Press Release: for Immediate Release
Kabankalan, Negros Occidental, Philippines; Ste Anne de Bellevue, Quebec, Canada

Mayon Turbo Stove: Next Generation Household Cooker Developed in the Philippines

Breakthrough in clean combustion provides low cost and convenient cooking fuel from rice hull

Inspired by the Mayon volcano, the Mayon Turbo Stove has a near perfect cone design that allows clean and convenient combustion of rice hulls. Low income rural families who own the new cooker with its twin air injectors are calling it the "poor mans gas stove". For (US) $7 per cooker, impoverished families in the Philippines are now converting crop residues produced by the worlds most important food crop into a high quality cooking flame. The mountains of surplus rice hulls found throughout Southeast Asia can now be used as a convenient and low cost, cooking alternative.

"It is essential we mainstream this cooker as quickly as possible. As the poverty situation worsens, women are increasingly affected by the burden of how to cook their families daily meals" said Roger Samson, Director of International Programs for Resource Efficient Agricultural Production-Canada. Where fuelwood is gathered in communities, the stove relieves women from walking 60-120 days per year to meet their annual household fuelwood needs and additionally prevents deforestation. A study on the island of Negros, found the Mayon Turbo Stove slashed cooking costs to (US) $5.18 dollars per year from (US)$60-$97 for families compared to purchasing firewood, charcoal, and LPG. The savings for these Negros families adopting the Mayon Turbo Stove was 3-5% of their total annual income.

The Mayon Turbo Stove was developed by Canadian renewable energy specialists working with Resource Efficient Agricultural Production-Canada in cooperation with MASIPAG and Paghida et-sa kauswagan Development Group (PDG) in the Western Visayas of the Philippines. The cooker is part of a three year Canadian International Development Agency (CIDA) funded project aimed at alleviating poverty and reducing greenhouse gas emissions in the Philippines through clean combustion of crop residues. REAP projects the stove could be adopted by more than 1 million households in the Philippines alone. Samson said, "We now challenge rice producing nations like the Philippines to use this stove as part of their rural poverty reduction strategy".

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(30)

Dear Stovers,

Stovers may be interested in an ongoing rice hull cooker stove improvement program REAP has been involved in with partner organizations in the Philippines. Here is a summary of the projects development to date.

Like many developing countries, the Philippines has a growing population and increasing rural poverty, and cooking fuels are becoming increasingly scarce. REAP recently completed a report for NREL on "Strategies for Enhancing Biomass Energy Utilization in the Philippines" and one of the most promising options identified was to utilize rice hulls as a low cost domestic cooking fuel source. There are more than 1.5 million tonnes of recoverable rice hulls in the Philippines which could be used as cooking fuel by more than 1 million families. Using rice hull locally in low cost cookers seemed the ideal way to utilize the resource as it is widely dispersed and of a bulky nature. Rice hull also has the natural advantage of being of a uniform and small size. These characteristics make it relatively easy to design an efficient combustion system for household cooking in comparison to burning with wood or other crop residues.

In 2001, REAP acquired a 3 year funding program from the Canadian International Development Agency (CIDA) to introduce an improved rice hull stove into approximately 10,000 households in the Western Visayas region of the Philippines. To improve the stove, we accessed all the major rice hull stoves available in the Philippines including versions from the International Rice Research Institute (IRRI), Philrice, the Central Philippine University (CPU) and a version of the Lo-Trau model developed in Vietnam. Some of these stoves were superior to others but all suffered from from one or several deficiencies including: incomplete combustion, excess air, uncontrollable fuelbed fires, high rice hull consumption and being overly expensive for rural peasants to purchase. We needed to build a stove for under (US) $7.50, as this represented one weeks salary in rural areas of the Western Visayas. Peasants also were used to buying charcoal and firewood stoves made from clay that sell for about (US)$ 0.50.

We decided to work with the Lo-Trau model because of its relatively low cost and simple basic design. With our partner organizations, PDG and MASIPAG, we streamlined production improvements to manufacture the stove to get production costs down to (US)$7 per stove. However, we observed that the stoves we were introducing to communities were experiencing problems of incomplete combustion and required constant maintenance and tapping. We made some initial combustion improvements to the stove by lengthening the frustum (the center cone) from 5 to 7 inches (which also shrank the cone top and concentrated the flame under the pot). We also drilled secondary air holes, 2 to 3 from the top of the cone. To minimize fuelbed fires, we eliminated one of four rows of holes at the base of the fuel bin to reduce upward airflow through the fuel bin. These changes improved the stove, but the flame remained excessively smoky and the stove required regular tapping (although this was reduced) to maintain combustion. The CPU stove we tested had a single air vent pipe through the bottom of the ashpan, which appeared to help reduce smoke events. We decided to experiment with different sized pipes to determine a level of air that would be adequate but not excessive. We noticed that the single pipe caused a blue flame in the center of the cone. However, surrounding this oxygen source, the flame was still an orange-yellow colour. We realized we needed more air mixing in the cone as we perceived there were still oxygen dead spots that led to incomplete combustion of the gases. One option we tested was twin air pipes of 1inch diameter to increase turbulence inside the cone. They ended up creating vortexes in the flames and appeared to slow the rate of air flow out of the cone (which was excessive in the centre with the single large air pipe). The result of the twin air injectors was that after 3-5 minutes, a blue or nearly colourless flame was present throughout the cone. Maintenance of the stove also was reduced, tapping of the stove was only required after 10-12 minutes to maintain the stove flame. However, we still experienced some smoke events after ten minutes of burning when the rice hull turned to ash and reduced airflow from the holes at the base of the fuel bin. We decided to increase the size of the 10 secondary air vents from ¼ to 3/8 inch. After this modification, we experienced no more smoke events due to oxygen problems. Smoke events only occurred when the flame was going out due to lack of fuel. This occurred generally when the fuel bed turned grey from the hulls being completely burnt out. Simply tapping to introduce more fuel, about every 10 minutes maintained the flame. The new model also has been found to be easier to start, and produces less smoke upon termination. Essentially we believe now the stove has a near perfect air situation. There appears to be no excess air and no oxygen deficient areas of the cone, or oxygen deficient periods during the entire burn cycle. When new fuel is added, smoke infrequently occurs and a clean burning flame returns rapidly. Clean combustion occurs as the new design appears to increase the gases residence time in the inner cone and exposes them to higher temperatures. The rice hull ash falling out is now of a whitish grey colour. The changing nature of the airflow through the fuel bed (as the relatively porous hull turns to ash) is dealt with through the twin air pipes and secondary air at the top of the inner cone. The most important new design improvement appears to be the twin air injectors that create a swirling and mixing action. Older stoves in communities are now being retrofitting with the twin pipes.

We have had very favorable feedback thus far from communities using the stove. Households are experiencing reductions in rice hull fuel requirements, less maintenance and less smoke. The main activity we are now examining is to build a smaller stove with a 6 inch diameter fuelbed. The 7" diameter fuelbed model now appears to have excessive heat output for smaller pots of rice because of more complete combustion of the rice hulls and gases and better control of the air flow. The project is still in its first year and we are currently producing and marketing approximately 350 stoves per month. Savings appear considerable for families purchasing firewood, charcoal and LPG. A user survey found the Mayon Turbo Stove is reducing the annualized cooking cost (annual stove and purchased fuel cost) in Negros by 91-94% compared to purchasing these aforementioned fuels.

A line drawing and instructions on how to build and use the Mayon Turbo Stove can be found at www.reap-canada.com. We would be most willing to work with other groups who are interested in building the improved stove in other rice producing nations.

Good luck trying the stove and we look forward to your feedback.

Trevor Helwig, Claudia Ho Lem and Roger Samson, REAP Canada