



STOVES FOR RICE HUSK AND OTHER FINE RESIDUES

Introduction

Rice husks and other fine residues have historically been regarded as worthless wastes, disposed of by being burnt on site or, on occasions, flushed away into rivers. By converting them into a resource, they become an asset rather than a liability. However, fine particles have particular characteristics that make them impossible to burn in a standard stove. The major sources are rice-husk and sawdust, but other residues, such as millet husk and peanut shells can often be burnt.

Common to all fine residues is the need to get the mix of fuel to air correct. Where residues are densely packed, air cannot reach the middle of a heap of residues, smouldering occurs, along with lots of smoke. Ways must be adopted to burn this smoke before it leaves the stove. If residues are too widely dispersed, they are impractical to burn, but another approach allows fuel to trickle down, mixing with the air in the correct proportions. For residues such as rice husk, there is the added problem of *low calorific value*. This means that each small particle produces a lot of ash for a small amount of heat. Getting rid of the ash must be addressed in the stove design.

One way to deal with such residues is to convert them into briquettes. In some circumstances this is a good solution and a lot of research has been done on how to make and burn briquettes. However, briquetting is an extra process and adds cost to the fuel, and is not always appropriate. This document looks at using the raw material directly in the stove.

Types of stove

Rice-husk stoves

There are several approaches to burning fine residues. One way is to have the residues running through a funnel shape that provides a slow steady flow. With rice husk, a particularly abundant and difficult residue, a good example is the Lo-Trau stove (also called Ipa-Qalan stove) is shown in Figure 1. It is made of sheet metal and is lightweight (2.5kg).

Husk is poured between the main drum (1) and the inner drum (2). The husk is ignited, and burning can be regulated by the user. The combustion process can be quenched at any time by removing the inner drum (2). The stove consumes approximately 1.2 – 1.5 kg of husk per hour, it is easy to light, burns cleanly and cooks rapidly. Ash drops down to the ash-holder at the base of the stove and is recycled onto the fields. Care needs to be taken with the ash, which contains silica, as prolonged exposure can cause lung problems.

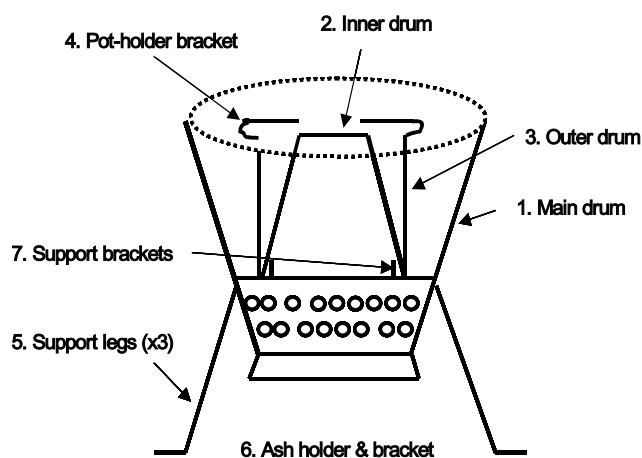


Figure 1: Lo-Trau rice husk stove. Illustration: Liz Bates

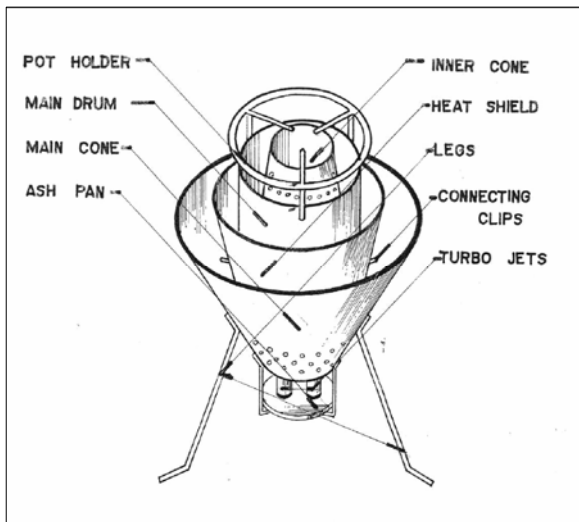


Figure 2: Mayon Turbo stove.
Illustration: REAP-Canada

A more recent development, the Mayon Turbo stove, shown in Figure 2, has higher-efficiency combustion resulting in a blue gas-like flame. This has been achieved through improvements to the air flow which has led to reduced fuel consumption, and through structural changes to make it more stable and require less maintenance.

The Mayon Turbo stove is available in various sizes. The cooker costs around US\$12-\$18 depending on the size. Over the past few years, REAP-Canada and their local partners have distributed 5000 rice hull stoves in the Philippines (REAP).

REAP is now stepping up efforts to introduce this simple technology both nationally and internationally. In the Gambia, testing of the stove has shown

that it also works very well with bulky porous fuels such as rice hull and crushed cocoa shells. Other fuels such as sawdust, corn cobs, peanut shells, coffee shell and millet husks can also be effectively used by mixing these fuels with rice hull or cocoa shell.

Sawdust stoves

In urban areas, sawdust is a major problem. Mountains of it can build up adjacent to sawmills, creating both an environmental problem and also a fire hazard. However, sawdust is both cheap and has a high calorific value, so it is therefore a valuable resource if it is burnt properly.

Cooking stoves

This stove, recommended by the development organisation ECHO, is simple to make and use if there is a good supply of sawdust (Forst). It burns with a high temperature and makes little smoke. The design uses 28 fireproof bricks to make a small square. It can also be made in a large tin or metal bucket. Other fine residues such as rice husks, wood shavings and other dry organic materials can be used.

A narrow bamboo or plastic pipe is inserted at the base, to the centre to act as an air inlet (A). A wider bamboo tube or pipe is held in the centre of the stove and tightly packed around with sawdust until the stove is filled (B). The pipes are removed very carefully by slowly twisting them out. Four bricks are placed on top to hold a pan. The sawdust is lit at the bottom by dropping in some paper and then a lighted match. If too much air enters through the air inlet hole and the stove is too hot, partly close the inlet with a brick or stone (C). Once lit, the stove will produce a great deal of heat and burn for up to six hours. It may be useful to place a flat piece of metal with a hole cut in it, on top of the sawdust. This metal plate drops down as the sawdust burns and helps to ensure even burning. It should be used in a well-ventilated room as gases are emitted.

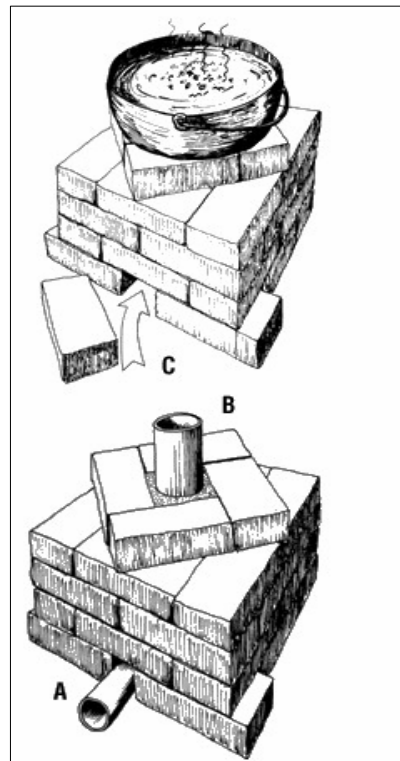


Figure 3: Sawdust cooking stove.
Illustration: TEAR Fund

Heating stoves

Sawdust is particularly useful as a heating fuel. The Fulgora stove (Bland, 1999) was originally patented in the UK (now expired). The stove is made of mild steel and comprises two concentric bins with a removable core tube down the centre. The removable inner bin has a hole through the bottom to the air chamber below. Sawdust is packed hard into the inner bin against the core tube, after which the removable core is carefully lifted out.

A couple of sheets of newspaper are used to heat up the flue and around the base where the stove is lit. Gases are drawn upwards through the hole at the base of the inner tin to where combustion occurs around the central core of the sawdust at the base of the fuel. The burning gases rise through the centre core, and are drawn down between the inner and outer walls of the heating stove, providing good heat exchange to the room as they pass between the two chambers before passing out of the room through a flue. A pipe attached to the flue leads the burnt gases outside. Further details can be found in *Boiling Point 43* (Note Errata given in BP44 for gas flow direction – this text is correct).

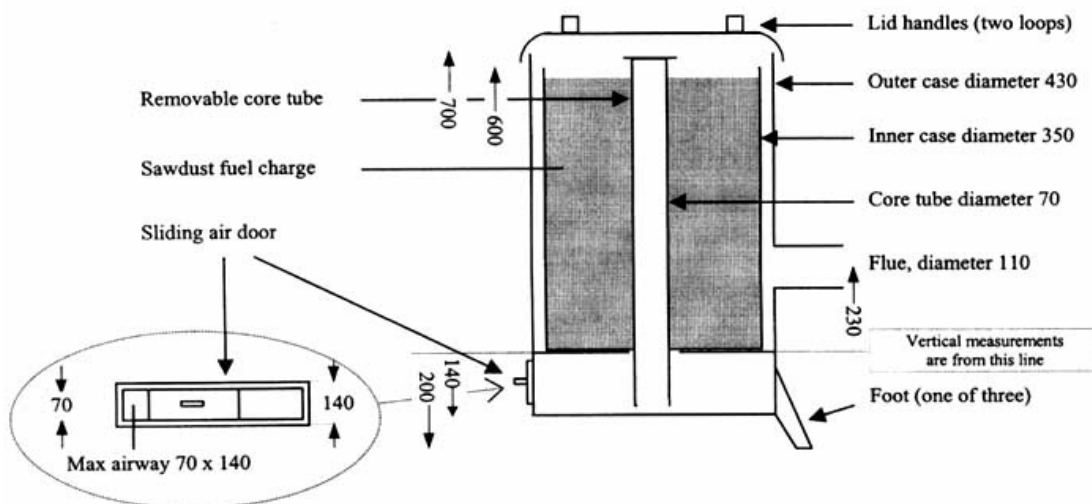


Figure 4: Fulgora woodburning stove (all dimensions in mm). Illustration: Fulgora.

A simpler design has been published by Vita, known as the double-drum sawdust stove (Wartluft). It is an inexpensive home-made stove for burning loose sawdust. Constructed from empty oil drums, the stove can heat a room 30 sq. m. for 6 to 8 hours without tending. In addition to sawdust, bark residue from sawmills and planer shavings from planing mills can be burned in the stove. The limiting factor for fuels is their moisture content. Though fuel having more than 100 percent moisture content will burn, most of the heat is used in evaporating fuel moisture. Fuel below 60 percent moisture contents works well. Fresh sawdust, shavings, and bark typically have moisture contents ranging from 50 to 110 percent. The best source of fuel is sawdust or shavings from dried lumber.

More advanced systems

Belonio rice husk gas stove

Very recently, the process called 'gasification' has been used to produce a very clean burning stove that uses rice husks. Gasification is when the gases within the rice husks are driven out of the husk and can then be burnt separately and cleanly. This is a much more advanced technology, it requires a small amount of electrical power to drive a fan, so can only be used where people are able to afford the stove and where there is backup available for servicing.

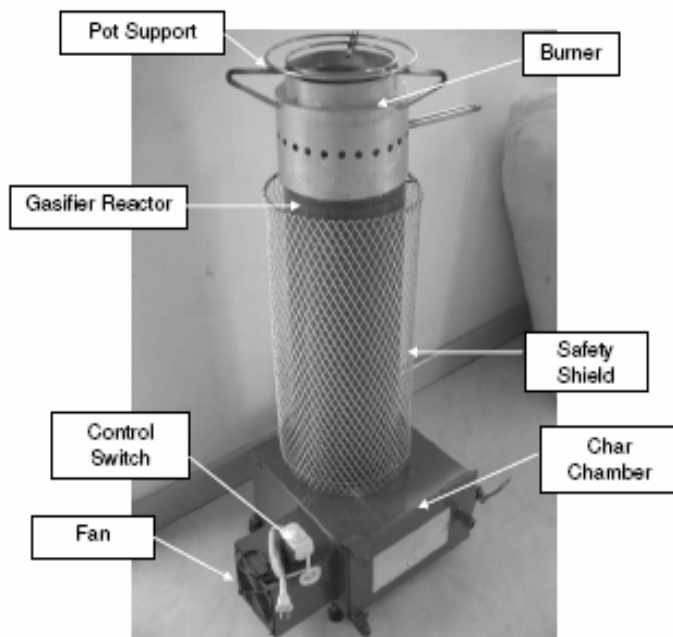


Figure 5: Belonio rice husk gas stove. Picture: Belonio

In the reactor, rice husks are burned with limited amount of air. This produces a gas, which is highly toxic unless it is burned on the top of the stove where it behaves similarly to bottled gas and burns with a clean blue flame. At the lower end of the reactor is a fuel grate made of stainless steel, which holds the rice husks during gasification. This grate can be tipped easily to discharge char after each operation. During burning, the grate is locked into its working position. Around the reactor is an aluminium screen to prevent accidental contact with the hot reactor during cooking (Belonio_1 2006).

Rice husk gasifier bakery oven

A rice husk gasifier-type burner for bakery ovens has recently become commercially available. This rice-husk-fuelled burner significantly reduces the cost of fuel for baking. The useful gases from the rice husk are driven off in one part of the oven, and ignited as in a standard bakery oven and it burns with a luminous bluish flame. Once installed, the fuel costs are about one third of a standard oven using bottled gas (Belonio_2 2006). This stove is discussed in more detail in the Technical Brief on Institutional Stoves.

Benefits

Socio-economic benefits

- Low-income rural families can now utilize surplus rice hulls found throughout much of the developing world as a clean burning and low cost cooking fuel alternative, thus reducing their household cooking expenses
- Well-designed stoves can reduce emissions and thus improve indoor air quality and health
- A residue stove can produce a really hot flame, reducing the amount of time spent cooking; for example, boiling a litre of water takes around seven minutes
- Residue stoves are convenient to use, thus reducing drudgery for the cook – with the Lo-Trau and Mayon-Turbo, the cook has to tap them gently every few minutes to introduce new fuel.
- Further drudgery seeking firewood can be reduced as many of these residues will be available on-farm.
- Both these stoves are portable and lightweight so they can be used both indoors and outdoors
- Residue stoves can usually be used with a variety of small residues, including rice hull, peanut shells, cocoa shells, crushed coconut shells and/or corn cobs, millet husk, and sawdust
- Manufacturing and selling stoves to use residues can provide valuable employment

Environmental benefits

- Ash can be reused as a soil conditioner, fertilizer, and pest repellent around plants
- Using residues reduces pressures on forests
- Using residues gets rid of these materials in an ecologically-friendly way
- The quantity of cow dung used as fuel can be substantially reduced and this is a valuable fertilizer
- Where fine residues are burnt cleanly and replace wood fuel and dung, they make a valuable contribution to reducing greenhouse gases. Projects which promote these stoves may be able to access funding for such reductions.

Disadvantages and constraints

The main problem with such technologies is that they all give off gases, and unless care is taken to ensure that these gases are fully burnt, as they can be dangerous. The exception is the Fulgora heating stove, with a flue which discharges all the gases out of the room. The other stoves described should all be used in a well-ventilated room.

A second issue involves the availability of raw fuels. Residues tend to be seasonal and if this is to be the only stove that a household can afford, then fuel must be available all the year round. Similarly, a large stockpile of sawdust can soon be reduced to nothing if there are more people purchasing and using the residue than is being produced by the sawmill. This may only become apparent when all the stocks have been exhausted. Some care is needed, therefore, in promoting stoves of this kind.

Finally, heating stoves often have components which are hotter than they would appear. Stoves with fuel packed around the central core should never be opened during the burning process and warning messages should be used on the appliances to alert people to this danger and to indicate any hot components that could burn if touched. Residue stoves should have protection built around them to prevent access by small children.

Conclusion

Fine residues such as rice husk and sawdust should be regarded as a resource rather than as a waste product. Carefully designed technologies can enable those living in poverty to use such fuels cleanly and cheaply. Particular care must be taken regarding unburnt gases and hot components, but properly used, stoves for fine residues are clean and affordable technologies.

Bibliography and information sources

- *Belonio_1 Rice husk gas stove handbook*. APT, Dept of Agricultural Engineering & Environmental Management, Central Philippine University, Iloilo City, Philippines, 2005
http://www.repp.org/discussiongroups/resources/stoves/Belonio/Belonio_gasifier.pdf [Accessed: February 2007]
- *Bellonio_2 Rice Husk Gas Burner for Bakery Oven*, 2006
http://www.repp.org/discussiongroups/resources/stoves/Belonio/Rice_Husk_Gasifier_for_Bakery_Oven-Agri_Magazine.pdf [Accessed February 2007]
- *The Mayon Turbo Stove: Fueling the fight against poverty* REAP-Canada
http://www.reap-canada.com/bio_and_climate_3_3_1.htm [Accessed February 2007]
- *Double-Drum Sawdust Stove* by Wartluft, J L
<http://sleekfreak.ath.cx:81/3wdev/VITAHTML/SUBLEV/EN1/SAWDSTOV.HTM> [Accessed February 2007]
- *Alternative Fuels* Forst, C. Footsteps Issue 46
<http://tilz.tearfund.org/Publications/Footsteps+41-50/Footsteps+46/Alternative+fuels.htm>
- *The Fulgora Sawdust Burning Stove* Bland, H. *Boiling Point No. 43 - Fuel Options for Household Energy* Practical Action (ITDG), 1999

Websites

<http://www.irri.org/>

<http://www.repp.org/discussiongroups/resources/stoves/>

Practical Action

The Schumacher Centre for Technology and Development

Bourton-on-Dunsmore

Rugby, Warwickshire, CV23 9QZ

United Kingdom

Tel: +44 (0)1926 634400

Fax: +44 (0)1926 634401

E-mail: infoserv@practicalaction.org.uk

Website: <http://www.practicalaction.org/>

This document was produced by Dr. L Bates for Practical Action in March 2007.

technical brief