Getting Into Hot, Hot Water

T.V. Ramachandra
Centre for Ecological Sciences, Indian Institute of Science

Energy has been a dynamic force in the growth and development of human society. The demand for energy is not an end in itself but, for the services like illumination, heating, cooking and mechanical power it provides. Therefore sustainable energy management is an integral part of the eco-development of a region. The key features of sustainable management are: [a] satisfying basic needs, through economically efficient and environmentally sound and viable options, [b] promoting end use energy efficiency improvements, [c] beginning a transition to renewable energy sources, and [d] greater community participation in development programs.

Eco-development of a region depends critically on the health of our renewable resources such as soil, water, vegetation, livestock and genetic diversity. The integrated development of all these components is essential for sustainable and environmentally sound development.

Among various improved designs of cookstoves, the ASTRA model developed at ASTRA (Application of Science and Technology to Rural Areas, Indian Institute of Science) is widely accepted among the users from rural areas. This is evident from various studies conducted in the villages. A three pan model was first disseminated in Unchagi village in Uttara Kannada district and Ugra village in Tumkur district of Karnataka State, India. The study carried out among user populations reveals that fuel savings range from 32% to 42% using the improved cookstoves.

The Research and Its Results

The study was conducted in four hamlets which consist of 82 households and a population of 661. In order to study cooking fuel consumption patterns for 23 households were selected randomly for cooking stove experiments. The actual quantity of fuelwood required for one day cooking was weighed initially and next day the fuel left over was weighed using single pan balance of 50 grams accuracy. This experiment was conducted for two consecutive days, twice a week. This was done to take into account day to day changes in the type of food cooked, quantity, etc.

The results show that fuel wood consumption per capita is quite high ranging from 2.50 kg to 3.25 kg per day. Of this, 1.68 kg is used for water heating and 1.32 kg is used for cooking. This requirement is met by minor forest, soppinabettas and partly by residues from areca and coconut. In order to bring down the consumption of fuelwood and hence pressure on forest, dissemination of fuel efficient cookstoves were taken up under an eco-development program. A few youths were given training to build stoves suitable for the local households taking into account the pans used etc. Local employment has been generated in a limited sense along with the cookstove construction as some skilled masons have taken up constructing fuel efficient stoves as a profession.

In order to study fuel consumption pattern for cooking 23 households were selected randomly for cooking stove experiments. The actual quantity of fuelwood required for one day cooking was weighted initially and next day the fuel left over was weighted using single pan balance of 50 grams accuracy. This experiment was conducted for two consecutive days and twice in a week. This was done to take into account day to day changes in the type of food cooked, quantity, etc.

While to find out fuel consumption pattern for water heating the experiment was conducted in similar way for all 82 households in Sirsimakki - Mundgesara catchment and 22 households surrounding this microcatchment.

The fuel need for cooking in these sample households is 1.92 + 1.02 for cooking in traditional stoves while for improved fuel efficient cookstoves is 1.1 + 0.78. This means that there is a saving of 42% in the quantity of fuel used by switching over from traditional stoves to improved stoves. In the water heating stove, the average fuel consumption in the traditional stoves is 1.68 + 0.80 while in improved bath stoves it is found to be in the order of 1.36 + 0.63. This result is based on the sample of 104 household shows a potential of 19 to 24% saving in improved design.

Fuel needs are for cooking and water heating for bathing in rural households, among various other activities like jaggery making (processed palm sap), and space heating during winter in hilly regions. This study reveals that 63.41% of the households uses improved cookstoves, 30.49% uses biogas plants, 11% uses LPG, 1% uses Kerosene stove, and 1% uses electric hot plate for cooking purpose. While for water heating 50% households uses improved stoves with chimney and the balance still depends on traditional stoves.

In the villages where the study conducted, most farmers own horticultural land where they have coconut and areca plantations. For mulching needs of these plantations, they depend on minor forests. Government has provided user rights to these farmers in the ratio of 9 acres of minor forest land (also called soppina betta) for every acre of Areca plantation. Farmers are permitted to collect green leaves and dry litter from these area but they do not possess any ownership rights. In this process farmers get both levy matter for mulching and fuelwood mainly for cooking needs. While agricultural residues are used for water heating.

Landless farmer collect fuelwood from forest, to collect 20-25 kg fuelwood a person spends about 5-6 hours and transporting about 2-3 km walk. Normally this work is done by woman and children twice or three times in a week. (November - February) depending on their requirement. For rainy season (June - November) usage, fuelwood is collected and stocked during summer (March - May). Average time spent to collect and transport 20 - 25 kg of fuelwood by a person is about 5.5 to 6.0 hours.

Time saved in cooking by using improved cook stoves is about 42%. This is found by standard comparative cooking experiments done on traditional stoves and improved cookstoves. Similarly in water heating stove or bath stove, the time saved is about 36 - 38%. Heating 50 liters of water in 50 liters capacity bath stove from 22 to 45 degree Celsius time taken in traditional stove is about 45 min while in improved stove the time taken is about 26 min.

Description of Implementation

To disseminate fuel efficient improved cookstoves and water heating stoves (bath stove), first a meeting with villagers were organized followed by, discussion with local NGO's. In the second stage training of few youths were carried out regarding construction and monitoring of stoves. Improved cookstoves and bathstove were constructed at our project cost on first cum first serve basis.

About 60% households responded positively to our program of improved cookstove dissemination and about 40% responded to improved bath stoves. Also, you may note that there are various government agencies/ departments like agriculture department, block development office at taluk level, for administrative purposes districts are further classified into taluks (for example in Uttara Kannada District there are 11 taluks) to carry out the dissemination of fuel efficient stoves and other development program on subsidized basis.

Low income and poorer segments of the community (like scheduled castes and scheduled tribes) the subsidy is 100%. While to popularize these devices government offered 60% subsidy to all initially in the form of construction material while labour charges are borne by the households. Since most of these government programs are target oriented, success rate is quite low. That is to meet the fixed target during the year, dissemination were carried out without proper curing, training and monitoring.

Apart from income level, most crucial factor play a very dominant role in the adoption of new devices is the education or literacy level of household members especially women. During our survey, I have noticed that women with formal education are more receptive to the technologies and maintenance of the devices. There is a positive correlation between the income level of household and education, and also between adoption of new devices and educated women.

Response of the Users

Most of the users prefer the three-pan improved cookstove compared to two-pans. About 90% of users highlighted the improvement in the general condition of the kitchen, while landless households and small land holding farmers complained about the space problem to switch over to improved stoves.

Family with large land holding uses mainly biogas of capacity in the order of 210 to 300 cft for cooking and improved stoves for water heating. The improved bath stoves are modified by these villagers in order to use bio residues like areca husk, coconut husk etc. About 56% increase in adoption of biogas plants and 44% increase in adoption of improved cookstoves is noticed in last 5 years may be attributed to keen interest of local villagers in adoption of new technology, and also due to high level of literacy. The success of biogas and improved cookstoves among the first set of users, who are also progressive farmers have contributed to increasing trend in adoption.

Middle class families with land holding, 2 acres, 50% have switched over to biogas plant of capacity 140 to 210 cft while some have switched over to LPG. In addition to biogas plant some have fuel efficient cookstoves. 70% of households in these villages have improved stoves for water heating. It was noticed that the households using copper/aluminum vessels for water heating have higher probability of fuel saving than the households using clay pots.

Most of the users are used to using large pieces of wood/logs for cooking and water heating are free wood is available from nearby minor forest and soppinabetta. The improved cookstoves have been modified to suit their requirement of feeding wood (by about 22% of users). About 118% users preferred traditional stoves for water heating because of flexibility in using wide variety of fuels of different sizes, available in different season.

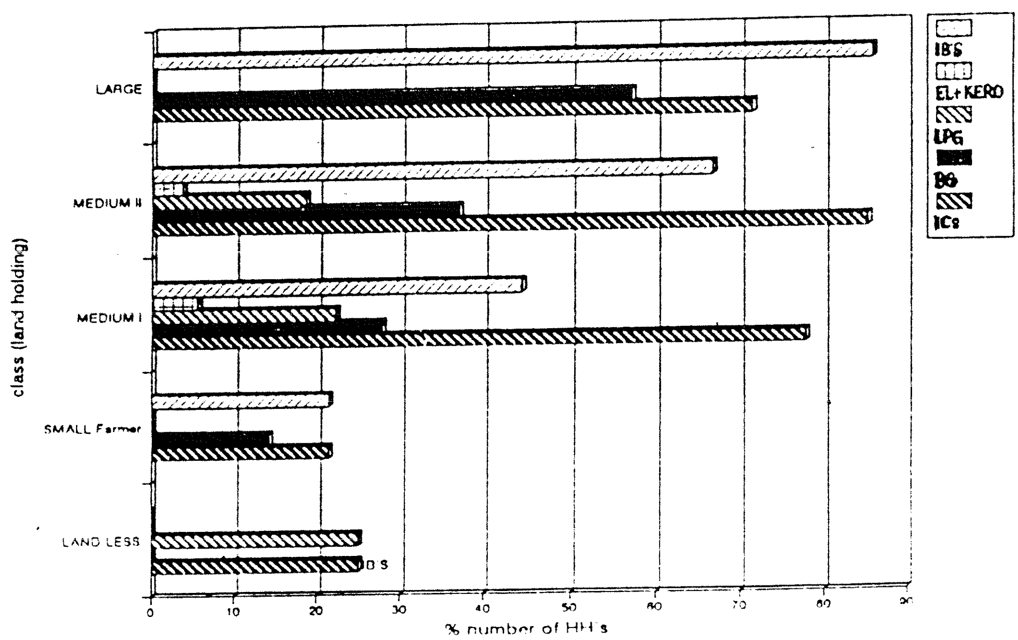
With regard to repair and maintenance of improved cookstoves, about 32% repaired once or twice in the

Factors in Stove Adoption

Landholding, literacy level, and income level are the forces driving towards adoption of energy efficient devices and effort to improve the general condition of the kitchen. **[1] Landholding:** the illustration below shows that the medium I & II class (land holding) are tend to use the improved cookstove compare with other classes. **[2] Education level:** Women with formal education are more receptive to new technologies. This implies that, it is feasible to start dissemination of new devices with economically better off and users with foral education. **[3] Income level:** Medium households tend to adopt new devices compare with lendles and larger farmers.

Percentage number of households adopting new devices can be illustrated in this graph:

Fig Land Holdings & New Devices



course of four years. Most of the users maintained chimney by cleaning it regularly to remove the particle deposition.

Conclusions

This study highlights the role of [a] the initial survey in the selection of devices like improved stoves, biogas, etc according to user needs; [b] educating users about the usage and maintenance of new devices; [c] motivation; [d] feedback and monitoring in making the implementation of new technology a success in the field.

Identification of appropriate target group for dissemination in new locality plays a predominant role. If the initial target group consist of individual who are receptive to innovation technologies, the adaptation rate is high. This is evident from the study. As indicated before, 6 biogas plants installed in 1985 with the help of nodal agencies and its subsequent success has helped 19 more households to go in for in last five years. Similar is the case of improved stoves for water heating and cooking 63.4% of households have improved cookstoves and 50% of households have improved stoves for water heating.

Lack of knowledge of technologies is evident from the energy survey conducted in 74 villages of Kumta Taluk and Ankola Taluks, Uttara Kannada district (about 60% of respondents). Propagation of information regarding technology, operation, maintenance, economic aspects and advantages through various mass media like television, regional popular magazines, etc, would further help in dissemination of appropriate technologies,

In all major household energy and environmental programs it is necessary to carry out indepth studies related to [a] social impact studies, including links between fuel scarcity and health effect; [b] economic and political impact of new technology; [c] cost benefit analysis for different technical options taking into account hidden benefits like reduced workload, increased safety etc; [d] impact of household energy end-use pattern by switching fuels. It is necessary to set up technical backup unit at block level (for cluster of 10 - 12 villages) to provide post installation maintenance and monitoring of the devices.

Research and immediate action is required to reduce excessive exposure to indoor air pollution, which is particularly a problem in poor communities. Particles

Calculating the Performance Value of ICS

The analysis of consumption pattern consisted of following:

- more than one type of fuel is used for cooking and water heating in any household. The quantity of fuel consumed is determined by substracting the weight of the remaining fuel of each type on every day from the initial weight of each type recorded on previous day.
- the values of daily consumption of fuels by weight in each household are thereafter converted to their equivalent dry weights using the measured moisture content values. These are then converted into equivalent value using the net calorific value of each type of residue. The daily energy consumption for a family is computed by adding all these values.
- the daily energy consumption of each household is further converted to per adult energy consumption using the adult equivalent of the nuber of people.
- for each family daily per adult energy consumption is computed for two consecutive days twice in a week. The average value is coputed for each time. Thus from a sample of 23 households we have 46 values for cook experiments.
- the daily per adult fuelwood consumption values for each household having improved cookstoves (IC) and traditional cookstoves (TC) are averaged separately to calculate the average daily per adult energy consumption for the respective categories.
- both parametric and non parametric tests were used in analysis to compare sets of measurements for IC's and TC's.
- the percentage saving achieved by the use of IC over the use of TC for cooking and water heating are then estimated.

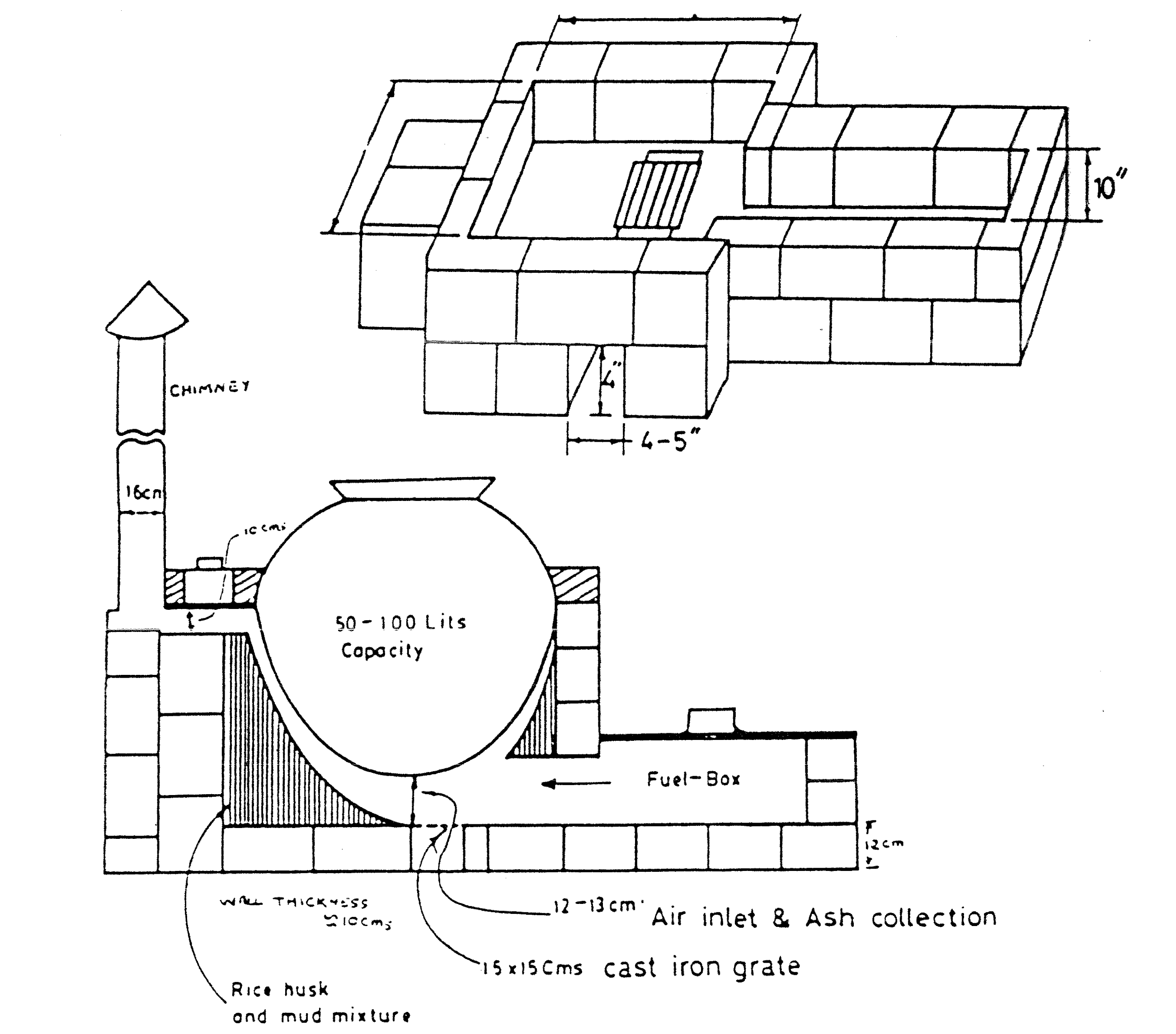
produced by these fuels can cause chronic lung and heart disease, cancer and acute respiratory infection in children, women and elderly.

Technical Drawing and Specifications

The better thermal efficiency is possible in this design mainly due to 1) increased generation temperature by controlled and optimized excess air in combustion; and 2) improved heat transfer efficiency by proper dimensional and structural design of the passage with respect to the pans cooking.

In order to achieve this, it is necessary to maintain the dimensions as per the sketch (see figure). The optimal design parameters like [a] the distance between the grate and the bottom of the vessel is 12 cm; [b] distance between the wall of the vessel and the stove wall is 4 cm; [c] duct size is 10 x 10 cm which are arrived at with series of rigorous experiments carried out in laboratory and in the field by our Institute team of experts: Prof. Kumar, Prof. Lokras and Prof. Hedge M.S.

The experimental results from field show that in about 25 - 30 minutes, 1 kg of fuel is burnt to heat 50 liters of water from 28 to 55 degree Celsius with 40% efficiency. These stove have dual advantages of being fuel efficient, helps in fuel conservation and in smokeless environment which may help in keeping the healthy indoor environment and hence helps in reducing the drudgery associated in fuel collection, cooking and water heating.



MONITORING AND EVALUATION:
Beyond the Function and Into the Impact

By Jennifer McAvoy, ARECOP

Most program managers know that monitoring is important in ensuring that the original objectives of their programs are being met while evaluation can provide insight into whether the program was planned and implemented effectively to achieve maximum results.

However, in improved cookstove programs we often tend to focus on the most superficial indications of successful programs while overlooking the hidden indicators of stove adoption that can give even greater insight into developing effective programs. For example, many monitoring sheets that are used by extension workers to check off appropriate answers during interaction with stove users reflect the tendency to focus on only the most obvious benefits of improved cookstove adoption, such as fuel saving, time saving and smoke removal. Indeed, these are the benefits that most stove programs are built around.

However, monitoring and evaluation that aims to investigate the broader set of benefits and deeper impact experienced by users can lead to heightened understanding into the status of the stove in the household and new innovations for future programs, including possible links to other community development programs. In addition to why, or why not, the user is satisfied with the stove, what have been the actual advantages of the stove for the user? For example:

- Has there been any reduction in the time spent collecting fuelwood? Do users feel an impact on the better use of resources in their immediate environment?
- Has there been an increase in time and/or opportunities for other activities, such as income generation activities? Have ICS users initiated such activities? Is there more time for cooking more nutritious meals? What is the extra time, if any, used for?
- What is the status of the health of the users before and after installation? Have there been any improvements in the health of users and children? Do children have fewer colds and respiratory ailments? Do women feel healthier? Are their respiratory tracts clear?
- Is the stove used for all cooking activities or only some? For what percentage of cooking is the improved stove used vs. the traditional stove? Why? How is the improved stove perceived by the user and among other household members? Would they recommend this stove to others?
- Under what circumstances was the stove installed in the homes of users and what was the users reaction/attitude at the time? Is there any difference in attitude now? More or less favorable or the same? Did users request or suggest any modifications to the stove to suit their purposes?
- Is the subsidy provided agreeable to the users? Is this the most effective way to disseminate stoves? Does it fulfill long term and/or short term objectives?
- In terms of the introduction to the users, it may be useful to assess the effectiveness of user education/awareness programs. What kind of materials are used in awareness raising? What is the reaction of the users upon initial introduction? Do users receive enough fundamental understanding of the function of the stove, as a result of education and training, to make suggestions for modifications? Can they make minor repairs and maintain the stoves well?

Essentially, in addition to the actual functioning of the stove, using questions that go beyond the function and into the impact can lead you to evaluate the benefits of the stove that make a significant difference in the lives of the users. For example, in addition to finding out if there is less smoke in the kitchen, have the users themselves experienced improved health? Why or why not? What other factors are involved? How can these factors be incorporated into cookstove programs? It may be useful to incorporate improved cookstove installation with improvements in the kitchen, such as racks, water containers, sanitation, improved layout and ventilation, which will complement the benefits of the stoves and can be monitored at the same time.

Many of the above questions can only be answered over a long period of time as opposed to within six months or a year after the stove is installed. For example, a community that is participating in a stove program may not experience an positive impact on the improved use of natural resources until three or four years later. This time lag presents a good reason to develop long term relationships with these communities. As we discover the multiple benefits of improved cookstoves in the lives of biomass users, we also open the door to opportunities to integrate improved cookstoves into other development activities and, thus, expand our coverage even further.

Please share your experiences with monitoring and evaluation of improved cookstove programs with us. How have your monitoring and evaluation techniques developed with experience? What are some innovations that have grown out of greater insight into ICS? We look forward to hearing from you.

Monitoring can begin in any phase of a stove program.

It is optimal if monitoring is initiated at the begining of the program and continues until the program is completed. But, if a program that is operational does not already monitor, it is always feasible and adviseable to begin monitoring. Stove program can be divided into a number of distinct phases. In each phase diffrent kinds of useful data can be gathered.

[1] Initial needs assessment
At the begining of the program it is necessary to determine users' needs, understand the existing kitchen management practices, and determine the skills and needs of the people who are currently building stoves, and those who are likely to build improved stoves. It is also important to try to determine feasible testing and distribution strategies.

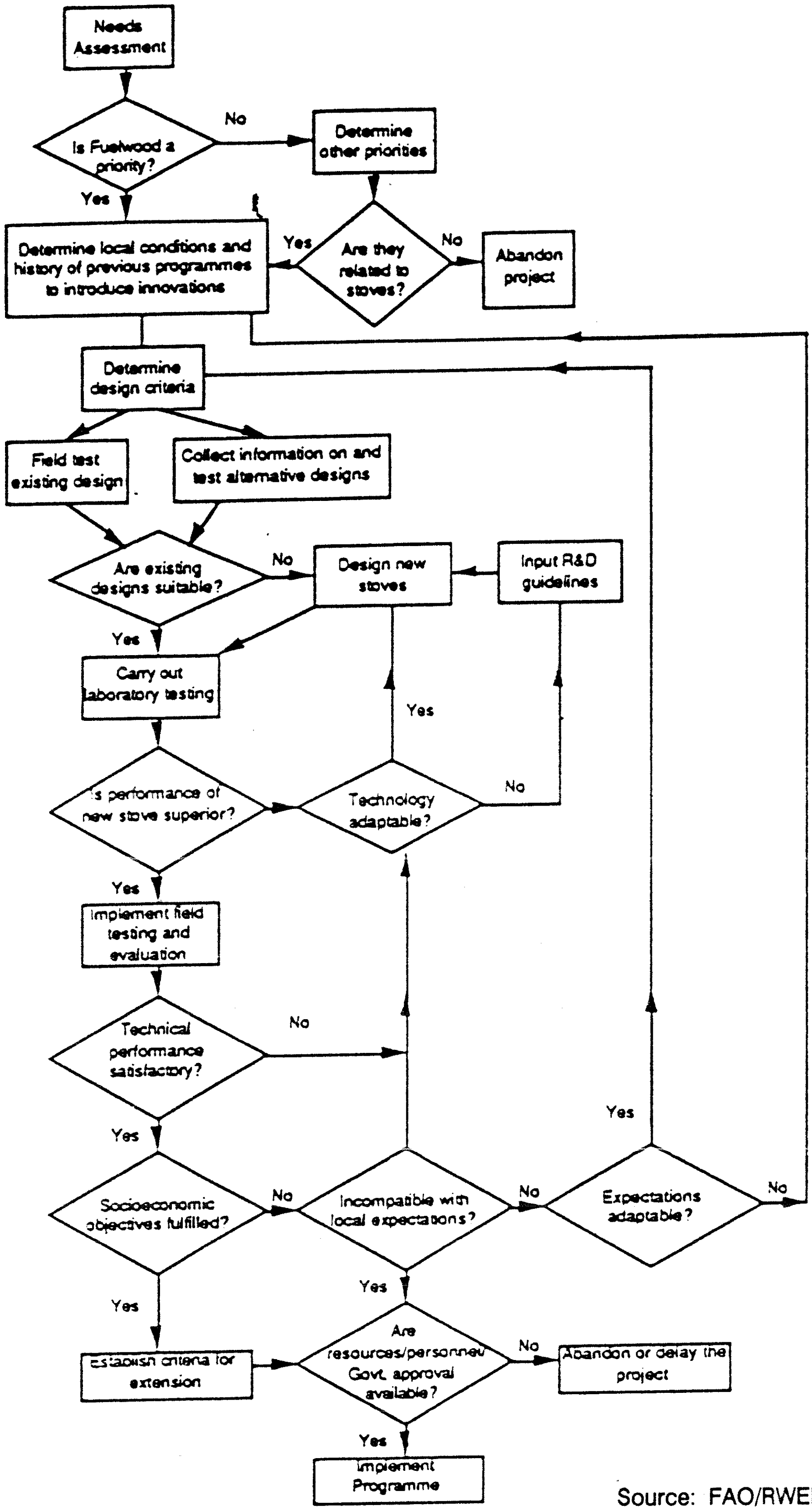
[2] Design and testing
Once needs are assessed, exsisting stoves are modified, or new stoves are designed and tested in some type of a laboratory situation. A small number of stoves can then be given or sold to households to evaluate and test their performance in the fireld. If these stove are compatible, then a more extensive field test phase can be undertaken. If the stoves do not prove acceptable, further development and testing become necessary.

[3] Extension
During the extended field test phase a number of diffrent strategies for building and distributing the stoves will probably be developed. Training programs for stove users, producers and extension workers can then be developed and refined. Promotion programs can begin and staff can be assigned to visit people who have a stove to find out what they think. Further research and development work can help ensure that the performance, ease of construction and acceptability of the stove continually increase and that the cost of the stove decreases. New models may also developed to meet the needs of different people.

[4] Dissemination
If this extended field program is successful, larger dissemination programs can be undertaken, usually within the framework of a national stove program. The emphasis of these programs is larger scale construction, distribution and sales of stoves. Production of stoves can take place in households, village artisan workshops, or larger factories. Stove can be distributed and installed by extension workers, specially trained stove artisans, or groups of trained villagers.

Source: FAO - RWEDP 1990:10

A FLOW CHART OF STOVE PROGRAM DEVELOPMENT



Source: FAO/RWEDP, 1990