

## Case study summary

# Centre for Rural Technology, Nepal (CRT/N)

2007 Ashden Award

CRT/N's 2007 Ashden Award recognised the work it had done to upgrade water mills and improve livelihoods in the Himalayan villages of Nepal.

Many traditional water mills grind grain to produce flour in the remote villages of the Himalayan mountains and foothills in Nepal. The Centre for Rural Technology runs a programme to upgrade traditional water mills, so that they work more cleanly and efficiently, can operate for a longer period of the year, and also be used for other activities apart from grinding.

- The water mill modifications consist of replacing the wooden penstock with high density polyethylene pipe, and the shaft and runners with precision-made metal parts. The mill improvements increase the grinding capacity by more than 100% and also improve durability.
- Upgrades are partly paid by the mill-owners, assisted by the programme subsidy. Short shaft upgrades cost about US\$350, whilst long shaft upgrades cost about US\$1,050.
- By the end of 2006 over 2,400 mills had been upgraded, providing service to about 96,000 families.
- 237 of the upgrades have used a long shaft on the mill runner so that other mechanical equipment (such as oil presses and rice de-huskers) can be used; and 31 of these generate electricity using an induction generator.
- It is estimated that the 2,400 mills upgraded by 2006 avoid about 2.16 million litres/year of diesel, equivalent to 5,760 tonnes/year CO<sub>2</sub>.
- Millers with improved water mills can earn more income and have extra time for other purposes.
- The flour produced from water mills is of better quality than from diesel mills and has a higher market value.

### Update

- By 2009, 5,700 water mills had been upgraded, benefitting about 296,000 families. 735 of the upgrades were of the long shaft type, with 14 generating electricity.
- Estimated CO<sub>2</sub> savings of 16,000 tonnes per year through avoided diesel emissions.
- Several new products developed, including an improved alternator for generating electricity and a smaller family-sized hydro plant.

CRT/N is an NGO established in 1989. In 2008/9, it had a staff of 60 and a turnover of US\$504,000, of which US\$124,000 was spent on the water mills programme. CRT/N is funded by selling professional services to clients and by grants and awards.

### Nepal statistics 2006/7

(UNDP/WRI)

GDP: US\$465/year per person

CO<sub>2</sub> emission: 0.1 tonnes/year per person

78% of people live on less than US\$2/day

67% of people lack grid electricity

### Location



**"We generate electricity from this which is very good. We can have the water mill as well as generating electricity which is great."**

Khadga Shrestha.



Grinding maize with an improved water mill.

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## Case study

# Centre for Rural Technology, Nepal (CRT/N)

### Background

The streams in the mountains and hills of the Himalayas in Nepal support many traditional water mills (ghattas), which use heavy grindstones to mill grains and make flour. Watermillers often have to work for about 12 hours per day in order to make a living, and the entire milling family lives on site and breathes in flour dust all the time. Traditional mills are largely made from wood, and most parts have to be replaced every two years. With low operational efficiencies, these traditional mills are now unable to satisfy demand, with long delays for farmers wishing to get their crops milled and a rise in the number of diesel powered mills. Diesel mills are often far from the hill villages, so people have to walk long distances to use them. Although diesel mills produce flour more quickly, the high grinding speed reduces flour quality.

The Centre for Rural Technology Nepal (CRT/N) manages a programme of water mill upgrades to speed up the rate of flour production, and to supply mechanical and electrical power for other uses as well.

### The organisation

CRT/N is an NGO established in 1989. In 2008/9, the organisation employed 60 people and turnover was US\$504,000, of which US\$124,000 was spent on the water mill programme.

CRT/N is funded by selling professional services to clients and by grants and awards. The water mill programme is run by CRT/N on behalf of the Alternative Energy Promotion Centre (APEC) of the Government of Nepal and the Netherlands Government.

### The technology

#### How does it work?

Traditional water mills (ghattas) have been used in Nepal for centuries to provide mechanical power for agricultural processing, such as grinding wheat. In order to power a traditional mill, water is led from a fast-flowing stream along a canal, and then down a steep chute or penstock into the mill house. The water, flowing at a rate of up to 100 litres per second, turns the wooden runner of the mill, which rotates a vertical shaft. The grindstones are attached directly to the shaft, on a raised floor above the runner. Grain is fed between the grindstones from a hopper, and flour pushes out from the sides. Key mill parts are made of wood, resulting in a lifetime of only two years.

With an operational efficiency of less than 25% and a typical mechanical output of 0.2 to 0.5 kW, these mills grind between 10 and 20 kg of cereal per hour. The water mill modifications provided by CRT/N consist of replacing the wooden penstock with high density polyethylene pipe, and the shaft and runners with precision-made metal parts. Sometimes the canal is also upgraded for irrigation.

The mill improvements increase the grinding capacity to between 20 and 50 kg per hour, and also improve durability. Some mill upgrades include a long shaft to attach other equipment like saw mills or electric generators

#### How much does it cost and how do users pay?

US\$1 = 65 Nepali Rupees (NR) [March 2007]

The millers pay part of the cost of the improvements, and the remainder is covered by the programme subsidy. The subsidy for the short shaft version was about 50% when the programme began, but this was gradually reduced. In 2007, owners paid US\$170 - \$250 (NR 11,000 to NR 16,000) for a short-shaft upgrade, out of a total improvement cost of US\$310 to \$390 (NR 20,000 to NR 25,000). The millers' contribution is usually paid partly in cash (sometimes raised as a loan from a local micro-finance organisation) and partly in kind, through providing transport and labour for installation.



Farms and fields in the Himalayan village of Kavre

#### The technology in more detail

The improved runner is hydraulically shaped and the blades are cupped to catch the water more effectively and thus increase the efficiency of the mill. Both blades and runner are made from mild steel. Because the improved mill is more efficient, it can work down to water flow rates of about 10 litres per second rather than the average flow of 40 litres per second, and this extends the milling season into the drier months.

Most improved water mills have a short shaft linking the runner to the millstones, in a similar arrangement to the traditional mill. Some upgrades have a longer shaft that does not link directly to the millstones; instead, the grinding shaft is run from it using a belt drive. The advantage of installing a long shaft is that other equipment can also be coupled to the shaft, such as a rice-hulling machine, a saw mill or a generator to produce electricity. Induction generators are particularly suitable where there is a low head but high flow as is typical for these mill sites. They can generate 0.75 to 2.5 kW electric power depending on the site and season. This will supply the miller's own needs, and sometimes those of neighbours as well, either directly or by charging batteries.

The long shaft improvement costs US\$900 to US\$ 1200 (NR 60,000 to NR 80,000), depending upon the type of end use undertaken, with a subsidy of US\$300 (NR 18,000) given in 2007. If a generator is installed this increases the cost further. This high initial cost has deterred uptake of long shaft improve mills: most of the millers who have installed them already had other business interests which would benefit from the mill power, and thus had more cash income to pay. The villagers who take their crops to the mills pay the full cost of the milling service. By tradition this is charged as a fraction of the grain milled, usually 1/15th to 1/20th, and payment is often made in kind.

#### How is it manufactured, promoted and maintained?

CRT/N contracts manufacturing to twelve existing metal-workshops, which it has approved to produce parts for improved water mills. Service centres offer a one-year warranty on the parts that they install, after which users have to pay for servicing and repairs. The drive belt on the long shaft version needs replacing every six months, the grindstones every three to five years and the shafts every ten years.

CRT/N has established 16 local service centres, which promote the improved water mills, train the millers, and provide repair and maintenance services. Service centres consist of local NGOs, metal workers and Watermillers' Associations authorised to provide service. CRT/N helps build capacity for both manufacturers and service centres, and continuously monitors them to ensure they are providing the required quality service. Eventually, it plans for the Watermillers' Associations to take over the servicing.

All the new mill parts have unique serial numbers, which are used to provide a traceable record in case of future faults.

#### Benefits

At the end of 2006, over 2,400 traditional mills had been improved, providing milling services to about 96,000 families. 237 were long-shaft upgrades with auxiliary services, and 31 of these included electricity generation.

#### Environmental benefits

Water mills are usually closer to the villages than diesel mills, so provided that they have the capacity to mill grain quickly, people will use them in preference. Business has declined for diesel mills in areas where there are a large number of improved water mills, some have closed down and new diesel mills are not being built. A CDM study estimated that each improved water mill could replace about half the capacity of a diesel mill and offset about 900 L/year of diesel, equivalent to 2.4 tonnes/year CO<sub>2</sub> or 5,760 tonnes/year CO<sub>2</sub> for all the water mills upgraded by the end of 2006.

Because improved water mills grind more slowly than diesel mills, the flour does not get so hot and does not pick up the taste of diesel. This means that the flour has a longer shelf life, is more nutritious and has a higher market value.

#### Social benefits

The milling efficiency of an improved water mill is high and thus millers can work shorter hours. The water mill upgrades have improved the self-respect and social standing of the mill owners, who have traditionally come from low-status social groups. As a result several millers' associations have been formed with the aim of improving their advocacy power as well as livelihoods, for example through negotiating for quality services, marketing of products and water rights issues. The associations also provide education and training to the millers.

Customers generally have to walk some distance to get to the mill, so usually wait for their crop to be ground. Since the improved mill has a higher throughput, this waiting time is reduced from about 3 to 4 hours to 1 to 2 hours, and frees up time for other activities.

**"It's much easier with a water mill here in the village. It was hard before because we had to go far away to the mill but now it's nearby. In the dry season, we had problems before because there was not enough water for the water mill. These days the water mill will run with less water."**

Mathura Mahat



Hammering the blade of a metal runner into the correct shape



The metal runner for an improved water mill



### Economic and employment benefits

Owning an upgrade increases the income of a watermill, because grain is ground more quickly so more customers can be supplied. In addition, improved mills can operate at a lower water flow rate than the traditional mills, which extends their period of operation into the dry season for up to two months each year. There are now mills operating for 6 to 12 months of the year depending upon the availability of water. Users generally need the mill services throughout the year.

On average, the annual income of traditional mill owner ranges from about US\$620 to \$770 (NR 40,000 to NR 50,000). Income increases by at least 25% with a short shaft upgrade.

Owners of long-shaft improved water mills can sell additional services such as rice-hulling, cutting timber and electricity, and this can increase income considerably more. One miller who bought a top-of-the-range US\$ 1540 (NR 100,000) upgrade including a generator, rice huller and irrigation pump is earning an extra US\$850 (NR 55,000)/year from rice hulling, so will pay back the initial investment and running expenses in just under two years.

The local manufacturing of parts for improved mills results in an estimated 50 days work per unit produced, and the metal workshops earn about US\$8 (NR 500) profit on each unit. Additional employment in promotion, transporting and selling is estimated to be 25 days per unit. Parts last ten years, compared with approximately two years for traditional mills.

An unmodified water mill requires regular maintenance, which consumes timber at a rate of one tree every two years.

### Potential for growth and replication

There is demand for upgrades in all the hill districts of Nepal. The technology is directly applicable in other countries in the Himalayas with traditional water mills, and CRT/N believes there is potential in countries such as Pakistan, Afghanistan, Bhutan and Tibet. IT Power India (a previous Ashden Award winner) ran an upgrade programme in India.

### Update: what happened next?

By 2009, a total of 5,700 water mills had been upgraded, benefitting about 296,000 families. 735 of the upgrades were of the long shaft type, with 14 generating electricity.

A study of carbon savings by Winrock International, Nepal estimated that the scheme saves about 16,000 tonnes/year of CO<sub>2</sub> through avoided diesel use.

CRT/N is also developing and installing new products. Work continues with Kathmandu University to develop an Axial Flux Permanent Magnet Alternator, which is a cheaper generator, designed to work on the short shaft upgrade and supply about 1 kW of electrical power. Three prototypes are in use. 20 independent family-sized hydro plants have also been installed.

### Contact details

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**“The traditional water mill had limited output. The water mill owners’ income has improved, the output has been doubled. That’s how we’ve benefitted.”**

Santa Tamang



Rice hulling using an improved mill

**“It’s good not having to wait so long for the flour. I didn’t like being away from home for so long. The price is half what we had to pay at the diesel mill and it doesn’t smell like it did there.”**

Mrs Mina Katri Chhetri, mill user, Badal Phaka



Miller with improved old mill

Last updated: May 2009