

Improved stoves as a means of poverty alleviation

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Introduction

Fuel wood (charcoal and firewood) is the main source of household energy in Madagascar; a situation which is alarming because the country's forest areas are decreasing by 2.5% per year.

Madagascar is ranked economically among the poorest countries of the world, and therefore substitute fuels, such as gas or oil, are not affordable for the majority of households. Given the absolute necessity for the population to use fuel wood, it is important to have an energy policy which aims to limit depletion of the country's natural resources. The two main objectives of the Woodfuel Energy Saving National Program (PNEBE) are:

- to reduce consumption of wood fuel
- to alleviate the cost of household energy.

This study is designed to measure the economic impacts of the massive dissemination programme of improved stoves throughout the country. Only direct impacts for the beneficiaries (households) resulting from improved stoves dissemination will be measured.

Study framework and methodology

The group SOFRECO, a French consulting office, and Hery Vao, a Malagasy company, are carrying out the study on behalf of the PNEBE. The study is part of a project run by the Ministry of Energy and Mines of Madagascar, co-financed by the Malagasy Government and the World Bank.

The PNEBE is disseminating improved stoves in 16 cities through-



Figure 1 Dry forest near Toliara, Madagascar

Foyers améliorés comme un moyen de lutte contre la pauvreté à Madagascar

Madagascar est classée parmi les pays les plus pauvres. Une étude mesurant l'impact économique d'un programme à grande échelle de foyers améliorés montre que les économies d'énergie représentent environ un mois du salaire moyen d'un travailleur de cette région. Le modèle informatique utilisé pour cet exercice peut être extrapolé pour étudier l'impact de programmes de foyers améliorés dans d'autres villes.

out the country through training craftsman, animation, sensitization etc. The populations of the cities range from under 5000 people to over 200 000 in the largest city, totalling over 850 000 people (136 000 households) in the 16 cities.

Methodology

The research analysed changes in household expenditure following the introduction of fuel-efficient stoves. A baseline measurement of fuel wood consumption for each city in the study was undertaken. Secondly, variations caused by price fluctuations in monthly fuelwood costs in each city were calculated per household. Finally, based on the number and characteristics of the stoves, the savings due to the fuel-efficient stoves were determined.

Monthly cost of woodfuel

A socio-economic survey was conducted on high-income, middle-income, and low-income households using a representative sample of more than 3500 people in the 16 cities. The results of the survey are shown in Table 1.

Changes in monthly fuel costs

In order to evaluate the change in household wood fuel expense attributable to fuel-efficient stoves, it was assumed that, prior to their introduction, the quantity of consumed fuel used by a given household was fixed; only the variation of fuel price affected the household expenditure. The fuel price was kept under observation in the 16 cities to analyse specific variations.

Table 1 Monthly cost of fuelwood per household (FMG¹)

City	Main users		Costs (FMG/month)	
	Charcoal	Firewood	Charcoal	Firewood
Ambatolampy	69	27	37862	25955
Arivonimamo	66	34	35825	28752
Miarinarivo	44	53	45882	33069
Tsiroanomandidy	63	33	31826	25955
Toamasina	69	12	32183	36811
Ambatondrazaka	62	31	21956	31526
Vatomandry	14	81	21364	18173
Mahanoro	25	72	17448	18083
Toliara	79	18	48284	51635
Tolagnaro	71	28	39314	26070
Betioky	50	50	28397	41266
Ambovombe	23	77	45075	48278
Fianarantsoa	71	26	31688	24265
Ihosy	51	48	45382	36807
Ambositra	47	51	36467	13429
Ambalavao	66	34	21745	30097

¹ As per April 1, 2001, 1USD = 6750 FMG (Malagasy francs)

Saving from fuel-efficient stoves

The PNEBE team spent two years developing 20 prototypes of improved stoves in their laboratory. These comparative tests within the laboratory try to simulate typical stove use in the home. Each stove was tested several times against a Malagasy traditional stove. The results are shown in Table 2.

Because the laboratory results do not reflect perfectly the observations made by Malagasy families using stoves, 500 improved stove prototypes (for fuel wood and charcoal) were tested for acceptability in a representative sample of households from a variety of the traditional homes.

In addition to various parameters on acceptability of stove, the effect of specific types of cooking was studied (Bazile D., 2001). Table 3 compares household use with that determined in the laboratory for each city. A Weighted Index less than 1 indicates that for the studied fuel, food preparation in the household is more energy consuming than during tests in laboratory. Conversely, an index more than 1 indicates that the cooking practices in this city are an improvement on the performance of the prototype in the laboratory.

The saving made by a household

depends on the type of stove and the style of cooking in a particular city. Using these weightings (based on household measurements), the laboratory results were adjusted to reflect cooking practices in each region. From this, the monthly savings obtained by using fuel-efficient stoves in the 16 cities where PNEBE is conducting its dissemination campaign were calculated.

Finally, the extra investment needed for purchasing a fuel-efficient stove compared to the price of a traditional stove was determined. The investment in a fuel-efficient stove is usually less than US\$2 (close to 10% of minimum monthly salary) The lifetime of the improved stoves was found to be double that of traditional stoves, giving an overall cost reduction over the lifetime of the stove.

Results, discussion and perspectives

The PNEBE has trained 475 craftsmen in 225 training centres between May 2000 and October 2000 in the selected 16 cities of the project. These craftsmen were responsible for disseminating more than 30 000 fuel-efficient stoves by the end of February 2001.

The production rate of improved stoves vastly exceeds the targets set by the Ministry of Energy and Mines and the World Bank. The dissemination target of 30 000 fuel-efficient stoves by the end of the project (end of December 2001) was reached in February 2001 – half-way through the campaign. Dissemination levels are now stabilising at around 4000 fuel-efficient stoves per month. Overall, the large-scale dissemination of fuel-efficient stoves has contributed to a saving of more than FMG 1.87×10^9 as a result of reduced woodfuel purchase for household use. To this are added FMG 241×10^6 savings from the purchase of more durable stoves. The overall saving in the 16 cities of the project is thus about FMG 2.11×10^9 .⁶

Household savings depend on various parameters, which differ from city to city. The main parameters include:

- the price of the fuel-efficient stove: a high price still prevents initial purchase by some Malagasy households
- the price of fuel wood: a high price for household energy in a particular city makes households more conscious of the benefits of a fuel-efficient stove

Table 2 Results of fuel saving with improved stove prototypes tested

	Type of stove	Saving	Pot Size (cm)																				
			24	26	28	30	32	34	36	38	40	45	50	60									
Firewood	LAFATRA métallique PM	45%			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
	LAFATRA métallique GM	48%							■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
	LAFATRA terre cuite Ambatondrazaka	43%																					
	FOUR MACONNE monomarmite	26%																					
Charcoal	Dago métallique PM, UPED	20%	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
	DAGO Métallique GM	31%																					
	FE Terre Cuite Mitsinjo, UPED	8%																					
	FE 'SERPENT' Terre Cuite PM Ambatondrazaka	34%																					
	FE 'LEZARD' Terre Cuite PM Ambatondrazaka	39%																					
	DAGO Mixte PM, UPED	35%																					
	DAGO Mixte GM	64%																					
	MITSITSY Be, UPED	26%	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
	MITSITSY MM, UPED	30%																					
	MITSITSY GM	63%																					
	MITSITSY TGM	30%																					
	MITSITSY TTGM	38%																					
	MITOMBINA GM	60%																					

Table 3 Weighted index of laboratory results compared to those in the field

City	Fire wood	Wood Charcoal
Ambatolampy	1.00	0.93
Arivonimamo	1.00	0.80
Miarinarivo	1.00	0.81
Tsiroanomandidy	1.00	0.89
Toamasina	1.16	1.24
Ambatondrazaka	10.06	1.00
Vatomandry	0.81	1.33
Mahanoro	0.779	0.88
Toliara	0.87	1.00
Taolagnaro	0.99	1.01
Betioky	1.11	1.21
Ambovombe	1.12	0.97
Fianarantsoa	0.77	0.99
Ihosy	1.44	1.22
Ambositra	0.73	0.98
Ambalavao	1.31	1.03

Table 4 Benefits in each city obtained by the use of fuel-efficient stoves (FMG x 10³)

City	Reduction due to woodfuel saving (FMG)	Capital cost of more durable stove	Total benefit
Ambatolampy	45 016	778	44 238
Arivonimamo	99 905	5197	94 708
Miarinarivo	224 466	12 656	221 810
Tsiroanomandidy	40 967	4	40 963
Toamasina	327 506	2800	324 706
Ambatondrazaka	63 565	-3 100	66 665
Vatomandry	16 664	697	15 967
Mahanoro	4013	957	3056
Toliara	159 124	-1037	160 161
Taolagnaro	25 984	1026	24 958
Betioky	9736	-380	10 116
Ambovombe	31 917	1349	30 568
Fianarantsoa	747 505	-237 186	984 691
Ihosy	44 339	-1 266	45 605
Ambositra	18 198	1649	16 546
Ambalavao	10 688	27	10 661
Total	1 869 591	-241 141	110 732

- the choice between fuelwood and charcoal. Charcoal must be bought, whereas the poorer households, living in the outskirts of the city, will collect fuelwood at no cost
- the appropriateness of available stoves.

Follow-up studies will allow the impact of dissemination of fuel-efficient stoves in each city to be measured, supported by a computer-simulated model.

Conclusion

Overall there was a saving of over two billion Malagasy francs during the 9 months of dissemination in these 16 cities. The economic impact is very important at household level, where

household savings have averaged between FMG150,000 and 200,000 per annum, which is equivalent to the minimum monthly salary (The monthly minimum salary in Madagascar is FMG160 000, that is US\$24). Even if one part of the saving is straight away allocated to new energy use (Bazile, 2001), this is itself an improvement in the standard of living for deprived households. The large-scale dissemination of fuel-efficient stoves is thus an efficient means of reducing poverty at national level.

This project has measured impact for selected cities and has proved a useful tool for informing future work.

For energy planning in Madagascar, this model can be used for any large-scale stove dissemination in any city. So, from this one model, it is possible to predict the effect of the introduction of improved stoves and to measure the economic impact of a training and dissemination campaign in other cities. In addition, it is theoretically possible to match an intervention with specific parameters required in a particular context with a particular type of fuel-efficient stove within the PNEBE range of products.

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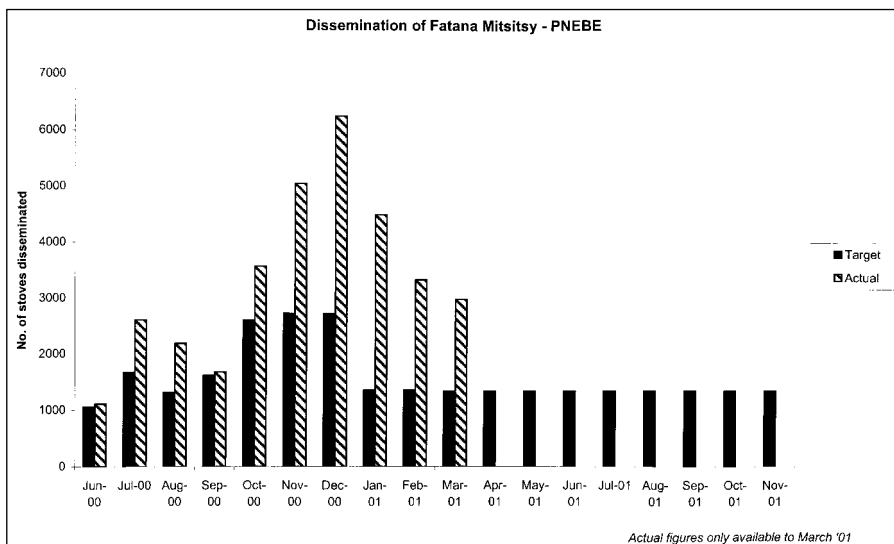


Figure 2 Dissemination of improved stoves by PNEBE approved craftsmen