MEASURING FAMILY FUEL CONSUMPTION

Brian MacGarry SJ, Head of Technical Skills Section,
Silveira House Training Centre, PO Box 545, Harare, Zimbabwe

ABSTRACT

Planning for family fuel saving requires measurement of total family cooking fuel consumption as a basis for comparison. Two simple methods of comparing fuel consumption are described to: (1) test acceptability of a charcoal cooking stove in low-income urban homes; and (2) measure fuel saving produced by woodstoves in rural homes. The charcoal stove offered savings as compared to cooking with electricity and in some cases as compared with wood. Users who are charged a flat rate electricity tariff for a limited load found the charcoal stove more convenient as their maximum allowance of electricity did not provide sufficient cooking power. New charcoal stoves proved more efficient than traditional cooking methods with fuel savings of the order of 70%.

INTRODUCTION

Refined laboratory methods of testing the efficiency of a cooking stove tell us little about the acceptability of that stove in every situation (Foley et al 1984). Nor do they give an accurate indication of fuel savings in practice. Assessment of how a proposed new stove will serve the needs of a given group of people would be extremely difficult in the laboratory.

We describe here approaches to determining whether a proposed new stove saves wood or money for real housewives. In answering this question, we hope to provide some indication of what other factors might affect choices as to whether to change or not to change from traditional to new cooking methods.

Reflecting the financial and manpower constraints of a non-government training centre engaged in rural development by motivating groups in the field, the projects described are designed to gain the maximum participation of potential client households in making measurements in their own domestic situation. Only a few of the most significant parameters can be included and their measurement must be as simple as possible.

Two methods will be described, as applied in different situations. The first attempts to determine whether use of a specific new technology, a charcoal cooker, would save money for urban households. The second tests whether new styles of wood-burning stoves would reduce rural families' overall fuel wood consumption.

TESTING CHARCOAL STOVE

The question

Charcoal is not used by lower income urban families in Zimbabwe and deforestation due to heavy urban demand for fuelwood is becoming a national problem. Poorer urban dwellers complain of the cost of other cooking fuels, mainly paraffin and electricity. Thus, a recently developed charcoal stove seemed to offer a new alternative. Charcoal is readily available in the country, from wattle plantations where charcoal is a by-product for which there is at present insufficient commercial demand.

The stove in question was manufactured by a local firm and we obtained three free samples for use in our tests.

Testing method

We selected volunteers from the residents of Harare's lower-income suburbs through personal contacts: either parish churches or members of our own staff living in the suburbs in question, and their friends. Each selected family was lent a charcoal stove and given a 5kg bag of charcoal. We explained how the stove worked and obtained their agreement that they would do all their cooking on the charcoal stove from a specified morning until the bag of charcoal was consumed. They were not told the retail price of either the stove or the charcoal.

When the charcoal was finished, each household was visited again. Information was obtained on how long the charcoal lasted, how much was spent per week or per month on their present method of cooking and the price of their present stove and the cost of repairs and maintenance. We also requested any other comments on the relative merits of charcoal and other methods of cooking.

This procedure was followed in different types of household in different suburbs, from widows with children to large and fairly prosperous families.

Results

In the examples below, the price of a 5kg bag of charcoal is Z$2.00; a two-pot charcoal cooker, $36.00; and a three-pot charcoal cooker, $50.00. Prices of other stoves and fuels are listed in each case. For each household, the location and number of family members are indicated.

Households using wood only

Household (1); Tafara; 2 adults, 3 children, spending $2.50/week for wood which lasts 4 days; wood for the other 3 days is collected from rapidly thinning woodland nearby.

	Fuel/month	Stove	Comments
Charcoal	$ 4.00	$36.00	Clean and quick
Wood	$10.00	$ 5.00	

Charcoal break-even: 5 months

Other households in Tafara and nearby Mabvuku estimate wood should cost $4-$5/week if it was all bought, which no one can afford.

Household (2); Mbare; widow and 5 children; buys wood as offcuts from a carpentry shop 75c/each, which lasts 3 weeks;

	Fuel/month	Stove	Comments
Charcoal	$ 4.00	$36.00	
Wood	$ 1.00	$ 5.00	Wood always cheaper

Households cooking with paraffin only

Household (3); Tafara; 2 adults and 4 children;

	Fuel/month	Stove	Stove maintenance per year	Comments
Charcoal	$12.00	$50.00		Want to keep the cooker
Paraffin	$10.00	$ 7.00	4.50	

No break-even

Household (4); Mbare; widow and 2 children;

	Fuel/month	Stove	Comments
Charcoal	$13.00	$36.00	
Paraffin	$ 5.25	$ 7.00/year	Needs replacing as spares are not available

No break-even

Household (5); Mbare; lone widow;

	Fuel/month	Stove	Comments
Charcoal	$ 2.00	$36.00	
Paraffin	$ 1.05	$ 5.00	Used same stove for 5 years

No break-even

Households using both wood and paraffin

Household (6); Glen View; 2 adults and 7 children;

	Fuel/month	Stove	Stove maintenance	Comments
Charcoal	$20.00	$50.00		
Wood	$ 4.00	$ 5.00		
Paraffin	$ 8.00	$ 7.00	$4.50/year	
Total w & p	$12.00	$12.00	$4.50	

No break-even

Household (7); Tafara; 3 adults, 7 children;

	Fuel/month	Stove	Stove maintenance	Comments
Charcoal	$ 8.00	$50.00		Includes heating iron for clothes
Others (total)	$17.00	$12.00	$3.00/year	

Break-even 4 months

Households with electricity

Household (8); Tafara; 2 adults and 2 children; electricity charged per kWh

	Fuel/month	Stove	Comments
Charcoal	$ 8.00	$ 36.00	Satisfactory
Electricity	$ 6.00	$420.00	

Electricity break even: 16 years

Household (9); Mabvuku; 2 adults, 6 children: electricity: flat rate $7.00/month, max. 5A. Electric stove cost approx. $400.00.

Charcoal cost $4.00/month; using $36.00 stove cooking is quicker than with electricity, easier than with paraffin: would buy charcoal stove at this price, even though they would still pay for electricity for lights, radio and refrigerator.

Household (10); Mbare; widow and 3 children: electricity included in rent. Charcoal $2.70/month in $36.00 cooker - too expensive, as here electric hot plate cost less than this cooker.

Household (11); Mabvuku; 3 adults, 5 children:
Electricity; flat rate $7.00/month, 5A max. Charcoal cost $12.00/month in $50.00 stove. Electric stove cost about $400.00 - electricity break-even: 3 years. Would buy charcoal stove if it cost $15.00.

Household (12); Mabvuku; 8 adults, 7 children.
Electricity: $10.00/month flat rate; can only use one hot plate of a $400.00 stove at a time. Charcoal cost $8.00/month in a $50.00 stove: They want to buy stove at this price.

Comments

These families regard their fire or stove almost exclusively as a means of cooking. If it also heats the house this is incidental. These preliminary results show that the charcoal stove can offer savings within a reasonable period for some who now use wood fuel; these represent a growing potential user group as wood fuel becomes scarcer.

Electricity is more expensive than charcoal for most families, at least within the time scale most people would consider. Paraffin, although the cheapest alternative, is subject to interruptions in supply, so one family listed here is now trying to change to electricity from paraffin.

This sample is small and testing continues. It is necessarily slow because a certain trust in the questioner is required as well as a knowledge of the testing method.

TESTING WOOD STOVES

The question

Working with groups of rural people we had produced what we hoped were improved wood burning stoves. Our two main types of stoves, and the iron grate which most rural people in the provinces of Mashonaland, Manicaland and Masvingo use, are illustrated in Figure 1.

The mud stove is carved and moulded out of a solid block of anthill clay, a material which rural housewives are familiar with. The design owes something to the lorena stove (Evans 1979) and something to the new Nepali Chulo (Bachmann and Saubolle 1980). These two designs and the existing grate have been described elsewhere (MacGarry 1983).

Here we are not concerned only with cooking efficiency. An open fire in the central fireplace (choto) of a rural Shona kitchen serves many purposes besides cooking including: heating, provision of a social focus, smoking meat to preserve it, and drying clothes in wet weather. It is unlikely that any new method of heating will outperform the existing fire and hearth in all these areas. Hence

households that use a lorena-type stove, sometimes also light a fire in the central choto.

Our question is therefore; by how much (if at all) does use of a new stove reduce a family's weekly or monthly fire-wood consumption?

Gill (1982) has pointed out that the grate now used superseded the previously used three-stone hearth because it saved cooking time but not wood. Thus, our assessment must also consider these other factors that influence the housewife's decision, although fuel saving carries more weight than it did 20 or even 10 years ago.

Even so, a saving in firewood consumption will only seem important to users if it is sufficient for them to notice without using highly sophisticated measuring techniques. We have therefore developed techniques which they can easily use but are still adequate for our purpose.

Method

Wood is usually collected by women and in the season when there is less agricultural work to do. Traditionally, only dead wood was collected, or wood cut when clearing fields was used when it had dried. Now more green wood is cut, but it is still allowed to dry before use. The users test moisture content by the way the wood breaks and its general appearance. For the purpose of our measurements, we assumed that this method ensures a reasonably consistent moisture content in fuel used.

We aimed to measure the perceived overall fuel saving of a kitchen, ie not just stove (which may not be used all the time) vs traditional hearth, but stove/hearth combinations as used vs hearth alone. This can be done by asking housewives who use new stoves two simple questions:

a. How long did a headload of wood last when you had only the old hearth?

b. How long does it last now?

We asked these questions frequently over two or three years of all stove users. Six within 5km of our centre were visited monthly for the first year. We assumed that each woman's "head load" would be a fairly constant mass of wood as long as she was collecting from the same place, which they usually do for at least a number of months at a time. We have recently made a few measurements to test this assumption.

Results

Every enquiry showed an appreciable saving of wood using the new stoves. The women we questioned most regularly all reported that a head-load lasted about two days in the old hearth and fire to seven days when using either type of stove. This is significant even if we assume a total error of $\pm$20% in relating this to an actual mass of wood of standard heat of combustion.

The measurements summarised in Table 1 justify the assumption that a "normal head load" for the same woman will have a mass that varies less than 10%. The exceptions in the table are recognised as large loads or small ones. It is interesting to note the close agreement between sizes of loads collected by

women who gather wood together. The variation in size of load with distance is clear (compare loads carried 1-2km with those carried 4km). This is only a small sample and further measurements are to be made.

The users report variations in fuelwood use through the seasons although we have not succeeded in measuring these exactly.

a. During late rainy season, February-May, a variety of foods are cooked even between meals, so cooking fuel consumption rises.

b. During cold weather, June-August, more fuel is used to warm the house. Mudstove users often have a fire in the old hearth at night in this season, so their fuel consumption rises considerably.

c. During the post-harvest season, June onwards, users of either kind of closed stove burn dry maize cobs which are a more efficient source of heat in a stove than in an open hearth.

It was estimated that a good harvest could give cobs for two months cooking, but the three years of this programme have been years of drought and harvests have been poor.

CONCLUSIONS

The comparison of charcoal with other cooking fuels has shown that it could offer a saving for many urban families. Our figures only begin to show the variety of situations that exist and more work is planned.

Measurement of the effect of introducing new stoves on rural firewood consumption showed a large saving due to using the stoves under test, as compared with the very wasteful open hearth that is commonly used. Such dramatic improvements cannot be expected in many situations.

To observe seasonal effects on fuel consumption we need to define more closely the range of error to be expected from: a. variable size of a normal head-load and b. variations in moisture content of wood. Differences between different species of wood will need to be considered in some situations. However, if these refinements go much beyond what the users normally observe for themselves they would also go beyond the purpose for which this work was undertaken, which was to help the users find the best stoves for their own use.

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TABLE 1: Head-load mass measurements

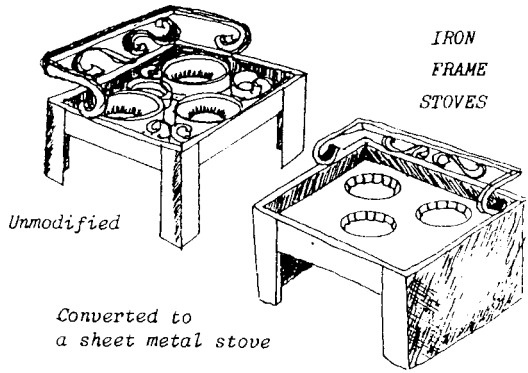
Collected by:	Age Yrs	Distance (km)	Mass (Kg) A	B	C	Comments
Mrs B Chamboko	± 50	4	28			)
Mrs M Chamboko	± 30	4	27			) collect
Ms M Chamboko	± 50	4	30			) wood
Mrs R Chamboko	± 25	4	29			) together
Mrs C Chamboko	20?	4	27			)
Mrs S Takadiyi	46	1	39	43	42	
Mrs G Tembo	36	1	42	42	40	
Mrs C Muchabaiwa	39	1.5	37	39	39	
Mrs L Chirau	45	2	49	37	47	
Mrs C Tapfumanei	37	1	27	39	32	
Mrs T Mandaza	39	1.5	42	38	43	
Mrs C Dick	49	1	32	28	30	- weak health
Mrs A Tembo	± 46	2	30	33	26	
Mrs E Mutizwa	37	2	39	42	41	
Mrs E Mandaza	43	1.5	40	42	42	
Mrs J Muzanenhamo	19	2	-	22	25	
Mrs H Mutasa	+ 45	1.5	20	-	22	

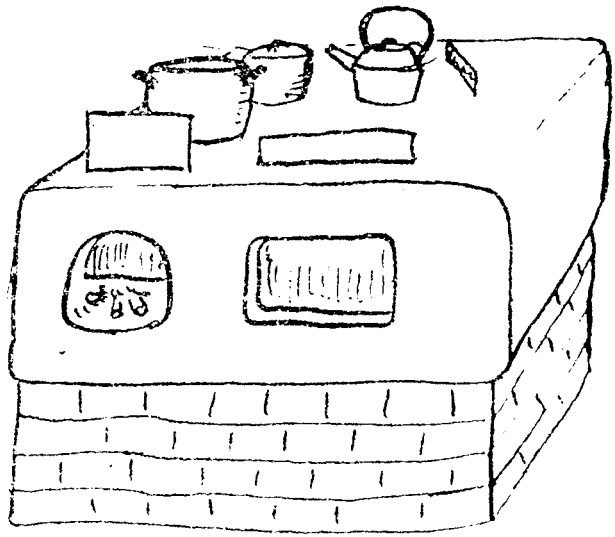
Distance: women's estimates roughly checked by enquirer.

Age: Chamboko family and Mrs Mutasa: enquirer's estimate
Others - own statements.

A,B,C represent loads collected on different days.

Figure 1: Wood-burning 'stoves'





mud stove