Name of the project/supporting organisation(s)	Organizational status	Type of potential resources
35. Women in Environment	NGO	T
36. Regional *gramin* banks	Banking sector	F
37. Centre for Self-help Development	NGO	ditto
38. Rural Self-help Development Project	ditto	ditto
39. International Centre for Applied Research Services	INGO	F+T
40. Nepalese Centre for Applied Research Services	NGO	R
41. Mrigendra Medical Trust	ditto	ditto
42. Karnali Local Development Project/SNV	Project	F
43. Lumle Regional Agricultural Research Centre	Educational	R
44. Health Development Project/Institute of Medicine	ditto	T
45. Asia Regional Cookstove Program Indonesia with country contact point in Nepal (Centre for Rural Technology)	ditto	T + R
46. Regional Wood Energy Development Programme (RWEDP/FAO)	ditto	ditto
47. Huta Ram Vaidya	Researcher in appropriate technology	T

Source: Delucia and Associates

Notes

1. CT = Credit investments on ICS installation, setting up ICS micro-enterprises
2. F = Funding support mainly built into area-based projects/programmes and assisting ICS implementing agencies/INGOs
3. T = Technical back-up services such as need assessments, training, demonstrations, promotion of ICS and impact assessment
4. R = Research

Dissemination of efficient ASTRA stove: case study of a successful entrepreneur in Sirsi, India

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1. Introduction

Improved cookstoves are now a part of many households in rural India. The government, entrepreneurs, artisans and NGOs have been disseminating the technology. The main objectives of the improved stove programmes are primarily to conserve fuelwood and forests, to remove smoke from the kitchen and reduce drudgery for women and improve their health. They also upgrade the domestic environment and help conserve rural trees and forests. Improved stoves are available for domestic cooking and bath-water heating for individual families and also for large institutions.

India has implemented a large improved stove dissemination programme; the total number of stoves disseminated in India is estimated to be nearly 30 million at a rate of over 2 million stoves per year (up to 1999). At the national level, dissemination is largely a government-controlled, target- and subsidy-driven programme [Ravindranath and Hall, 1995]. There is no proper periodic evaluation of the rate of acceptance, performance and impact of the improved stove programme. A review based on limited information concluded that the improved stoves are making only a marginal impact on fuelwood conservation and the quality of life of women. Some of the reasons are [Ravindranath et al., 2000]:

- absence of quality control and user education;
- lack of post-construction servicing and monitoring;
- absence of accountability for poor performance; and
- target-, budget- and subsidy-driven nature of the programme.

Increased participation of entrepreneurs may overcome some of the abovementioned problems [Ravindranath et al., 2000]. Currently in the government programme, the personnel of the local Block Development Office manage the stove dissemination activity. They normally hire trained or partially-trained stove-builders. Here we present a case-study of a successful stove entrepreneur from Uttara Kannada district, Karnataka, India.

The entrepreneur started building fuel-efficient ASTRA (Centre for Application of Science and Technology to Rural Areas) cookstoves in 1983. The motivation for the entrepreneur was enlightened self-interest, conservation of

fuelwood, avoiding women's exposure to smoke in the kitchen, and potential to earn money.

It has to be noted that neither did the entrepreneur (the Joshi family) have any prior skills in construction of stoves, nor were the family artisans. In later years, after the demise of the father, his son too became a full-time stove-builder and entrepreneur. Currently, the entrepreneur (A.R. Joshi) undertakes construction of the ASTRA cookstove, the bath-water stove and fuelwood-based driers.

The ASTRA *ole* (cookstove) design is a three-pan fuel-efficient and smokeless mud stove built *in situ* to stringent specifications. A thermal efficiency of over 40 % in the laboratory and over 30 % in the field have been recorded, compared to around 14 % for traditional stoves [Ravindranath et al., 1989]. Two-pan variants of the design are also disseminated in the region. The stove performance is sensitive to the dimensions of the stove and use practices. Thus, it is important to ensure quality construction according to design parameters and to provide education to obtain high performance.

2. Approach to stove-building

The approach adopted by the entrepreneur for dissemination of the ASTRA stove is described in Box 1. The efficient ASTRA stove was demonstrated, during 1983 and 1984, under the government programme in a number of villages under the direct supervision of technologists from ASTRA, who designed the stove. Initially, the stove-builders were directly trained by the stove designers and quality control was ensured. The ASTRA stove became very popular and the news of its benefits spread spontaneously, leading to awareness of and demand for the stove.

The key features of the approach adopted by the entrepreneur are that stoves are built on demand for payment, along with user education and guarantee on performance.

3. Rate of stove-building

The entrepreneur has not been receiving any incentive or payment from the government. However, some households have claimed subsidy from the government. The entrepreneur started building stoves in 1983 and his operation was on-going in 2001. The rate of construction of cookstoves was high during 1985-1987, in the range of 112-117 stoves built per year. Construction of the ASTRA cookstove peaked again in 1998 (150 stoves). Decline in the number of cookstoves built was observed from 1988 to 1995. However, the same entrepreneur was also building efficient bath-water heating stoves in that period. The annual rate of stove construction and income of the entrepreneur is shown in Figure 1.

The decline in the number of ASTRA stoves built is not due to any reduction in demand, but due to the builder's preoccupation with building efficient bath-water stoves. The entrepreneur earned Rs. 400/bath-water stove compared to Rs. 200/cookstove (1 US $ = Rs. 46 during 2001). The rate of improved stove construction, considering both cookstoves and bath-water stoves, shows that

Box 1. Stove dissemination approach adopted by the entrepreneur in Uttara Kannada district

1. Households make a request for the improved stove to the entrepreneur, personally or through a postcard.
2. In response to the request for the stove, the entrepreneur fixes up a date and time for construction.
3. Households procure materials such as sand, grate, bricks, prepared clay, pipe, ash-pit door and firebox doors from a designated supplier as instructed by the entrepreneur. The entrepreneur brings with him only iron angles and prefabricated stove-tops that have with experience been improved upon by the stove-builder.
4. On the date fixed for construction of stoves, the entrepreneur arrives at the household and requests for labour to assist him in construction. He will take about 2 to 2.5 hours to complete the construction. Then, he leaves instructions with the housewife to fire the stove when it dries, after 2-3 days.
5. Housewives are instructed on the methods of using the stove and the best practices for deriving high performance from the stove, including:
   - removing ash from the ash-pit;
   - cleaning stove and chimney;
   - closing doors of firebox and ash-pit during cooking;
   - use of reducers on stove openings for small vessels;
   - closing of the unused opening;
   - shifting vessels during cooking; and
   - cooking or simmering, using the stored heat, after firing stops.
6. The entrepreneur revisits after about a month to check for any problems and to ensure proper practices are adopted to derive maximum efficiency.
7. The initial agreement includes free repair at any stage in case of faults or minor defects without any specific time-limit. In case of reconstruction or major damage, the entrepreneur charges according to the extent of damage or repair. However, in most cases, such a situation never arises.
8. Full guarantee of the ASTRA stove and its performance is given by the entrepreneur to all his customers. In case of poor performance, he will carefully detect the faults and rectify them. He will also try his best to ensure proper performance.
9. The construction cost for the stove during the initial years was around US$ 3 and it increased to about US$ 5 by 1993. Currently, the cost for a cookstove is US$ 12. Households are expected to pay the full amount in cash right at the time of construction.

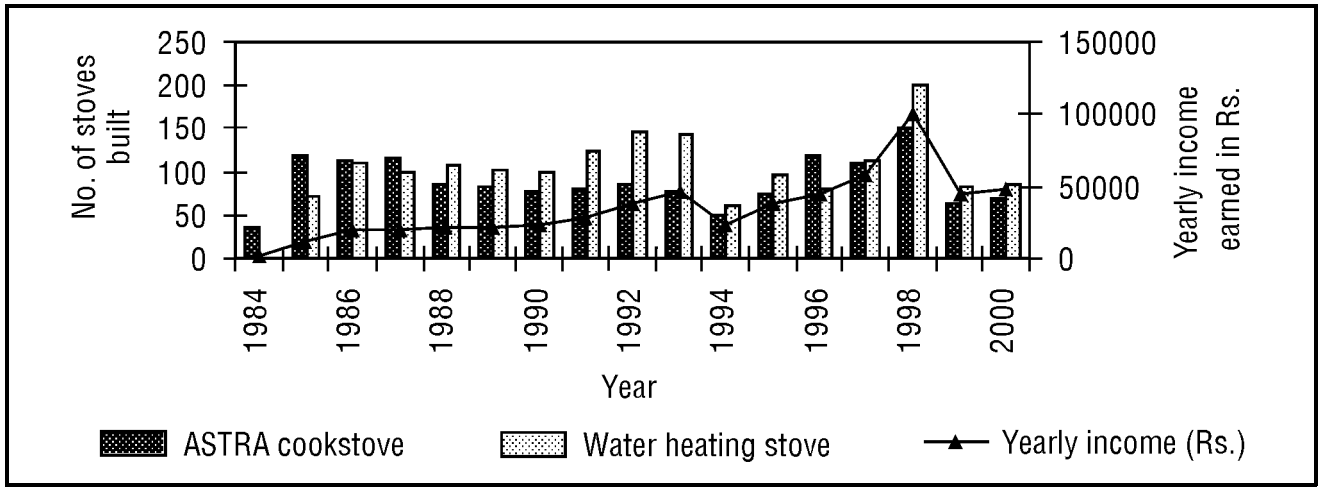

Figure 1. ASTRA cookstoves and water-heating stoves constructed by the entrepreneur and yearly income earned (in Rs; 1 US $ = Rs. 46 during 2001).

Table 1. Changes in percentage of ASTRA cookstove owners using the stove during 1994 and 2001

	During 1994	During 2001
No. of households with ASTRA cookstove surveyed	150	132 (out of 150 visited)
% of ASTRA cookstove owners using it regularly for cooking	99	47
No. of households not using ASTRA stove in 2001 due to shift to other fuels • Due to shift to LPG: 31 (20.7 %) • Due to shift to biogas: 24 (14 %) • That do not use fuelwood or either biogas or LPG: 5 (3.3 %)		38 %
% of household visited but family not accessible (either door locked or residence shifted)		12
% of ASTRA cookstoves dismantled and cooking shifted to traditional stove		3

the entrepreneur has been fully engaged. Thus, it can be concluded that the builder was fully employed, with no spare time to respond to any additional demand.

4. Performance

The fuel-efficient ASTRA stove aims to offer the household the following benefits: reduced fuelwood consumption, saving in cooking time and removal of smoke from the kitchen. The performance of the stove is therefore assessed for these factors.

4.1. Percentage of stoves in use

One of the first indicators for assessing the performance of the stove or the programme is the extent of its use. The rationale here is, if the housewife derives one or more of the benefits, she will continue using the stove. However, if the stove is not delivering the benefits or is inconvenient to use, she will discontinue using it or even dismantle it. The percentage of stoves in use was estimated through a sample survey. The list of all households with ASTRA stoves built by the entrepreneur was obtained and 150 households were randomly selected. These 150 households were selected from the top 10 villages. A survey of extent of use of stoves was carried out during 1994 and again during 2001. The results are given in Table 1. For these 150 households with ASTRA stoves, 99 % of the stoves were in use during 1994. This is a primary indicator of the acceptance and utility of the stove. The same 150 households with ASTRA stoves were selected for survey during 2001 to assess the extent of usage. Investigators could actually visit 132 houses (88 % of the original sample); the remaining 18 houses were either locked when visited or the families had shifted their residence. It is interesting to note that 71, or nearly 47 %, of the 150 households visited were regularly using ASTRA stoves for cooking. The percentage of households that dismantled the ASTRA stove and shifted to traditional cookstoves was less than 3 %. The remaining households had shifted to biogas or LPG. Thus, ASTRA stoves, many of which are over 10 years old, were also in use. Data is not available on the age of the stove during 2001. This shows that mud stoves if built and maintained properly could last over 10 years. The stove top (or the pan seat), which normally gets damaged, is manufactured and sold in the market. The damaged stove top is replaced by the households themselves, thus increasing the life of the stove. A national-level study concluded that only about 4.07 million improved stoves (about 15%) could be in the field or in use, out of 28.3 million installed till 1998, considering the limited life of the stoves [Kishore and Ramana, 2002].

In comparison, several studies have shown that the stove dissemination programme of the state of Karnataka had low levels of acceptance or usage of the ASTRA stove. For example, according to a study in Karnataka, only about 20 % of the stoves were in regular use. Further, the percentage is shown to decline with age [Ravindranath and Hall, 1995].

4.2. Opinion of households on the performance of the stove

The perception of the housewife is most crucial in the evaluation of the stove performance. A survey was conducted to ascertain the opinion of the housewife regarding fuel-saving, time taken for cooking and removal of smoke from the kitchen. The results are based on an opinion survey conducted in 150 households during 1994 (Table 2). According to the survey, 99 % of the ASTRA stoves built by the entrepreneur in the villages were in use.

Fuel conservation estimated through opinion survey: The survey of households showed that 98 % of households reported savings in quantity of fuelwood consumed when cooking on the ASTRA cookstove compared to the traditional stove (Table 2).

Fuel conservation estimated through measurement: Fuelwood consumption in the efficient ASTRA stove was measured and compared with that in the traditional stove (Table 3). The fuelwood use was estimated by the "displacement method". A bundle of fuelwood, in excess of the household's normal consumption, was weighed and given to the household early in the morning, before the stove was lit. The fuelwood remaining was weighed after 24 hours, the next morning. The experiment was repeated for two days. Fuelwood consumption was estimated per capita using the size of the family. Out of the sample of 150 households with ASTRA stoves, a set of 40 households was randomly selected for estimating fuelwood consumption. A sample of 25 households with traditional stoves in the same villages was selected for estimating fuelwood consumption, using the "displacement method". The results are given in Table 3. A sample study of ASTRA stoves in 40 randomly selected households, with stoves built by the entrepreneur, showed a per capita fuelwood consumption of 1.12 kg per day, with a standard deviation of 0.5. In comparison, the fuelwood use in traditional stoves from a study of 25 households showed a per capita consumption of 1.67 kg per day, with a standard deviation of 0.6. The field studies showed that the stoves built by the entrepreneur reduced the fuelwood use by nearly one-third, i.e., 0.55 kg/capita/day. A typical household of 6 members would thus conserve 1.2 tonnes of fuelwood annually.

4.3. Cooking time

All the households reported reduction in cooking time (Table 2). According to an earlier study, many households gave greater importance to saving in cooking time than to fuelwood conservation [Ravindranath and Hall, 1995].

4.4. Removal of smoke from the kitchen

All households barring one reported total removal of or reduction in smoke in the kitchen (Table 2). Earlier studies have shown that women often continue to use an improved stove for its smokelessness even if it consumes more fuelwood.

Table 2. Performance of ASTRA cookstoves built by the entrepreneur (opinion survey)

Assessed factors	Less (%)	More (%)	Same (%)
Fuelwood consumed	98	Nil	2
Smoke release into kitchen	99	1	-
Time taken for cooking	96	4	-

Table 3. Fuelwood conservation based on measurements

	ASTRA stove	Traditional stove
Number of households where fuelwood use was measured	40	25
Fuelwood use for cooking (kg/capita/day)	1.12 (±0.5)	1.67 (±0.6)
Fuelwood conserved per day (kg/capita/day)	0.55	
Annual fuelwood conserved per household (of size 6) (kg/household/year)	1200	

The performance assessment based on household opinion survey and measurement of fuelwood use showed a high performance, resulting in fuelwood conservation, removal of smoke from the kitchen and saving in cooking time. Thus, the stoves built by the entrepreneur are providing multiple benefits to the households, leading to continued demand.

5. Factors contributing to the success of ASTRA stoves built by the entrepreneur

In contrast to the performance of the stoves built under the government programme at the state level, the entrepreneur mode of dissemination proved to be highly successful. Some of the factors contributing to the high performance of the stoves built by the entrepreneur are enumerated below in Sections 5.1-5.4.

5.1. Demand driven

All stoves built by the entrepreneur were in response to specific demand by the households, which means the households are motivated and enthusiastic about the efficient stove. In the larger stove dissemination programme in India, the improved stoves are often given away as a part of some government programme, even in the absence of any demand. Under the government programme, there is a subsidy and households often get improved stoves free of cost or at a marginal cost. Thus, households may not or cannot insist on the quality of the stove construction.

5.2. Profit motive and quality control linkage

The entrepreneur was driven by the profit motive and thus ensured quality construction to ensure sustained demand. The demand for his stove was consistent and sustained from 1984 to 2001. The success is therefore a cycle of

sustained income, and high quality and performance, which generates demand for the entrepreneur's service, income and motivation for ensuring quality and performance.

5.3. Post-construction service and user education

One of the keys to the success of this entrepreneur was post-construction service. If there was any fault in the stove construction or if the performance of the stove was poor, it was rectified by the entrepreneur. The entrepreneur also provided adequate information on good practices in using the stove. Conversely, in the large government-sponsored programmes both post-construction service and user education were nearly absent [Ravindranath and Hall, 1995].

5.4. Self-financing and subsidy

Households paid for the stove components as well as the services of the builder. Thus they could and did demand quality performance. The entrepreneur was also under contract to ensure quality performance. In the government programmes, the subsidy feature, which in some cases meant a free stove, inhibited the households from demanding quality of performance. The builder under the government programme had no obligation to ensure high performance.

6. Conclusions

The improved stove programme should be "demand-driven" at all times, as against the government programmes that are target- and subsidy-driven. Trained and skilled individuals should undertake construction of the stove, with accountability for quality of construction and performance. Generation of demand depends on the performance and impact of the stoves in delivering one or more of the intended benefits, such as saving in fuel and cooking time and removal of smoke. The case-study of the entrepreneur is a success story of stove dissemination. The key factors and lessons are the following.

- The improved stove design should deliver significant benefits.
- Adequate motivation for the entrepreneurs in the form of employment and income is necessary to ensure quality service.
- The entrepreneur should ensure quality of stove construction and provide user education.
- Guarantee of performance backed by post-construction visits to the household ensured correction of defects in construction or operation.
- Stoves should be built on demand.
- Subsidy, if necessary for the poorer households, should be linked to post-construction performance. ■

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A study on improved biomass briquetting

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1. Introduction

A regional research and dissemination programme, "Renewable Energy Technologies in Asia", funded by the Swedish International Development Cooperation Agency (Sida) and coordinated by the Asian Institute of Technology (AIT), is being executed in six Asian countries during 1996-2003. Biomass briquetting is one of the three research areas under the programme, the others being photovoltaics and solar drying. Research and dissemination activities are being carried out at AIT as well as in three participating country institutions. The main objective of briquetting research at AIT is to develop improved heated-die screw-press biomass briquetting systems by reducing the electrical energy consumption by pre-heating the biomass in order to reduce the electrical energy consumption, heating the die of the briquetting machine by means of a briquette-fired stove and by incorporating a smoke removal system. This paper presents the experimental data on rice-husk briquetting with and without pre-heating and also details the design and operating parameters of a die-heating stove, which was used to replace the electrical coil heaters, to reduce the net electricity consumption.

2. The briquetting system

Utilisation of agricultural residues is often difficult due to their uneven and troublesome characteristics. The process of compaction of residues into a product of higher density than the original raw material is known as densification or briquetting. Densification has lately aroused a great deal of interest in developing countries all over the world as a technique for upgrading of residues as energy sources. Converting residues into a densified form has the following advantages.