The Glacier Trust

Patron: Sir Chris Bonington, CVO, CBE, DL

Forest Conservation and Improved Cooking Stoves (ICSs)

Brief summary

This project was designed as a response to climate change in the Middle Mountains of Nepal. Forest is a vital part of the mountain terrace agricultural system. Among its many functions, it provides fodder for animals, whose manure is a vital ingredient in the soil's fertility and its ability to retain water. Forest plays a key role in the ecosystem and has an important function in maintaining the water table. It is also the only viable fuel source in the mountains.

Increasing pressure on forest therefore presents a problem for the whole ecology. Poverty leads to poor forest management which can have adverse consequences for the entire catchment. By introducing Improved Cooking Stoves (ICS), the demand on the forest can be substantially reduced. Time free from gathering timber can be invested for other economic benefit for example in animal husbandry, agro-forestry or producing cash crops. This can provide additional food and cash security. Benefits to health from the reduction of kitchen smoke are immediate and save dramatically on doctors' bills.

A perfect example of agro-forestry: Cardamom growing on a wooded hill slope in Pawai. Crops fetched NRs 1100 per kilo last year (over £8). Compare this to a full week's wages of about £11 or less for many people. Cardamom provides an understory to the forest which reduces the impact of rainwater drops from the canopy, which in turn reduces erosion and landsliding. It also slows runoff, which enables the rain water to percolate down to the water table for use as groundwater elsewhere in the catchment.

The following report was written before a field trip was undertaken (12 – 24 November 2012) to investigate the impact of the introduction of Improved Cooking Stoves. The findings from that investigation are added as a **postscript**. While the positive impacts of ICSs greatly exceeded the expectations laid out in the main report, work remains to be done particularly with the metal stoves used at higher altitudes. These issues are discussed frankly in the postscript.

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Forest Conservation and Improved Cooking Stoves (ICSs)

Evolving a replicable project, implemented by Eco Himal, Nepal and focussing on the Village Development Committees (VDCs) of Lokhim[1] and Pawai (Lower Solu Khumbu district) and Bakachol (Khotang district).

Interim report September 2012, from reports by Narayan Dhakal (Project Leader) compiled and edited by Robin Garton for The Glacier Trust

1 Introduction

The Glacier Trust (www.theglaciertrust.org) is a UK registered NGO committed to developing strategies for climate change adaptation in the Himalayas. It provides funding and expertise for Nepali NGOs through which community capacity-building programmes can be implemented. One of the perceived effects of climate change in the Middle Mountains is increased landsliding. This is thought to result *inter alia* from changes in weather patterns, which have recently included both prolonged droughts and shorter, heavier, periods of precipitation. While much scientific work remains to be done to make a robust link between climate change and increased landsliding, responses are possible which should reduce landsliding and provide advantages both for health and prosperity.

Figure 1: Left: A traditional hearth pit at the centre of the kitchen; Right: A typical example of rafters in a Nepali kitchen (Photos: The Glacier Trust)

The holistic approach to this Middle Mountain project is described on our website (http://theglaciertrust.org/project-2/). It has different but interconnected aims. Forest conservation, particularly in relation to the forest understory, provides an observable control on landsliding and the potential for commercially viable agroforestry. Reducing demands on forest timber for fuelwood has an important role in conservation, for example improving the density of forest canopy can help exclude invasive species. Forest is the key factor in sustaining Himalayan terraced agriculture. Each hectare of terraced field needs to be supported by about 4 hectares of forest in order to produce animal manure, mulches and compost necessary to sustain the soil.

[1] In the event, despite initial enthusiasm, Lohkim did not participate in this programme to any extent. Reasons included the cultural and ritual importance of the kitchen hearth for the Rai community (see Fig 1) and the fact that this community had recently installed its own electricity. It will be interesting to see whether the benefits of ICS in the adjacent communities will precipitate a change of attitude in the Rai community.

However timber is the only practicable fuel for cooking and heating. An open fire at the centre of the kitchen is the traditional method of cooking and heating the household. This inefficient use of heat resource and the resulting ambient smoke causes respiratory problems, eye infections and has other seriously deleterious effects. It is also a danger to small children.

Time saving created by ICS gives direct economic benefit that both increases food security and enables further self-development over time. More efficient burning of fuel in a properly ventilated stove can make substantial reductions in the demand for fuelwood, reduce ambient smoke and improve health. The initial proposal was to introduce simple technology in the form of biomass briquettes (BBs) which can be made from residues of forest-invasive species (*e.g. banmara*), give excellent heat, provide economic benefit and have little or no visible smoke yields. However at that stage no research had been published on BBs gas emissions and in the light of Kandpal & colleagues paper[2] we commissioned experiments at Nottingham University in 2010. These found unacceptably high carbon monoxide yields, which carry dangerously high health risks for the normally poorly ventilated kitchen. We have tried to publicise this risk. See: http://theglaciertrust.org/storage/documents/Biomas%20Briquettes.%20The%20dangers%20of%20carbon%20monoxide%20poisoning.pdf

As a result the project went back to the drawing board.

2 Development of the project's focus:

Before initiating the project, a baseline survey was undertaken by postgraduate students at Kathmandu University.[3] Despite the students being inadequately briefed on the objective of the survey by the university, it nevertheless proved a very useful document, illustrating recent environmental changes that are affecting the farming community. The report highlights an alarming warming trend (most importantly in winter) since the turn of the century and also demonstrates increasing unreliability of precipitation throughout the year. Water shortages are therefore beginning to occur in some areas. The report discussed increases in weed and pest infestations of crops, the upslope spread of invasive species, early over-ripening of fruits such as *alcha*, and other alterations to the ecology. The survey raises issues about declining livestock numbers both as a result of increasing pests and reduced availability of forest fodder. However, the report found some of the forest in the study area to be in reasonable shape and managed through strong local initiatives.

Community based adaptations to climate change have been on an *ad hoc* basis, for example moving planting times from June into July in line with perceived alterations of the start of the monsoon. Crop rotation is still practised on traditional lines but at present attempts at agroforestry are limited to Bakachol. Some coping strategies in respect of crop and livestock pests were also being practiced from traditional knowledge, but lack of knowledge of a wider picture has precluded well considered adaptation strategies. One of the report's conclusions stressed that adaptive education was the fundamental first step in addressing these growing problems.

The Glacier Trust signed its first memorandum of understanding (MoU) with Eco Himal in March 2010. The MoU focussed heavily on aspects of training. In any aspect of development, the importance of training cannot be overstated. There are many examples of new technologies being introduced to developing countries which, even though they become central to village life, are abandoned for lack of understanding, maintenance or follow up. The project area had already proved to be no exception and the

[2] Kandpal, J., Maheshwari, R. & Kandapal, T.C. 1994 Indoor air pollution from domestic cookstoves using coal, kerosene and LPG, *Energy Conservation Management*, 36, 0167 – 1072.

[3] Maharjan, R. & Mandahar, S. 2010 Impacts of climate change on livelihood of hill communities of Nepal and their coping strategies (Studies of Bakachol VDC of Khotang District and Lokhim and Pawai VDCs of Solukhumbu Didtrict), Unpublished baseline report for the Glacier Trust, Kathmandu University. PDF available from The Glacier Trust.

baseline report identified aspects of unsustained NGO and other interventions. Thus, the introduction of ICSs required not only someone in the community who knows how to repair and maintain them, but who has an obligation or financial incentive to do so.

Table 1: Key points of the first MoU with Eco Himal

Awareness training in improved stove production and kitchen ventilation for 1 lead resource person from each ward. (Total 27 resource person for 5 days)
Installation of improved cooking stove (based on CRT recommendation). Material support with household kitchen ventilation awareness training
Capacity building training to Community Forest User Groups (CFUG) and promotion of cash crops through replacing invasive plants in the forest
Watershed Management (awareness training, plantation and fencing in necessary area)
Establishment of Multipurpose Agro/forest and livestock resource centre

3 Getting started

3.1 Assessment: Meetings between Eco Himal and the communities in March 2010 further identified a number of ways in which this adaptation to climate change could be implemented to provide a longer term net gain to the community. Besides assessing the likely uptake of cooking stoves, an important aspect of this dialogue was to motivate communities to register and administer forest and water rights for the communities.

Figure 2: Meetings with the community at Lohkim (left) and Pawai (right). Photos Narayan Dhakal[4]

Table 2: Initial assessment of stoves uptake

(Total) VDC	Households	Demand for metal	Demand for clay
Pawai wards 1-9	542	100	442
Bakachol wards 1-9	605	150	455
Lohkim	504	70	150
Total	1651	320	1047

Source: Eco Himal

3.1.1 ICS programme The importance of reducing ambient household smoke fits concisely into Eco Himal's existing health programmes in the villages. However it was very important to establish the right type of stoves for use in Pawai and Bakhachol in conjunction with an education programme about the importance of ventilation. Care Nepal had introduced stoves into Pawai some time back but these had not proved durable. Research into the most appropriate stoves took the form of discussions, which were held with a local NGO in Khotang, Practical Action in Nepal, URECA Pvt. Ltd and the government certified Council for Rural technology (CRT). Generally the two-pot ventilated clay stove promoted by

[4] All photos in Figures 2 – 13 are by Narayan Dhakal

the CRT seemed the most appropriate. This requires six pieces of steel armature: one rounded to support the fuel opening and five flat pieces to support the top. While the cost of metal is as little as NRs 500, the total cost, including transport and installation is NRs 2000. This sum is split 50/50 between the family and Eco Himal. Above 1700m a full metallic stove is more appropriate because of the additional warmth it provides. Costs, including transport up to the roadhead at Saleri, is about NRs 10,000.[5] This is divided 50% by the family, 40% government subsidy deducted by the Alternative Energy Promotion Centre (AEPC) in partnership with the Young Star Club in Saleri, and 10% by Eco Himal. Thus the costs to Eco Himal are NRs 1000 per cooking stove, whether clay or metal. In the project area 1047 stoves would be needed.

3.1.2 Assessing direct economic benefit

Table 3: One and two year cost benefit analysis of ICS for a typical family of 5-7 members (values in Nepali Rupees unless otherwise stated).

	Description of benefits	Cost per household	Increased cash and/or time	Reduced cost	Cost per unit NRs	Net cash benefit clay ICS	Net cash benefit in metal stove
	Cost* of full metallic stove	10,000		5,000			(5,000)
	Cost of clay stove (with 6 pieces of metal)	2,000		1,000		(1,000)	
1	**Health** Improve in the health condition of women and child (respiratory, eye etc.)Treatment expenses	3,000		80%	300 per check-up	2,400	2,400
2	**Fuel cost savings.** wood consumption per year (average)	3438 kg = NRs12,892.50		18.05% clay 25% metallic	@ 3.75/kg	2,327	3,223
3	**Time saving (a) Fetching Timber** Time can be utilized for other productive work (male and female)		40 days/year wages @ 150/day		150	6,000	8,333
4	**Time saving (b) Cooking & Cleaning** cooking time & clothes cleaning reduced	1.20 hour per day 438 hours per year (8 hours working day)	365 x 1.2hours (=15%) 54.75 days		150	8,212	8,212
5	**Maintenance** metal stove lasts 25 years and clay 5 years. Metal parts of clay stove can be used again for re-installation, so reduce the stove making cost and time	Traditional clay cooking stove needs construction twice a year			500	600	1,000
5	**Intangibles**. **(a) Academic:** School children can have more time for their homework	40% improvement academic result of the children					
	(b) Social responsibility. Increases the social status of the family and ability to help others	Change in social status, attained more social work			5 hours a month, 60 hours a year		
	Net benefit to family year 1					18,539	18,168
	Net benefit to family year 2					19,539	23,168

*For stove costs including transport and subsidy, please see paragraph 3.1.1.

Complied from various sources.

[5] The cost of bringing the stove from the roadhead to the household is borne by the household.

The above table assumes that, based on an eight hour working day, all saved time will be used productively. Local transport costs have not been included (because of high variability) nor have maintenance costs of the metal stove been included as these are minimal.

3.3 Forest conservation Development of existing Community Forest User Groups (CFUGs) in Pawai and Bakhachol into effective bodies to deal with preservation, reforestation, firewood allocations and income generation for the community.

3.4 Watershed management Registering rights of water sources ensuring preservation of clean water and the role of women in water management.

3.5 MAFREC Establishing a multipurpose agroforestry resource centre (MAFREC). This is seen as being self sustaining by promoting 'Forest woodland nursery, fruits nursery, non timber forest nursery, cash crops, vegetable and cereal crop seed productions, piglet production and goat production.' There was requirement for high school level education to bring long term community benefit. The students should 'wake with a spade and sleep with a computer.' Two visits were made to the Nahima Agriculture resource centre (Khotang) , which provided background education on many of the aspects of the proposed MAFREC, such as the problems of importing new varieties, and the virtues of Integrated Pest management (IPM) against Effective Microorganism (EM) controls and the economic importance of vegetable production. It also addresses other issues such as land abandonment and the use of empty terraces for cash crops such as broomgrass.[6]

4. Interim Review:

At a meeting with TGT on 19 May 2011 at Eco Himal Kathmandu Office, Narayan Dhakal reported that:

4.1 ICS A resource person has been trained for present installation and future maintenance and that commissioning of the stoves and parts had started.

4.2 Forest 'Dry picnics' had taken place to clear dead wood and clean up the forest floor debris and to remove some invasive species (*e.g. banmara*).

4.3 Protecting water sources (with fencing) and registering community ownership was taking place in some areas.

Figure 3: Identifying water sources for community rights registration and protection for drinking water supply.

[6] This was originally intended to be connected to the school in Lohkim, but in the event land could not be made available. A neighbouring VDC has shown great interest in taking up the project, but this will have to be the subjects of another programme.

4.4 MAFREC was on hold because of issues over the proposed site in Lohkim. The community was also 'spent out' on its own electricity programme.

5. Subsequent progress & implementation (second stage, 2011- 12)

A further budget was developed and a second MoU was signed on 10 September 2011.

5.1 ICS

Figure 4: Metal stove parts arriving before distribution

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Figure 5: Training in the manufacture, production and installation of clay ovens.

By July 2012 just under half of the ICS programme had been implemented and appeared to have been extremely successful. 101 metal and 394 clay stoves have been installed. Fuel wood consumption is set to decrease between 18 and 25% (to be verified), kitchen hygiene is improving, cooking time reduced and the reduction of ambient kitchen smoke is greatly appreciated.

Problems were encountered in the early part of the year because of ongoing strikes in the eastern Terrai. These appear to have been partially resolved. The ICS programme also slowed down because of emphasis on other parts of the programme as a whole, particularly in Bakachol, where better sanitation and electricity are also being introduced.

Figure 6: Top Left: A two pot clay stove in action; Top centre: Sociable and easy to use; Top Right and Bottom Left: Full metalic stove installed; Bottom Right: the proper place for kitchen smoke

5.2 Forest

5.2.1 CFUGs Care & Awareness The programme of forest cleaning continued at the instigation of CFUGs both in Pawai and Bakachol in order to reduce invasive plants and create space to grow a more useful understory. The dissemination of information about the programme was done in advance through Solu FM, a community radio for all forest users.

Figure 7: Tree planting in Bakachol. Educating children in ecological awareness is fundamental to this programme

5.2.2 Support for CFUGs Community Forest Users Groups have been motivated to plant trees and are being made aware of the importance of plantation for environmental protection to mitigate the effects of climate change. Wards in Pawai and Bakachol have been assisted with about 300 fodder plants.

Figure 8: Top Left: Members of the Bakachol community resting during a 'dry picnic' held in March 2011, attended by 84 people; Top right: Poly bag generation of saplings at Devithan; Lower left: Pine sapling nursery at Pawai; Lower Right: Sapling planting at Devithan by community members.

5.3 Nurseries A fundamental part of the forestry programme is the establishment of nurseries both for forest and non forest products. Three farmers and CFUG members have been trained by Eco Himal and a fourth is in training. These have been and equipped with nursery tools like green house tunnel plastic, Hajari (watering cans), Sprinklers, Siketcher (trimming tools), poly bags etc. They are now establishing nurseries for various plants for timber forest, non timber forest, fodder and fruits. One is specialising in higher altitude plants. Because of previous problems in obtaining saplings, this will prove of benefit both to the local and to more distant communities.

Figure 9: Left: Making a nursery. Right: Fodder plant sampling and grafting.

5.4 Support for livestock groups Upgrading the quality of livestock by the distribution of sheep, goats, pigs, cattle and improved buffalo (203 animals in all) is an important part of the programme. However browsing and compacting by livestock can be detrimental to forest regeneration. The understory is crucial to forest stability, reducing raindrop impact and runoff, conserving soil moisture content. Understory also provides cohesion, reducing landslide risk. Therefore ensuring the proper management of fodder plants

will reduce the impact of livestock on forest. 2600 fodder plants have now been introduced across four wards in Bakachol VDC in support of livestock groups.

5.5 Training in cash crop production

5.5.1 Asian watercress (*Simrayo*) This plant has been rescued from near extinction and is a useful dry season crop. Rich in vitamins and iron, it maintains the purity of the water source.

Figure 10: *Simrayo*, Asian watercress: The selection and planting out of seedlings and protection of the seedbed and water source with bamboo

5.5.2 Chiraito (*Swerita chirayita*) This is a high value, multi use, herbal medicinal plant used for anti malaria, body aches and other ailments.[7] It may prove to be useful for diabetes. To disseminate the idea of its plantation and inform people about its importance, a one-day training was held in a plantation in Bakachol VDC. Kusang Sherpa from Rakhabangdel and Iswor Basnet (agriculture staff) facilitated the training. The trainees came from the three wards where upland hill planting is most feasible. The main objectives of the training were:

- To give brief insight about the *chiraito*, its characteristics, where it is found and its uses
- To give insight about the economic importance of *chiraito*
- To teach the nature of soil it needs, technology of plantation, way of preparing a nursery
- The probable problem of pests and diseases and its control
- How to utilise bare and unused land and earn cash income out of it.

[7] For a range of its applications see P. Joshi and V. Dhawan 2005 *Swertia chirayita* – an overview, *Current Science*, 89, 635 –640. Also http://www.himalayahealthcare.com/herbfinder/h_swerti.htm

Figure 11 : Theoretical and practical learning about planting *Charito*

5.6 The water sources programme This is interconnected with the forestry programme. As reported elsewhere in Nepal, groundwater resources are drying up earlier in Pawai. Its causes are likely to be a function of climate change, resulting from protracted droughts and shorter, more intense rainfall.

Figure 12: Bamboo plantation surrounding Luchhne water source.

Protecting the water sources is therefore a priority and protection of land surfaces with forestation is seen as a means of achieving this. In one instance at Lunse 78 dry stone gabions have been installed at a cost of NRs 900,000, one third of which came from the community and two thirds from the District Development Committee. New planting was effected round the water source by the community. About 1,500 plants have been planted round other water sources across most of Pawai VDC. These include fodder and forage plants such as *Navaro*, *Badahar*, *Dudhilo*, *Amriso* (broom plant); *Nepier* is planted in farmland and near water sources and plants such as pine and bamboo have been planted in community forest.

6. Setting an example (Ripple effect): Plantation around Pachkanya Kalika Devi shrine of Pawai VDC.

The Pachkanya Kalika Devi shrine is a famous holy place and pilgrims visit it from across the county. Devi is female Goddess and people have a strong belief that she fulfils their wishes. Four times a year a mass of pilgrims from various parts of the country come to worship and purify their Karma. Originally the place was fully covered by forest but with the increasing number of pilgrims the forest is being destroyed for cooking fuel. In order to restore the beautiful natural surroundings and grow fruit for pilgrims, a fodder and fruit plantation has been created around this temple for 4500 saplings, of which nearly three quarters have now been planted.

Figure 13: Top: The Panchkanya Kalika Devi shrine; Lower Left: Degraded surrounding forest; Lower Right: Forest restoration under way with seedling plantation.

The underlying intentions of this initiative are that the transformation of this site will inspire ecological regeneration at other holy places and that the idea of forest conservation will in some measure become associated with peoples' religious faith. It is also hoped that this example will impress pilgrims sufficiently to replicate it when they get home.

In order to enhance both the amenities of the area and its water resources, Eco Himal's initiative of public toilets and drinking water supply is being facilitated by the Participatory Rural Health Development Programme.

7. Future progress of the project:

Problems that need to be addressed before the next stage of the programme mainly relate to ongoing training of resource personnel within the community. Of the nine people trained, two have proved outstanding and this has placed an additional burden on their workload. With the festival season approaching, people are keen to have stoves installed. Discussions are being held with another organisation, the Resource Management and Rural Empowerment Centre (REMREC) to make Bakachol a household smoke free VDC. Water source registration continues and should be completed by the end of the year. The remainder of the plantation programme is continuing with community input, monitored by staff members.

8. Achievements to date:

The total cost expended to date is just under NRs 2,000,000 (approximately £15,000), although the project is not yet completed. This sum includes the cost of the original baseline report, investment in training (paragraph 2) and staff costs. It has provided extraordinary value. The project is setting an example as to how, by addressing the problems of climate change, communities can achieve holistic improvements. Despite the non-participation of Lohkim, about 500 cooking stoves have been introduced, together with 13,000 trees for fodder, forage and fruit. Over 200 livestock have been

introduced and water sources secured. Additional financial security of abnout NRs 20,000 a year should be available to those who want to take advantage of their time savings and improve their food security.

The communities are now better informed about forest conservation, beginning to shoulder this responsibility and make new initiatives. The Plantation around the Pachkanya Kalika Devi shrine is particularly important and will spread the positive message throughout the country. Preserving holy places and their surrounding plantations has been practised from time immemorial but has recently been allowed to decline. So this initiative provides an important example of strengthening and developing Nepali mountain communities' Traditional Ecological Knowledge.

It is too early at this stage to gauge the effects of these efforts on landsliding and we hope to be able to initiate a monitoring programme in due course.

Postscript

Report on Improved Cooking stove Programme in Pawai (Solu Khumbu)
and Bakachol (Khotang) VDCs of Nepal.

Purpose: This report covers an informal survey of Improved Cooking Stove (ICS) project in the Village Development Committees (VDCs) of Pawai and Bakachol carried out in November 2012 for Eco Himal (Narayan Dhakal) who implemented the project. The project was funded by The Glacier Trust. 105 metal IPCs and 437 clay ICSs have recently been installed in the VDCs. An informal, non random sample was taken by interviewing 67 of the 542 Households (HHs) (12.4%).

Training of local technicians for the building of clay ICSs was effected by Nepal's Centre for Rural Technology (CRT). The stoves were of a notably higher standard in Bakachol than in Pawai. The full metallic stoves were designed by a company selected by Nepal's Alternative Energy Promotion Centre. These were chosen in the light of the government subsidy that attaches to them.

Content: The report looks at:

(a) issues surrounding the manufacture and the use of clay and metal ICSs;

(b) gives an assessment of the fuel wood saving;

(c) identifies improvements that could be made for metal ICS users;

(d) gives consideration to continuing with the ICS programme;

(e) identifies potential health, economic and ecological benefits.

(a) Issues surrounding the manufacture and the use of clay and metal ICSs

(a) 1. Clay ICSs (mostly two pot).

Cracking: Problems most commonly reported in Pawai were cracking, which requires continual maintenance by use of clay mixed with cow dung. I was not able to ascertain whether the stoves in

Pawai had been built with the correct combination of clay and fibre. One stove technician in Bakachol mentioned that his training had instructed him to add jute, matting, and/or goat hair to the clay mix beside cow dung. Min Bikram Malla (ICS chief at Practical Action) has also mentioned sugar as a useful additive against cracking. (We did not hear of this being used). The stoves in Bakachol appeared to give appreciably fewer problems than those in Pawai. The constituents of the clay in Pawai is also thought to be a factor in the stove cracking.

Smoke blowback: This seemed to be a problem for several households. Sometimes it was alleviated when the chimney warmed, but on other occasions wind direction seemed to be the predominant cause. One technician suggested it might also be caused by chimney construction and/or lack of cleaning.

Structure: The fire arch seemed to be a weak point in the stoves' structure. One technician suggested that two metal arches might be better than one. This was certainly evident from what we saw. The structure uses 3 longer and two shorter flat pieces of metal as a support for the clay. However the two shorter pieces proved a false economy and he suggested that having the five pieces of flat metal all the same (longer) length would be an improvement. We would recommend both aspects of this advice for future stove manufacture as the additional cost is minimal.

Three pot stoves: We saw very few of these. Frequently (especially in Bakachol) a traditional fire was used for brewing alcohol and heating animal fodder. In some cases, where the traditional fire had been used, they kept it on for some days for household cooking. Since the time taken to heat larger pots can be considerable and because the cost of a three pot stove is so minimally more expensive than a two pot, we would recommend encouraging more households to opt for three pot stoves in future. The additional NRs 300 will be easily be recouped in terms of fuel reduction.

Maintenance costs. One technician reported that he needed to charge NRs 700 rather than 500/day. Others seemed to charge 1000, or pro rata.

Generally, chimney cleaning seemed to take place when needed (weekly or two-weekly). In both cases (clay and metal) frequency of the removal of ash was to some extent dependent on the type of timber being burned. However daily removal of ash was rarely practised and in therefore wood combustion was less effective than it might have been.

(a) 2. Metal ICSs: These have been introduced above 16-1700m because, properly used, they give very good heat to the surrounding room. Sadly we did not see a single stove being used correctly.

In Pawai, the majority of stoves we saw were in Ward 2 (Chepel). There were some outstanding problems of installation, including a chimney pointing downwards outside, because no cap had been provided. Other chimney sections are still missing and one was discharging into the roof space, which will cause a fire. Further problems included the difficulty in removing the chimney cap for flue cleaning.

The main problem with the metal stoves is that villagers have traditionally cut long sticks to feed into an open fire. With the clay stoves this still works well and no change in wood cutting practice is needed. However the metal stoves are designed for shorter sticks to be used with the door shut and

the rate of burning is controlled by a screw-operated circular ventilator in the door. On no occasion did we see the stoves being used in this way, the householders saying they hadn't the time to cut the wood shorter (but in reality the additional effort may not have been considered worth the wood saving and perhaps they actually like to see the fire, even if it gives less heat). Therefore the door ventilators are now sometimes rusted solid.

(b) 1. Analysis of fuelwood saving by stove type and VDC:

It should be noted that the small number of HHs interviewed makes this survey more indicative than robust. However 63% of the **clay** stove users interviewed were saving 50% or more in fuelwood and over 90% were saving 30% or more. This should be set against the 18% saving expected by the CRT. Because of incorrect use, the **metal** stoves show a more varied picture, with only 10% saving 50% or more and

Table: *Comparative savings between clay and metal stoves (non random sample of 12.3% of HHs with stoves installed).*

	Clay stoves		Metal stoves	
Savings in fuelwood	% HH Pawai	% HH Bakachol	% HH Pawai	% HH Bakachol
Over 50%	75	58.9	37	-
40-49%	8.3	8.8	-	10
30-39%	16.7	20.5	18	30
20-29%	-	8.8	9	-
10-19%	-	3	9	10
0-9%	-	-	27	50
Number in sample	12	34	11	10

just under 50% saving 30% or more. Nearly 40% reported no savings, although this includes a teahouse which can now keep a fire going day round, which had been impossible before because of smoke! These findings should be set against the expected 25% reduction proposed by the CRT.

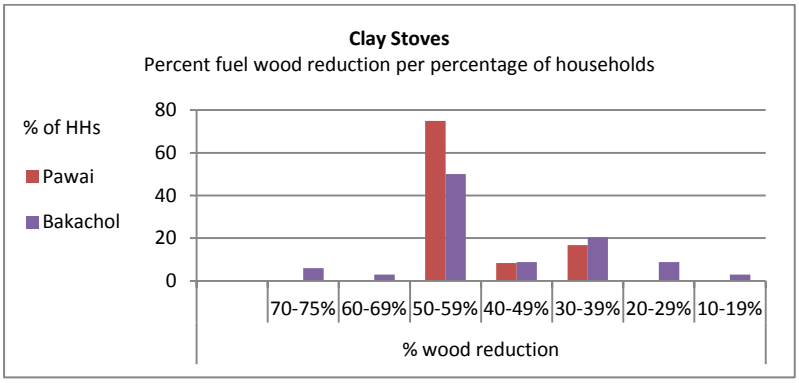

Figure 1: *Fuelwood reductions as a result of clay stoves*

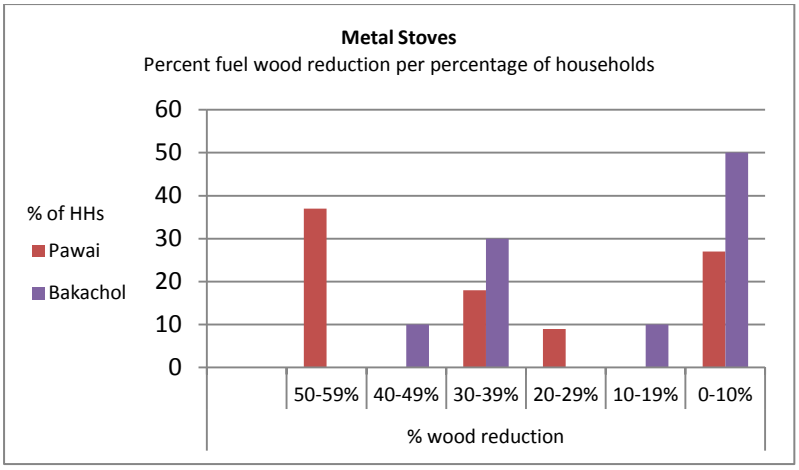

Figure 2: *Fuelwood reductions as a result of metal stoves*

(c) Improvements needed.

Potential improvements to clay stove manufacture has been discussed under **(1)** above.

Since forest at above 1600-1700m regenerates more slowly than that lower down slope, the relatively poorer performance of the metal stoves is a disappointment. Reducing timber demands on the higher forest is of particular importance to both groundwater and slope stability. We therefore propose a programme of 're-education' in which the user of each metal stove is visited by a competent technician who will check that work is completed (*e.g.* chimneys, chimney caps etc.). He will bring diagrammatic literature demonstrating how the stove works and take time to explain this to the user. Literature could take the form of a laminated sheet of A4 with a hole punched at the top so that it can be hung near the stove. The technician needs to be aware that that the metal stoves are not being cleared of ash and this reduces their effectiveness. Frequently users were trying to use stoves with the chimney flue closed, or half shut – often as a result of poor quality manufacture. Pot-tipping was another anomaly. People also seem to think that tipping the pot will reduce cooking time if the fire runs up the side (letting the smoke out of the stove), rather than heating the base. Perhaps the children may take an interest or perhaps they might be told about it at school, if their parents are feeling 'conservative' about these matters! 'Re-education' may have limited impact, yet any improvement in the use of metal stoves would have a disproportionately beneficial impact on the environment at this altitude. The Glacier Trust has therefore agreed grant of approximately £500 to Eco Himal for a programme for the 105 metal stove owners.

(d) Considerations for continuing the ICS programme.

Improvements to the clay ICSs have been suggested under (a) 1. The situation with the metal stoves is more complicated. Properly used metal stoves can give excellent heat and dramatically reduce timber demands. However these stoves did not look particularly well made and the door hinges will have a limited life. Given the problems and cost of transport, together with the poor quality of their installation and the particular importance of conserving forest at the higher altitudes, we considered what could replace them in any future project. One suggestion is that the clay stoves would be adequate with a circular metal plate to cover each of the cooking holes to stop smoke when cooking

has finished. These plates will get hot and heat the room. Technicians involved with the clay stove-making did not foresee any problems, but it would be as well to do a pilot first. Min Bikram Malla also suggested using a fire hood over an open fire.

(e) Benefits:

(e) 1. Smoke reduction: While the clay stoves have reduced timber demands on the forest beyond all expectations, and the metal stoves have had a significant, but lower, impact one of the outstanding successes of the programme (whatever type of ICS) has been the reduction in ambient household smoke. Visiting a kitchen without an ICS very rapidly reminds you of the extraordinary benefits to health from a ventilated stove. The impact on chest and eye infections seems to be immediately beneficial. A traditional medicine practitioner (who is now involved as a stove technician) reported a dramatic improvement in health. We frequently met people who, within months, had reduced or eliminated their doctors' bills (NRs 2–5000) twice a year. Because the stoves have been put in at different times, this was not the time to effect a health survey, but the Trust would be willing to support such a survey in a couple of years' time. Anecdotally, reduction in household smoke has also led to a reduction in cigarette smoking.

(e) 2. Economic: A basket of wood weighs 30-40kg (often 32-35kgs) and would cost about NRs300 (sometimes at least twice that in closer proximity to a town). Determining average household use is famously difficult, and indeed we found very different quantities being used. But 48 baskets/year (before the intervention), or 1608kg of fuel wood per household per year would not be unusual. While most have access to community forest, this saving of time (rather than cash) can be translated into other economic activity, for example growing cash crops, where there is a will.

(e) 3. Ecological:

On the basis of the Figure 1 above, and by taking a broad average, it is possible to estimate that the average fuelwood saving produced by clay stoves is just under 0.7 tonnes per HH per year, with a total estimated saving between the two VDCs of around 306 tonnes from the 437 clay stoves. From Figure 2 and using the same broad average, metal stoves as presently used seem to produce lower savings of an average of about 340 kg per HH per year or a total of 36 tonnes for those 105 HHs. This small intervention therefore appears to be saving something in the order of **342 tonnes** of fuelwood per year which will undoubtedly have beneficial consequences for the ecological health of the catchment.

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