

Report on the Adoption Processes of Rice Husk Stove in Rupandehi District, Nepal¹
Scott E. Justice, Ashok Chaudhary, Shreemat Shrestha and Olivier Morf

***Abstract:** This paper will briefly discuss the process of the successful introduction and adoption of rice husk stoves in Rupandehi and the circumstances surrounding it, as well as the total potential number of households that the rice husk stove could benefit nation wide.*

Introduction

NAEF began promoting renewable energy, *dhan bus ko chulo* or rice husk stoves (RHS), five years ago through the replication of 20 pieces of a from a design that we got from Agricultural Engineering Division, Kulmaltar, (NARI) Kathmandu, Nepal. We demonstrated and gave 3 pieces away to women's cooperatives to the west of Bhairahawa and demonstrated and sold the remaining stoves around Parsari, Madhwaliya, and Gangoliya Village Development Committees (VDCs) just to the north and east of Bhairahawa. The target areas in these VDCs were villages that had rice mills and therefore easy access to supplies of rice husk.



Figure 1: Bam Bahadur Chaudhar's family of Katiya Village, Parsa VDC, Ruapandehi has been using this rice husk stove for nearly 4 years.

The following year NAEF had discussions with the DFID's Livelihoods and Forestry project personnel about replicating and demonstrating the use of the RHS, but shortly after this the program was held up due to the Maoist insurgency.

¹ Draft paper submitted to Third International Conference on Renewable Energy Technology for Rural Development (RETRUD-08) 12-14 October 2008, Kathmandu, Nepal

After the peace accord with the Maoists NAEF was again able to return to these VDCs. Initially what we had seen and heard from our cooperating households was positive, in that they were not only continuing to use the RHS but were also promoting its use around them. Some months later June 2007, NAEF went to one of those above rice mills where NAEF had distributed RHS was Katiya, Parsari where we talked with rice mill owner and stove user and promoter Bam Bahadur Chaudhary. He said his family has used RHS's for the last 4-5 years and related to us that it was a tremendous help, as there are so many mouths to feed and cook for in his extended household of 15 people. He and several of his family members, and neighbors who had gathered said that there are 4-5 workshops and a couple of blacksmiths around in surrounding bazaars were making and supplying this stove. One of the blacksmiths saw a new version at the Butwal Industry Mela being exhibited by Butwal Technical Institute there. Since then most of the other blacksmiths has begun making this model (see Figure 1) as they related that it was cheaper, lighter weight, and easier to manufacture. But reportedly it can make more smoke than the earlier one which when operated properly is virtually smokeless. Figure 2 shows Mr. Chaudhari's daughter-in-law, who was making us tea with the stove. It boiled nearly a litre of water in 5 and a half minutes and used perhaps 250 grams or less of rice husk.



Figure 2: Maiya Devi Chaudhary of Katiya, Parsari VDC, and her sisters in-law have been using rice husk stoves for cooking main meals, and pictured here tea for us, for nearly 4 years in their extended family of 15.

They report that hundreds of families are using the RHS's around their VDC. We asked another older woman standing nearby if her family used it and she said that as they are a bit rich (father works in government office) and that they have only 4 members in their household they use gas stove. She said mostly families with many members to cook for and/or poorer households are using this stove. Bam Bahadur and his daughter-in-law Maiya Devi said that their rice mill used to just give away the rice husk for free but a couple years back, as use of stove increased and demand grew for rice husk, that his mill is now selling one large bora bag for 30 rupees. One bora bag can hold 15 - 20 kgs of

husk and can last 4-5 days in a large family, representing a significant savings over other energy sources.

Since these visits in June 2007 Ashok had talked with and visited several rural manufacturers of the RHS. We even found a very poor quality RHS for sale at a hardware in Galamandi in Bhairahawa. The proprietor reported he had bought it from someone traveling through the bazaar but had not sold it as he really did not know how to use it. In January 2008 we took a tour around searching for the workshops making RHSs. The first workshop we came to was Dolanendra Sapkota's, proprietor of G.C. Engineering Workshop, in Balwari Bazaar (see Figure 3). In addition to the two people who work in his engineering workshop, he had hired 8 additional workers for producing 10 pieces of the lightweight RHS per day. He started about 1.5 years ago. He said that warm season numbers produced is about 25% less. He said that he had first seen the RHS two years ago when someone brought an older stove in to his workshop for repair. He sales it wholesale for 350 NRs and that the retailers sell it for around 400 NRs. He claims it will last about 1.5 years before it will need to be repaired or a new one bought.



Figure 3: G.C. Engineering Workshop, Balwari Bazaar, Rupandehi is making approximately 10 pieces a day / 1500 pieces a year for the last 1.5 years.

We then went off the main road into Simra Bazaar and found Durga Chaudhary's workshop. He has sold about 100 pieces in the last month. His workshop has a small homemade sheet metal rolling machine to roll the cones into shape. At nearby Darshan Tole in Simra Bazaar Basist Chaudhary has a small workshop where he sells about 10 pieces per month. We also heard from these two workshops about other small blacksmith/workshops in Madrani Village, Makraha VDC there, that takes orders of about 3-5 pieces per month. And that Kanchi bazaar has a workshop that will soon start making stoves. All these workshops seem to be making from orders from local, nearby villagers.

When discussing with the workshop owners and retail sellers of about why there seems to be so much demand these days and all said it was because of the higher cooking energy costs- high cost of CNG LPG gas, loss of subsidies on kerosene and the difficulty in buying them/cues. Others have said that due to the turning over of the forests to local forest user committees in Rupandehi in the last few years the availability of firewood has diminished. Another response is that it is a new technology and easy to use and easy to find the fuel so that even if the costs were not going up people would be interested in them.

We also paid a visit to Butwal Technical Institute to find out how much they had been working in support of this technology. We met with long time BTI technical foreign advisors and teachers Allen and Andrea Smith. They told me that Mr. Ram Vilash, who has been hired in the past as a consultant was responsible. Mr. Bilash had tried to get BTI interested in promoting the stoves that he had found himself in Kathmandu, but with no luck. He has a very small workshop in the north of Butwal (no phone number) where he had manufactured 2 or 3 RHS. They said that he had displayed his stove in BTI's stall at one one of the annual Butwal Industrial Fairs some years back. But they don't think he did had more of a program for that as he was working 100% out of his pocket. BTI is attempting to locate Mr. Vilash to help us find out more.



Figure 4. Nepal Garalu Hastakala Udyog workshop, main bazaar Bhairahawa. After an demonstrations, orientation and site visits Mr. Vishwukarma (middle) now sells various models (qualities) of RHS along side the turbo and saw dust stoves.

In continuation of the promotion of the technology NAEF took one heavy model and one lightweight model RHS to Mr. Shankar Psd. Vishwukarma, Proprietor Nepal Garalu Hastakala Udyog, Bhairahawa Bazaar. He is one of the largest manufacturers of other two² improved and widely used *bipankhi chulo* or turbo (forced air) stoves and *katko*

² Turbo stoves of various sizes use variously sized 6 volt DC computer fans powered either by cheap ubiquitous and inexpensive Chinese variable voltage transformers or old motorcycle batteries. Sawdust

dhulo chulo or sawdust stoves in Rupandehi. He had heard of RHS but had never seen one. After several demonstrations, orientations, and site visits, over a period of a few months he began manufacturing the RHS in February with up to 10 pieces per day. He proudly reports that he is helping to popularize the RHS not only in the villages but also in the urban areas, though he complains that the RHS is replacing or reducing the demand of his higher cost (and more profit and lucrative) turbo stove.

Main observations:

- Richer households are not (yet) interested in this technology. This technology is self selecting for poorer rural families. From our initial interviews we believe that the majority of households using the RHS are from poor and large middle income joint families. Many or most have members working in nearby industries. But away from Rupandehi's industrial corridor it appears adoption is less and that the RHS and other new stoves are not reaching the poorest of the poor.
- RHS technology seems to be mostly used in rural areas, unlike the bi-punkha chulo which is urban and rural based. This comes from our interactions with bi-punkhi manufacturers and hardware stores.
- The manufacturing of these improved stoves like RHS has generated employment in the small metal workshops. But some of the workshops are only making one type of stove and are not familiar with the other types, which if manufactured could boost employment further and speed adoption of the new stoves.
- We estimate that there are now nearly 3000 families in Rupandehi using the RHS up from zero 4 years ago. But how much rice husk is there and how many families could it benefit? If a family is using year round for cooking their demand for rice husk would be 20-30 kgs per week or approximately 1000 - 1,500 kgs of "renewable energy" rice husk per year. Multiply by 3000 households that are currently using RHSs (and we currently assume they do so full time) the demand for "renewable energy" rice husk is 4,500,000 kilograms or 4,500 tons of "renewable energy" rice husk. Current estimates of total rice husk production in the Western Development Region (WDR) of which Rupandehi District lies in, is estimated at over 150,000 tons³. That is enough rice husk for 100,000 households. The WDR's total household population is approximately 860,000. So theoretically there is enough rice husk for approximately 12% of the families / population of the WDR. Not enough for the 40% below poverty level HHs but perhaps enough for the 8% extremely poor households.

stoves are an old technology but new to Nepal but have also become recently popular. Both burn their fuels more efficiently and with less smoke. Though several NGOs have claimed responsibility for sawdust and turbo stoves, it more likely appears that these two stoves gained their popularity mostly from word of mouth and small and industrious private sector workshops. Therefore, like many other private sector initiative success stories, there is currently no one from the development community showing interest to follow up on these two stoves and therefore no data on these stoves coverage and environmental and social impacts.

³ See Comparative Performance Comparative Performance Study of Rice Husk Stoves, S. Shrestha & R. G. Rasaily, Agricultural Engineering Division, NARI, Khumaltar. 2006.

- National wide there are 4,5 million tons of paddy produced nearly one million tons of rice husk is available.

Recommendations:

- A more systematic impact assessment is needed to understand the implications for livelihoods and women's: 1) health improvement cleaner burning, clean air; 2) drudgery reduction via reduction/elimination of gathering firewood/cow dung for the cooking fires.
- How to increase the adoption of this technology (and its benefits) by very poor families. This could be through accessing existing women's micro-credit programs, and familiarizing them, and their poorest members with this technology.
- I little more research is needed to see how the rice husk could be "extended" with the use of other available bio-mass (other crop residues such as rice straw or forest litter). This could boost the total theoretical numbers of poor families able to access this technology.
- Such a study needs to also explore the current use of the RHSs, how much rice husk/biomass they are actually consuming and their likely environmental impacts. It is our belief that the RHS would easily qualify for carbon trading via Clean Development Mechanism (CDM). CDM is an arrangement under the Kyoto Protocol and involves countries from the industrialized world funding reductions in greenhouse gases from the developing world, and being credited with some of the pollution reduction themselves. This reduction can be costed in terms of the number of dollars it takes to prevent one ton of carbon dioxide being produced (USD / ton CO₂). This would be paid by the 'carbon buyer' for whom the improved global environment is what they are 'buying'. Recently Nepal has benefiting from the CDM via it's biogas projects. We feel that these similar renewable agricultural "bio-mass"⁴ and clean burning RHSs should have even greater scope for carbon dioxide reductions and trading. Many biomass fuels generate lower levels of such atmospheric pollutants as sulphur dioxide that contributes to acid rain. Though the RHS is fairly unsophisticated it has the same combustion efficiency and emission levels comparable with the best fossil fuel boilers⁵. In this light rice actually becomes a sustainable, food and "energy" crop.

⁴ Biomass energy offers another opportunity for agriculture to contribute to carbon sequestration. This is because the combined effect of the original sequestration and the subsequent release of carbon would approximate to a zero net release (or recycling) of carbon into the atmosphere. The use/burning of the theoretically available 533,500 tons of rice husk in Nepal for clean energy use via stoves and factories would avert the release of over 800,000 metric tons of CO₂ annually (see Appendix 4) from the burning of conventional fossil fuels.

⁵ It may prove much harder to argue for the inclusion of the turbo and sawdust stoves as renewable biomass stoves as there source of fuel currently is firewood/wood that may or may not be coming from sustainable forest reserves of Nepal.

Appendix One: Current uses of rice husk

Burning/smoldering piles in the evening for 1) insect control; and 2) in winter for heat.
Bedding material for poultry & livestock
Insulating material
Heat source for puffed/beaten rice mills and oil expelling mills in rural and urban areas.
Heating industrial boilers in urban and peri-urban areas.
Producing Rice Husk Briquette- but due to higher costs, frequent wearing of the screw, availability/higher cost of rice husk it is not popular. More than 30 industries were established in early 90s, but only one is in operation and sells at high price in Kathmandu five star hotels.
Calorific Value of Rice Husk 16.2 MJ/kg – Lower as compare to other biomass that 18 – 20 MJ/kg due to rice husks high silica content.

Appendix Two: Theoretical amount of rice husk in Nepal

Paddy rice is also called rough rice by weight, the composition of paddy rice is approximately: **22% husk** (including about 2% trash), 10% bran, and 68% rice (2% of the rice are very small pieces, brewers rice, and fines). Total rice production in Nepal 2004 was 2,425,000 tons. That gives theoretically 533,500 tons of rice husk availability.

Appendix Three: Rice husk and ash elemental breakdown⁶

Element	Mass Fraction %	Composition of Rice Husk Ash	
Carbon	41.44	Element	Mass Fraction %
Hydrogen	4.94	Silica (SiO)	80 – 90 %
Oxygen	37.32	Alumina	1 – 2.5 %
Nitrogen	0.57	Ferric oxide	0.5 %
Silicon	14.66	Calcium oxide	1 – 2 %
Potassium	0.59	Magnesium oxide	0.5 – 2.0 %
Sodium	0.035	Sodium oxide	0.2 – 0.5 %
Sulfur	0.3	Potash	0.2 %
Phosphorous	0.07	Loss on Ignition	10 – 20 %
Calcium	0.06		
Iron	0.006		
Magnesium	0.003		

Appendix Four: Burning biomass and it's emission of carbon dioxide⁷

Carbon and oxygen have molecular weights of 12 and 16 respectively. CO₂ has a molecular weight of 44. One ton of pure carbon would equal 1 ton x 44/12 = 3.66 ton of CO₂. From Appendix Three we see rice husk is 41.44 % by mass. So burning one ton of rice husk equals .41 x 1 x 44/12 = 1.5 tons of CO₂. Multiplied by the theoretical supply of

⁶ Precipitated Silica from Rice Husk Ash IPSIT - Indian Institute of Science
<http://cgpl.iisc.ernet.in/site/Portals/0/Technologies/PrecipitatedSilica.pdf> Last accessed 8 March, 2008.

⁷ Biomass Burning And The Production Of Greenhouse Gases. Joel S. Levine, Atmospheric Sciences Competency, NASA Langley Research Center Hampton, Virginia http://asd-www.larc.nasa.gov/biomass_burn/biomass.html Last accessed on 8 March 8, 2008.

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533,500 tons of rice husk is 802,028 metric tons of CO₂. Compare this to the biogas programs in Nepal that release and recapture 46,990 metric tons of CO₂ per year. Earlier we conservatively estimated that 3000 families using the RHS in Rupandehi are using 4500 tons rice husk per year. That would be the equivalent of 6750 tons of CO₂ recycled per year or 14% of Nepal's total biogas program. Add to (from another badly needed assessment that all the industry boilers, puffed and beaten rice mills, and oil expellers use of renewable biomass energy rice husk and the above figure could easily surpass the biogas programs.