.

Villagers contribute their labour during the installation of the ram pump, helping with transport, pipe-laying, concrete-mixing and construction of the reservoir. The community using the ram pump also collects a small fee of P10-25 (£0.11 - £0.27) a month from each household to pay the technicians for maintenance of the system.

## **Training, support and quality control**

AIDFI manufactures the ram pumps in its own workshop to ensure the quality remains high, and does not use subcontractors. If ram pumps are not maintained properly, they will fail, so AIDFI must ensure that trained local staff will maintain the pump. At the start of installation the AIDFI installers select two or three local people to be trained as technicians. The installers live in the community during the installation, and the local trainees help them, so learn in detail about all aspects of the ram pump system. After the installation is complete, the local technicians are trained further in maintenance and provided with a tool kit and spare parts for the pump. The technicians are typically paid a fee of P70/day (£0.77) from the community fund, to check the system is working correctly and perform any retuning, replacement of parts or other maintenance as required. This is a significant amount of money in a region where the cash income from agriculture is typically P15,000 (£165) a year or P40 (£0.45) a day, and therefore gives a real incentive to provide good maintenance. With proper maintenance and replacement of valves, the ram pump system should last for 20 years.

AIDFI technicians visit each site four weeks after installation to make sure everything is working correctly. After this there are no further routine visits, but AIDFI gives assistance if any problem arises. Full details of all installations are kept in the AIDFI office.

## Benefits

The 98 ram pumps installed to date by AIDFI are delivering over 900 m<sup>3</sup> of water every day, serving over 15,000 people and irrigating large areas of land.

For many people, the most important benefit of the ram pump is having an adequate, safe water supply for the first time. Villagers no longer have to undertake the difficult and sometimes dangerous task of collecting water, and they now have ample water supply, typically 200 to 1,000 litres/day per household. When water had to be carried up steep slopes from the local source in the valley to the villages, only the minimum required for eating and drinking was collected. Now that there is a plentiful water supply in the village itself, there is water available for personal hygiene and sanitation.

There is also a significant time saving, especially for the women, not just from avoiding the trip to collect water, but also because clothes can now be washed in the village, instead of down at the stream. This time is now being used in caring for children and livestock, and tending vegetable gardens.

A further benefit is that there is now sufficient water for irrigation of vegetable crops in the dry season, for keeping pigs and poultry and even for fishponds. In one region AIDFI has set up a lemongrass oil distillery as a self-sustaining small enterprise, using the water provided by a ram pump and heat from a solar water heater. If a community still has surplus water after they have met all their own needs, they sometimes sell it to a neighbouring community that does not yet have a ram pump. Water is also used to help establish newly planted trees – AIDFI insists on tree-planting whenever a ram pump is installed in a region whose water supply is at risk due to deforestation.

Some communities are setting up ram pump associations, to look at different ways of using water to increase their income. There are reports of people who have increased their cash income from P15,000 (£165) a year to P80,000 (£880) a year – a 400% increase! – although in most cases the increase is probably closer to 30 - 40%. Families also save a significant amount, about P20 (£0.22) a day, in the dry season through not having to buy vegetables. The new money earned and saved is being spent on improving nutrition, transport to school, healthcare and clothing.

About 10% of ram pump installations have replaced electric or diesel pumps for water supply. Here, the community saves P7,500-9,000 (£80 - 100) per month in running costs, so the ram pump pays for itself in under 2 years, and avoids the associated CO<sub>2</sub> emissions.

AIDFI provides direct employment to 21 people of whom about 14 are involved full time with the ram pump work.

## Potential for growth and replication

Over the past 10 years, AIDFI has installed 98 ram pumps at 68 sites, including 12 during the past year. Over the coming year it expects to install between 20 and 25 more pumps, and there is potential for much more growth in the market. Although the pumps can clearly operate only where there is a water source flowing within a couple of kilometres of a village, there are probably at least 10,000 such sites in the Philippines. The main limiting factors on the rate of installation are the rate at which AIDFI can survey sites (about 100 per year), and the available funding.

There is clearly room within the Philippines for other groups to replicate the work of AIDFI in installing effective ram pumps, and NGOs based on other islands are interested in doing this. Several other manufacturers have recently started to produce pumps, although they do not have the same approach to design and maintenance, and it is not yet clear whether their installations will prove effective.

Other countries around the world have significant potential for ram pump use too. The pump design itself, with durable permanent parts and low-cost, easily obtained replacement parts is ideal for replication, and AIDFI has taken care to document information well, so that other people can

understand. One of the most important aspects of the AIDFI approach is the way that users are trained and paid to keep the pumps working well. The people of the communities have pride and a sense of ownership of the pump, and really value the water provided, and AIDFI equips them with the skills and tools to keep the pumps operating effectively for many years to come.

## **Management, finance and partnerships**

AIDFI has its headquarters on the outskirts of Bacolod, the capital of Negros Occidental (the Northern half of the island of Negros), where it manufactures the ram pumps and also allows visitors to learn about the technology and its benefits. All installations on the islands of Negros and Panay are carried out by AIDFI staff, and carefully vetted installation teams are used on Cebu, Mindanao and Luzon.

The AIDFI Technical Department is split into three sections: Research and Development works to improve the ram pump design and conduct performance tests; Fabrication and Installation surveys sites, carries out design work and installation, and trains the local technicians; Promotion and Marketing handles client relationships and promotes the ram pump at agricultural fairs and exhibitions. Other AIDFI staff work on administration, community development and organic agriculture.

AIDFI works closely with a range of NGOs, government bodies and international agencies, and these are often the clients who pay for the capital cost of installing the ram pumps. Key funders for AIDFI include Winrock, the World Bank (Department of Social Welfare), Connect International (Netherlands) and a number of smaller donors.

*This report is based on information provided to the Ashden Awards judges by the Alternative Indigenous Development Foundation Inc, and findings from a visit by one of the judges to see its work.*

*Dr Anne Wheldon, Technical Director, Ashden Awards*

*Dr Mike Pepler, Technical Manager, Ashden Awards*

*May 2007*

The Ashden Awards has taken all reasonable care to ensure that the information contained in this report is full and accurate. However, no warranty or representation is given by The Ashden Awards that the information contained in this report is free from errors or inaccuracies. To the extent permitted by applicable laws, The Ashden Awards accepts no liability for any direct, indirect or consequential damages however caused resulting from reliance on the information contained in this report.