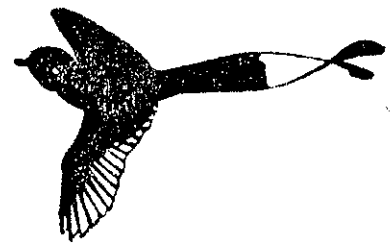


Report Submitted to
Dept. of Science and Technology
Govt. of Karnataka

Through
K. S. C. S. T.
I. I. Sc., Bangalore

by
M. S. Hegde

Centre for Ecological Sciences
INDIAN INSTITUTE OF SCIENCE, BANGALORE

ACHIEVEMENTS AND ACKNOWLEDGEMENTS

Fuel efficient, smokeless HOSA OLE: ASTRA OLE are working satisfactorily in all the houses in Unchagi village. Fuel saving is 31%. The village is saving 120 tonnes of fuelwood annually in 140 houses. There are 10 people in this village who are experts in Astra Ole construction and these people have taken this new stove to over 60 villages of Uttara Kannada. Astra Ole has found good acceptability as is clear from the fact that more people have paid Rs.150/- and got constructed in their houses.

A new bathroom stove has been designed and its fuel efficiency is 40%. Besides saving over 50% of fuel, agricultural residue like areca husk replaced wood in this stove. The stove is popular in many villages. The stove is now getting diffused in many villages of Uttara Kannada.

Prof.R. Kumar, who is the brain behind the design gave all the moral support for its dissemination. He visited Unchagi twice. Mr.V. Balasubramanian and Prof.L.S. Prahlada Rao, Department of Science & Technology, Government of Karnataka gave all the support and encouragement in the propagation of this stove. But for them, the project and the Astra Ole could not have been at the houses in the villages of Karnataka. Thanks is too small a word for their effort. Mr.Sanjay Das Gupta, Special Deputy Commissioner, Karwar was a source of encouragement in this regard.

My thanks are due to Professor Madhav Gadgil who gave all the support and assistance from CES, IISc.

Actually, the people who constructed the stoves are Mr.R.S. Bhat, Mr.R.S. Hegde and Karna Gauda of Unchagi. Measurements are carried out by Mr.C.M. Shastri and Malathi Hegde. I am indeed grateful to them.

Thanks are due to Mr.S. Rajagopalan, Joint Secretary, KSCST and his staff who have been extremely helpful in the management of this project. It is a pleasure to take up projects from KSCST, IISc. I would do more work for this organisation.

Financial support from the Department of Science and Technology, Government of Karnataka through KSCST is gratefully acknowledged.

I trust that a small venture of saving fuel in one village - Unchagi would become a seed for covering this technology to every village of Uttara Karnataka and finally every village of this country.

M.S. HEGDE
IISc., Bangalore

CONTENTS

1. Background

A new fuel efficient wood burning stove was developed by Kumar et al based on the experiences gained from a 3 pan community jaggery unit [1,2] with the financial assistance from KSCST, IISc. The community jaggery unit was first field tested at Unchagi, a village in Uttara Kannada in the year 1981. For the first time, a principle of controlled combustion of fuel was applied in this community jaggery unit. The total fuel efficiency was 60%. Design of the new 3 pan fuel efficient wood burning stove for cooking food with all the characteristics of the community jaggery unit was given by Kumar et al in the year 1982 [3]. The new stove was first field tested again at Unchagi in the parents' house (Mr.S.R.Hegde) of this investigator in May 1983. This was then called 'Hosa Ole' (Hosa means new and ole means stove in Kannada language). Several more stoves were constructed in and around Unchagi with the financial assistance from DRDS, Karwar. New and simple method of construction of the Hosa ole was perfected by August 1983. Although the laboratory demonstration stove at ASTRA Centre, IISc. showed over 80% fuel saving, in the villages 55% fuel could be saved and found to be highly acceptable to the villagers. Apart from fuel saving, the stove was smokeless, any type of fuel could be burnt in it efficiently. The instant success of this stove in the villages of Uttara Kannada drew the attention of Mr.V.Balasubramaniam and Prof.L.S. Prahlada Rao, then Secretaries in the Department of Science and Technology and Environment, Government of Karnataka. A major programme of dissemination of this 'Hosa Ole' now named as 'ASTRA Ole' was

taken up through training the local artisans of Karnataka. The financial assistance for this came from the Department of Science and Technology, Karnataka and outside support from Karnataka State Council for Science and Technology. The first ASTRA OLE construction training programme was held again at Unchagi from January 26, 1984 to February 4, 1984. With two more training camps at Anekal and Ungra in Bangalore and Tumkur district respectively; the methodology of training programme was established. The stoves constructed during the training programme at Unchagi is given in Appendix A.

It was thought appropriate to have a long term evaluation of these stoves. In addition, other fuel needs such as for bath water heating was important enough to be considered for conservation. Also, the performmance of ASTRA OLE in houses of different economic strata, of different caste and so on was important information needed for its proper dissemination. Acceptability of ASTRA OLE to a village as a whole and also fuel saving in one village was an important factor needed. With these points in mind, a project on the dissemination of fuel efficient stoves was proposed to the Department of Science and Technology, Government of Karnataka, with the following objectives:

(a) Construct 100 ASTRA OLEs which would cover every household of the groups of villages in Unchagi valley,

(b) Record difficulties in the method of spreading this new innovation,

(c) Train as many people as possible to construct the ASTRA OLE,

(d) Conduct training and demonstration to the people of neighbouring villages,

(e) See if we can bring about innovations in its construction, and adoptation to local needs, and

(f) See if a new room stove is designed and developed to save fuel.

With these objectives, the project was started in March 1984 with the financial assistance from the Department of Science and Technology, Government of Karnataka through Karnataka State Council for Science and Technology, Indian Institute of Science, Bangalore (G.O.NO.DST 40 TCH 83, 23 February 1984). In this report, the results on the detailed studies on the fuel consumption pattern, food habit, conventionalstoves, dissemination of Astra Ole, overall fuel saving in the village as a whole, performance of new Bath Water stove and its dissemination have been described.

2. Methodology

Mr.R.S.Bhat, a trained person to construct Astra Ole from Unchagi was emmployed for a period of 10 months to collect data on the fuel consumption pattern and construction of Astra Ole. The work was carried out with the help of 'Mahavishnu Yuvaka Mandali', Unchagi. Firstly, the houses for Astra Ole construction were enumerated. As far as possible, no house was left out in the villages centred around Unchagi. The village map with the location of houses where the studies have been carried out is given in Fig.1. The figure shows the Unchagi valley surrounded by villages, Unchagi, Kotegudde, Buggon, Hosa Hervatta and Valagalli. Apart from 40 houses where Astra Ole were already constructed during the first training camp at Unchagii, 100 houses were taken

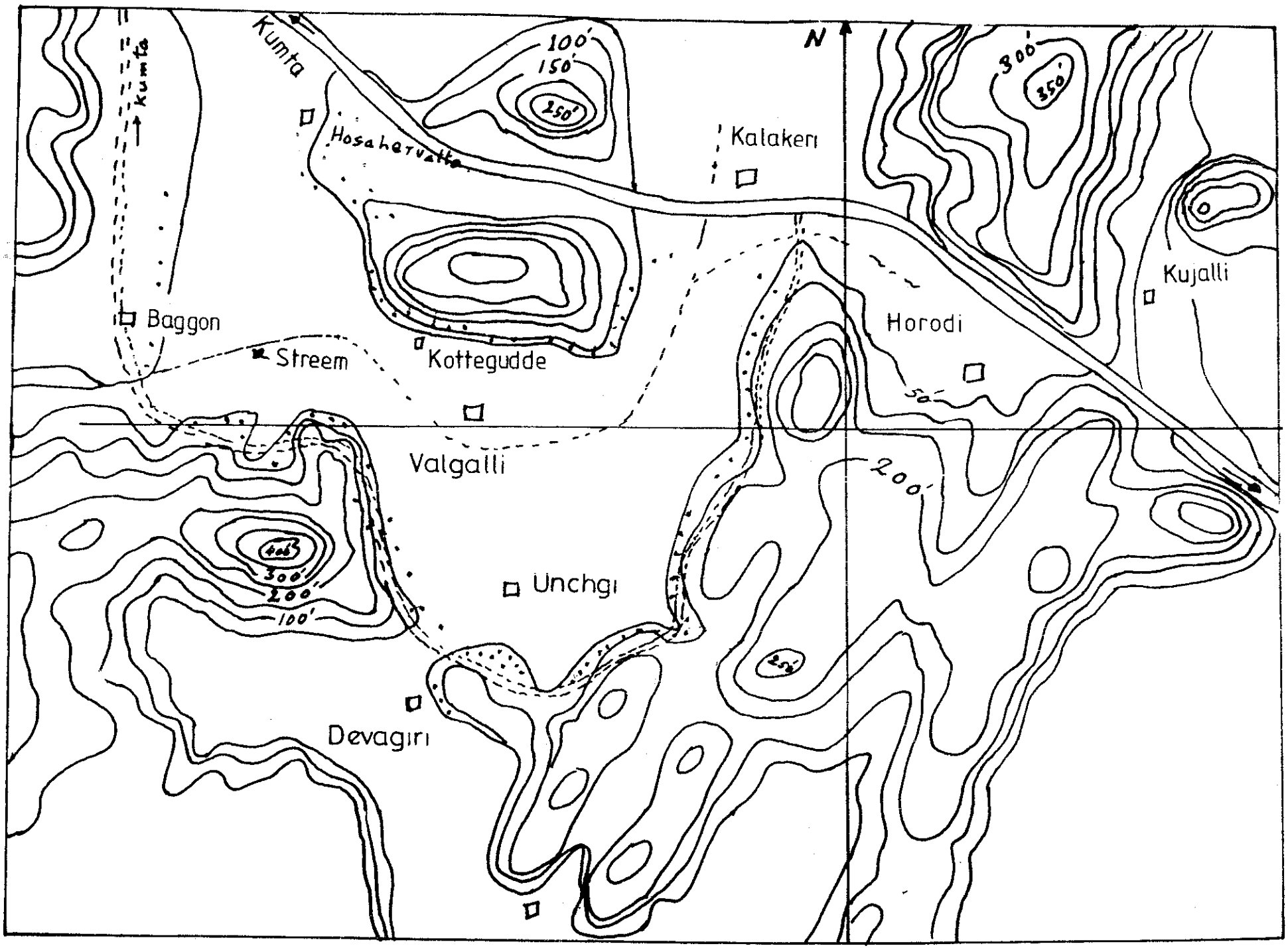

Kumta
Kumta
100'
150'
250'
Hosahatvatte
Kalakeri
N
300'
350'
Kujalli
Baggon
Streem
Kottegudde
Horodi
50'
Valgalli
200'
300'
200'
100'
Unchgi
Devagiri

Fig 4

up.

Materials for construction, viz., 4" x 10' pipe, fuel box cover, grate, lids for second and third oven, cover for chimney to protect from rain, were organised through the Yuvaka Mandali. Local blacksmith Mr.Venkatramana Achari fabricated the covers for fuel box etc. The Yuvaka Mandali with its Secretary Mr.R.S.Hegde organised the supply of materials. Stove was constructed out of latterite stone and mud, got ready by the house owner. For this, no payment was made. This is the contribution from the house owner. With the help of several local artisans, Mr.R.S.Bhat got all the stoves constructed.

Before starting the construction, several problems arose due to the type of vessels used, nature of food cooked. A study was therefore undertaken to modify the Astra Ole to suit the local needs. The major modification effected was towards cooking on flat bottom vessels in addition to cook 'dosa', 'chapathi' which are cooked on flat iron sheets.

Lastly, monitoring the stove was carried out by testing the fuel efficiency of the stove. Specific fuel consumption were measured over 50% of the stoves in randomly chosen houses. Saving of fuel on week long basis were also carried out.

Extensive experiments on the construction of bath water heating stoves based on the 'Astra Ole' design were carried out in one house (Mr.S.R.Hegde's, Unchagi) and the results are presented here. Efficiencies of the old bath room stoves were measured for comparison. A method to construct the new bathroom stove was

evolved. The dissemination of new bath room stoves in many villages of Uttara Kannada have been carried out. The measurements on stoves have been carried out by Mr.C.M.Shastri, Centre for Ecological Sciences, (Field Station, Sirsi), Indian Institute of Science Bangalore.

3. Fuel consumption and fuel resources in Unchagi

Data on the fuel consumption pattern was collected to assess the fuel needs of this village along with the sources from where they got fuel. Domestic fuel needs for cooking and bath water heating were estimated by actually weighing the quantity of fuel used for one day. The results are presented below.

(a) Number of houses (Unchagi) 63

(b) Population 363

TABLE 1

FUEL NEEDS OF ONE DAY IN UNCHAGI

Fuel Type	Quantity for cooking kg/day	Quantity for bath kg/day	Total kg/day	Source
Cut wood	223	49	272	Reserve Forest Chandavar and Betta land
Shrubs and dry twigs	207	151	358	Minor forest around the village
Coconut products	13	68	81	Plantation garden
Areca products	4	16	20	Plantation garden
Miscellaneous	--	10	10	Minor forest
Total	447	294	741	

Thus the fuel needed for cooking = 1.23 kg/day/person

Fuel need for bath water heating = 0.81 kg/day/person

Total fuel need for one year for
63 houses for cooking and bath = 270 tonnes

Apart from this, fuel is neededfor par-boiling rice, drying agricultural produce during rainy season, some amount of cooking to feed cattle. Mostly lesser quality fuel (shrubs and leaves) are used for this purpose. An estimate for all this shows that about 30 tonnes are needed. Sugarcane juice used to be evaporated using wood in this village but due to the introduction of a 3 pan community jaggery unit in 1981 with bagasse as fuel, about 40 tonnes of wood is saved annually. No longer they use wood to make jaggery in Unchagi.

Thus, the village with 63 houses need about 300 tonnes of fuel out of which about 15% is met from the agricultural residue, 35% as cut wood and 50% as shrubs, twigs and dry leaves. The cut wood is obtained from the reserve forest Chandawar, 15 km from this village. A mere 15% of cut wood is met from the privately owned Betta land. The minor forest around the village has been providing the shrubs and twigs. The total area of minor forest available for this village is just about 70 ha. Even an excess estimate of 1.5 tonnes/ha annual yield as estimated by Dr.Narendra Prasad et al of CES for such a degrated land, fuel shortage is clear as given below.

TABLE 2
FUEL SCENE IN UNCHAGI VILLAGE

Type of fuel	Fuel need	Local sources	Shortage
Cut wood	95 tonnes	15 tonnes (Betta land)	80 tonnes (to be obtained from Chandavar forest) through bullockcart
Shrubs, twigs leaves	160 tonnes	105 tonnes from minor forest	55 tonnes (to be obtained from Chandavar, through head loads)
Agricultural residue	45 tonnes	45 tonnes from coconut and areca farms	Locally available

Thus, net shortage for 63 houses is 135 tonnes per year if self sufficiency within the village is demandeed. Therefore there is 45% shortage of fuel in this tiny village inspite of having minor forest, betta land and coconut and areca nut gardens. This shortage is found to be the reason for continuous degration of minor forests due to over exploitation over the years. The root of shrubs are now being dug as fuel resulting in exposing the top soil and the minor forests are slowly getting opened with latterite stone. Due to continuous exploitation of Chandavar reserve forest, the area is getting denuded and it is no better than a minor forest. Thus, any attempt in conserving fuel is going to be beneficial to the people as well as to stop degradation of forest land. There is only one biogas plant in 63 houses and since the land holding is small, cattle holding is 2-3 in number per family, no other farmer has any plan to have a biogas plant. Therefore, conservation of domestic fuel through the efficient use of available fuel in the village could be a right strategy.

4. Food habbit of villages in Unchagi valley

Rice is the staple food in this region of Karnataka. Cooked rice is mixed with 'sambar' made out of boiled pulse, vegetables and spices. In addition cooked vegetables are eaten.About 50% of the people eat fish and it is cooked on a separate oven outside the house for religious reasons. In the morning, people have breakfast with 'Dosa' and 'Idli' made of rice and black gram which needs cooking. Tea is the normal beverage consumed. During lunch and dinner rice, sambar, sabji or fish are eaten. Only 50% of the families take tea during afternoon and evenings. 'Ragi' flour is boiled to make porridge and consumed by only 30% of the families during only about 150 days in an year.

The rice is mixed with yogert (curd) and dishes prepared out of it which do not need cooking. The weight ratio of cooked and uncooked food is found to be 1:0.5. Studies on the food habit and cooking pattern has shown that only 30% of the time, 3 dishes are cooked; 25% of the time, only one dish rice is cooked and 45% of the time only 2 dishes are cooked. The new stove should therefore respond to such needs.

The cooking vessels are of aluminium (37%), brass (11%), stainless steel (7%) and copper (10%) and mud pots (35%). Out of this, nearly 60% of the vessels used are flat bottom and the rest are round bottom. In a single house, both flat and round bottom vessels are used for cooking and therefore, the stove to be constructed should be suitable for both th type of vessels.

5. Conventional wood burning stoves and their efficiencies

Four types of stoves are used in these villages as shown in figure 2. Type of stove and percentage accrance, their fuel efficiency and the specific fuel consumption are given in Table 3.

TABLE 3

Village	No.of houses	Type of stove (See fig.2)	% occurance	Efficiency	SFC
Unchagi	63	A	50%	10-12%	445gm/kg
		B	26%	15-18%	440gm/kg
		C	19%	15-20%	350gm/kg
		D	5%	16-20%	340gm/kg

These data were collected before the dissemination of Astra Ole. Fuel efficiencies of these stoves were measured by water boiling test using sun dried 'matti' (termatia tomentosa) cut wood.

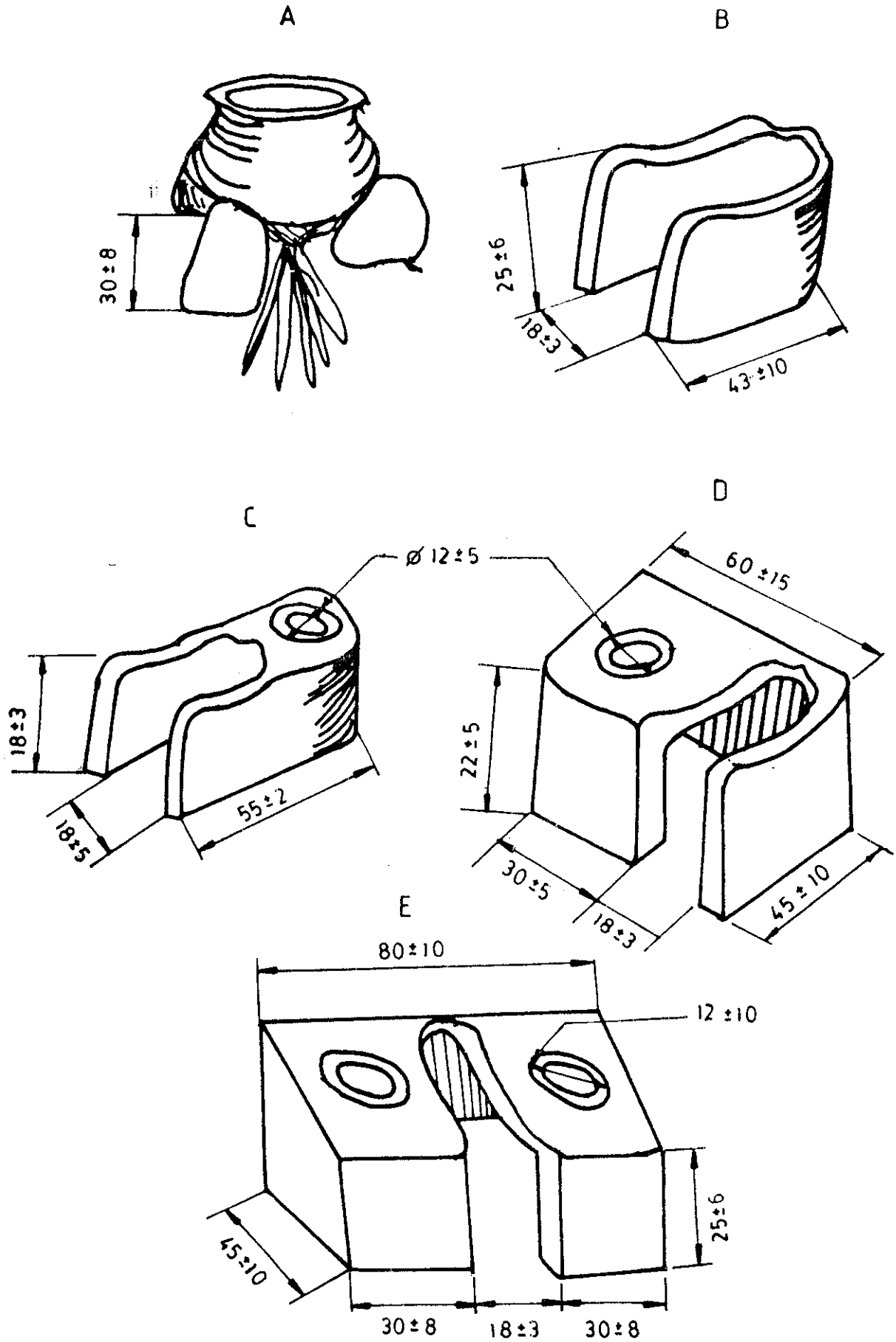
$$\%\text{Efficiency} = \frac{[\text{Wt (kg) of water heated} \times \Delta T + \text{Wt. of water evaporated} \times 540] \times 100}{\text{Wt (kg) of wood} \times 3800 - \text{Wt (kg) of charcoal left over} \times 6000}$$

Calorific value of wood taken = 3800 Kcals/kg

Calorific value of charcoal taken = 6000 Kcals/kg

The Specific Fuel Consumption (SFC) which is a direct measure of goodness of the stove is defined as follows:

$$\text{S.F.C.} = \frac{\text{Weight of wood burnt in gm}}{\text{Weight of cooked food in kg}}$$



NOTE : ALL DIMENSIONS IN CM

Fig. 2

Lower the value of SFC better is the stove and more fuel can be saved. It is needless to state here that the conventional stove as in Fig.2 are smokey, coconut tree products cannot be used inside the house dueto excess smoke. Efficiency is low.

6. A brief description of Astra Ole

A detailed account of Astra Ole, design, development and its use can be had from Lokras et al [4]. Extensive experimentation has been carried out to have high efficiency in 3 pot wood burning stove. Several studies have been carried out, both exerpimental and theoretical, to achieve high efficiency.

The cross sectional view of this stove is shown in figure 3. The important features of this stove are:

(a) Fuel is burnt over a cast iron grate letting air from below the grate.

(b) Fuel is kept covered in a fuel box.

(c) Three round bottom vessels of same size are used in this stove.

(e) Required amount air is let-in through a window below the grate.

(f) There is no air gap between the pots and the stove.

(g) Flue gas passes below the bottom of the second and third vessels and goes out through a chimney.

(h) Distances between the bottom and top of the stove are adjusted respectively to 13 cm, 15 cm and 2.5 cm below 1st, 2nd and 3rd pan to achieve maximum heat efficiency.

(i) Secondary air hole is provided below the first pan.

(j) Heat insulations is provided with rice husk and mud mixture.

FOR ROUND VESSEL

(a)

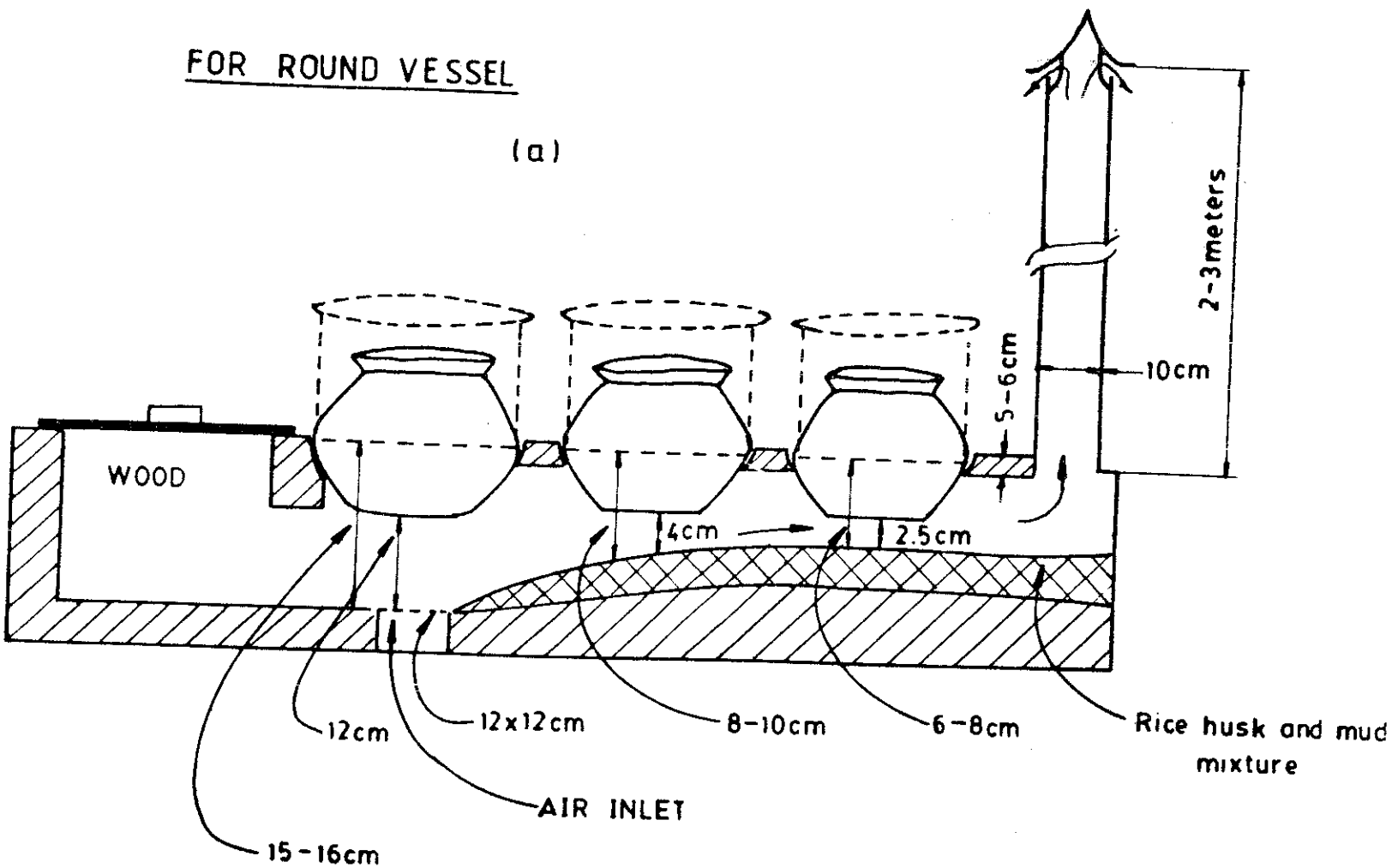


Fig. 3

These details can be found in figure 3. Fuel efficiency of this laboratory constructed ASTRA OLE is 45% taking all the three pots together. The SFC is 70 gms/kg.

To translate this plan into field and to make it suitable to the conditions desired by housewives, (eg. flat bottom vessels), a preliminary study was needed.

The distances below the pots 13 cms 5 cms and 3 cms are very critical parameters to achieve high efficiency. If the distance below the pots are increased by say, 3 cms below each of the pots, the stove efficiency falls below 25%. But when flat vessels are kept on this stove (see figure 3), distances increase by more than 5-6 cm.

The design took into consideration the amount of heat required for cooking a family of 6 people. Accordingly, 4 kW heat i.e. stove burning about 1 kg of fuel per hour was found adequate. The grate area needed to burn 1 kg of wood in 1 hour is found to be about 5" x 5" (160 cm^2). Round bottom vessels of the shape given in figure 3 of same size were taken for experiments. The pots were dipped into the stove so that maximum heat transfer can occur to achieve highest efficiency.

In actual practice as has been pointed out in the previous section, if a flat vessel is kept on the stove constructed to keep only round vessels, the distance below the bottom of vessel increases by 5-6 cms thus reducing the efficiency from 45% to only 22%. Even cooking is difficult due to less heat transfer. Therefore, there was a need to have a optimised design

for cooking in flat bottom vessels.

7. Astra Ole for flat vessels

After several experiments and field trials, Astra Ole for flat vessels which can be disseminated in these villages was brought out. The cross-sectional view of the stove is given in Figure 4. The difference between figure 3 and figure 4 is that a hump is provided below the second and third pans to keep the required distances. Although this modification looks very simple, this was essential to achieve high efficiency. Table 4 shows how the efficiency is affected by variation of bottom distances.

When flat vessels are kept on a stove designed for round bottom vessel efficiency was only 22% (see table 4). The highest efficiency with flat bottom vessels for a family size of 6-8 people achieved in the laboratory was 42%. This is 3% lower than the ASTRA OLE for round bottom vessels. This is essentially due to lower heat transfer area in the case of flat bottom vessels. The SFC values of the stove with flat bottom vessels was 110 gms/kg. The final design of this stove shown in Figure 4 has been followed now for diffusion in these villages.

It should be noted here that when round bottom vessels of suitable size are kept on the flat bottom stove, the distances below the pots decrease by about 1-2 cms and hence there were no serious problem in its usage. Also it is ideally suited for keeping frying pans and such vessels and hence stove could be used for cooking variety of dishes in different type of vessels.

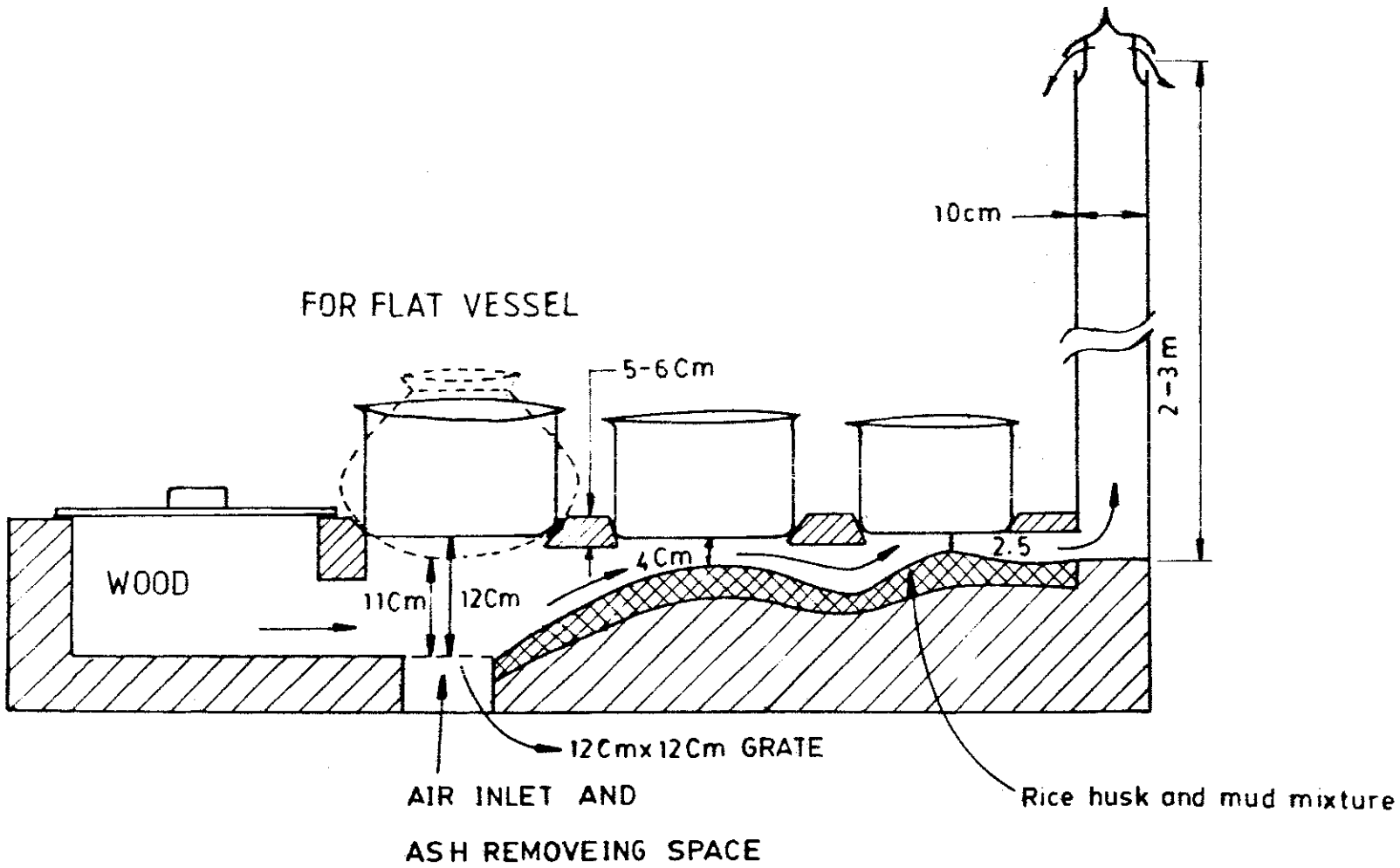

FOR FLAT VESSEL
10cm
2-3m
5-6Cm
WOOD
11Cm
12Cm
4Cm
2.5
12Cmx12Cm GRATE
AIR INLET AND
ASH REMOVEING SPACE
Rice husk and mud mixture

Fig. 4

A simple method to construct this stove has been devised with locally available materials so that the stove dimension can be kept as close to the original design to achieve reproducible efficiency. The steps to construct the stove is very briefly given in figure 5. A detailed account of its construction can be found in Astra Ole construction manual published by KSCST, IISc.[5]. A typical Astra Ole in Uttara Kannada village is given in figure 6.

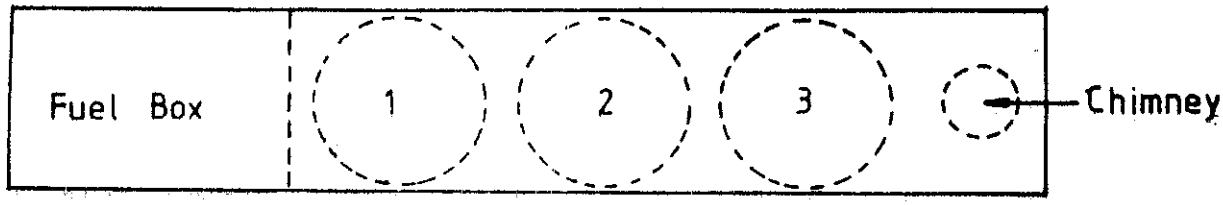
Several minor modifications were made during the diffusion of this stove in Uttara Kannada villages. They are;

a) Shutter for the air inlet provided in the original design was not essential and hence was discarded.

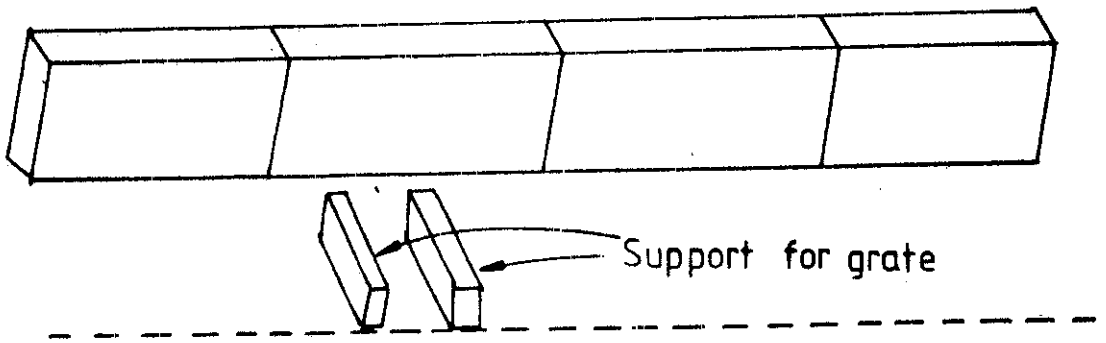
b) The stove is constructed out of mud. A small gap of the order of 2-3 mm between the stove seatt and the vessel could not be avoided. Therefore the secondary air inlet was of no extra use and hence it was not provided.

c) Since the stove has to be adjusted for the vessels already available with the household, the distances are adjusted to suit the needs of both round and flat vessels, i.e. the distances now are 11 cm, 4 cm and 2.5 cm below the 1st, 2nd and 3rd respectively

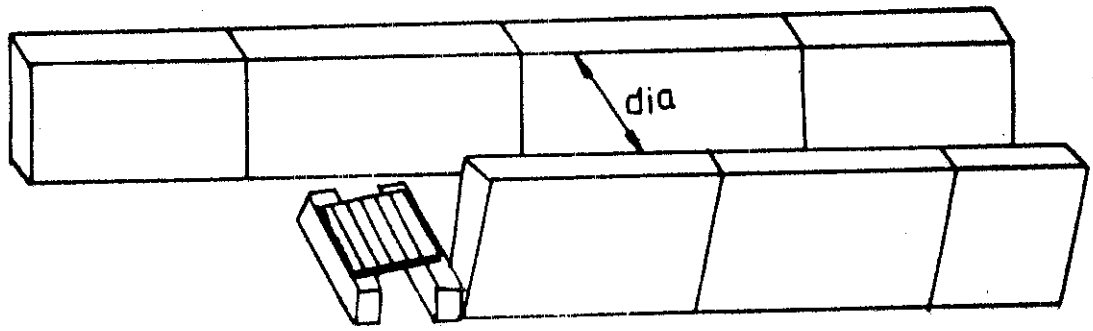
d) The size of the third pot hole was always kept small at the request of the housewife since use for the third hole was not felt by them. In the 3 villages under study, 95% of houses have adopted ASTRA OLE.



(a)

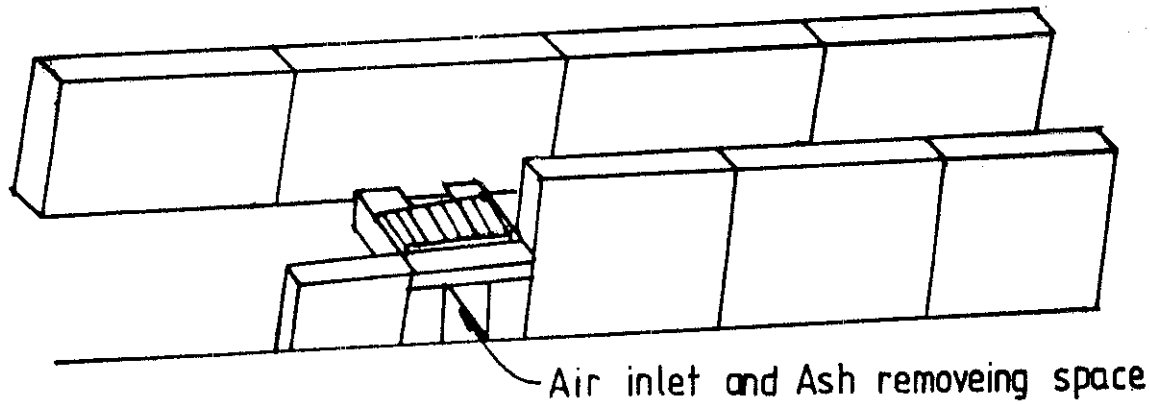


(b)



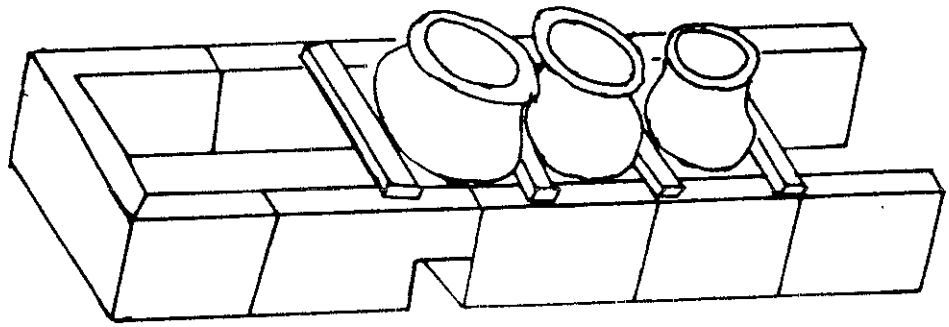
15cm x 15cm Cast iron grate

(c)

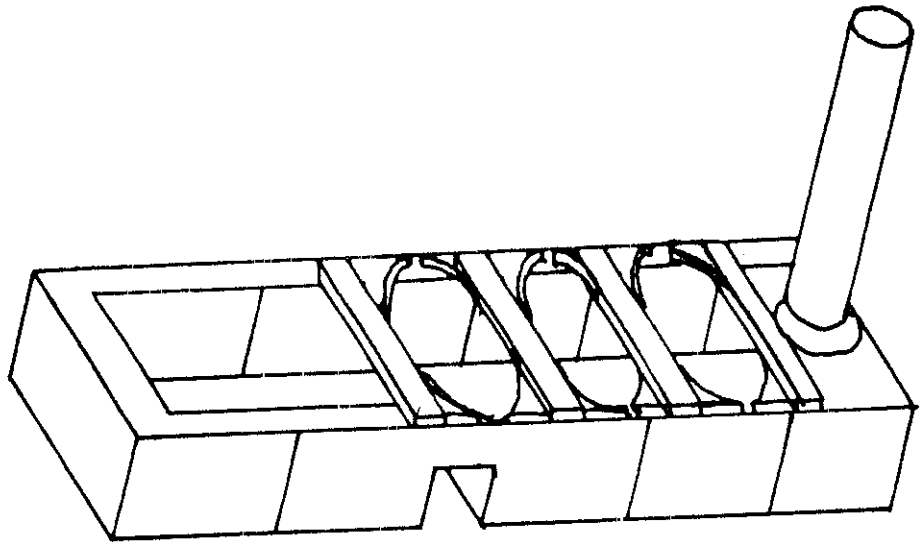


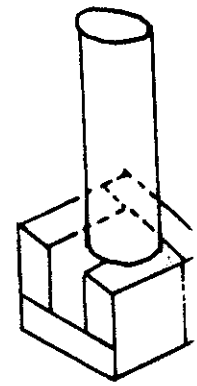
(d)

Fig 5

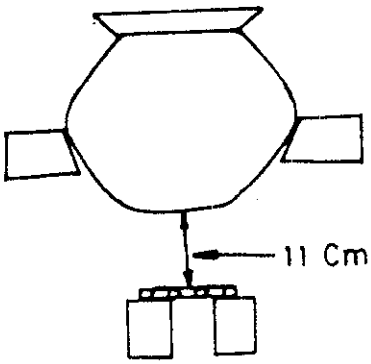


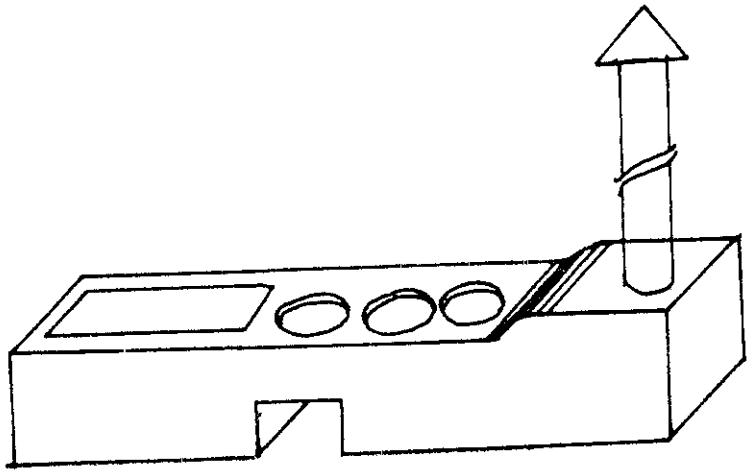
(e)

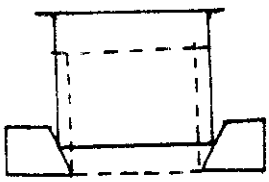




(f)

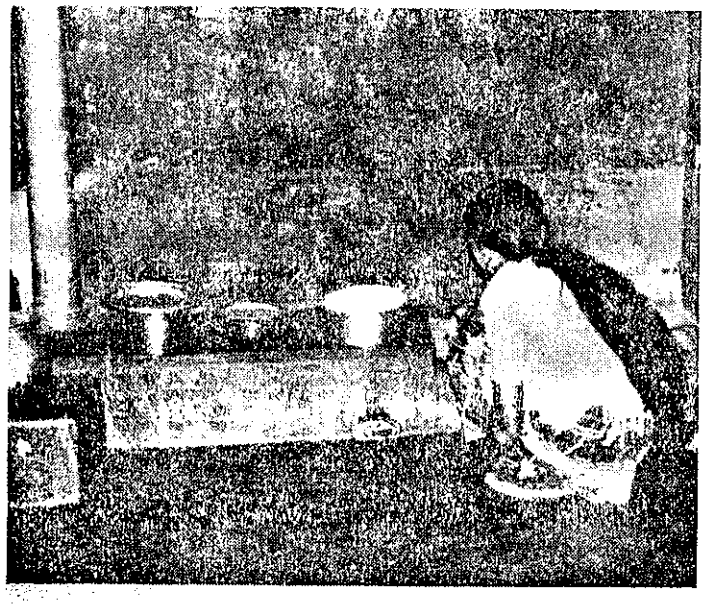






(g) Fig 5

ASTRA OLE AT UNCHAGI



8. Diffusion of Astra Ole

In Appendix B, names of 100 house owners in Unchagi, Hosaheravatta, Kotaguddi and Vallayalli villages of Unchagi valley are given. Thus 140 Astra Oles in these villages constituted 95% of the houses. A few houses in Unchagi had thatched roof and thereore they did not accept this stove. Also, at least 5 houses were not willing to adopt this stove and the reasons against it were nothing to do with the stove itself.

It is important to mention here that all the 140 houses are using Astra Ole since one year. Almost every house in this village has been cooking in smokeless Astra Ole and therefore Unchagi can be called a SMOKELESS VILLAGE.

In appendix C, a list of 255 houses in Uttara Kannada where the trained persons from Unchagi (particularly Mr.R.S.Hegde, R.S.Bhat, Mr.Umesh Hegde, Mr.Karna Gauda) have gone around and constructed Astra Ole. In the project proposal, it was mentioned that attempt will be made to persuade the people of neighbouring villages to adopt the new stove. This has been accomplished more than committed in the project. Except 15 stoves in this list, all others have paid Rs.150/- per stove. This does show its acceptability and its utility in Uttara Kannada.

9. Field performance of Astra Ole

The efficiency of these stoves could not be readily measured since the standard dried wood was difficult to carry from house to house. Also, housewives were not cooperative to measure efficiencies by water boiling test because they felt that their

wood is unnecessarily wasted. Since SFC values are easy to measure during the process of their cooking, only SFC measurements were done to evaluate the merits of Astra Ole. Frequency distribution of SFC values measured in 75 houses havig Astra Ole is shown in Figure 7. In the same figure, frequency distribution of SFC in conventional stoves (40 measurements) are also shown.

Although SFC is not considered a standard method of evaluation of stove, this serves as useful measure to study fuel consumption. The figure clearly shows that the spread in SFC values for Astra Ole is very low. 68% of Astra Ole give SFC values between 150 to 200 gms. SFC values obtained in conventional stoves for similar food habit do not overlap. The spread is high. This clearly demonstrates the uniform fuel saving in Astra Ole.

The mean SFC value of 172 +_ 26 gms/kg was obtained in Astra Ole in the village (lunch time cooking with 3 dishes). Measurements were for a standard meal consisting of rice, vegetable curry and cooked vegetables. A comparison of the SFC distribution of Astra Ole and conventional stoves clearly shows that the variation in the SFC in Astra Ole is almost negligible as compared to the conventional stoves having the value 405 +_ 126 gms. Although SFC value of 172 gms/kg obtained in the field condition is higher than the laboratory value of 110 gms/kg, it is 57% lower than the mean SFC value of the conventional stove. Therefore taking results of one time cooking in all the three vessels simultaneously, a saving of 57% of the fuelwood is achieved in Astra Ole. In addition stove is smokeless, any type of fuel (except rice husk) can be burnt in this stove. Time required

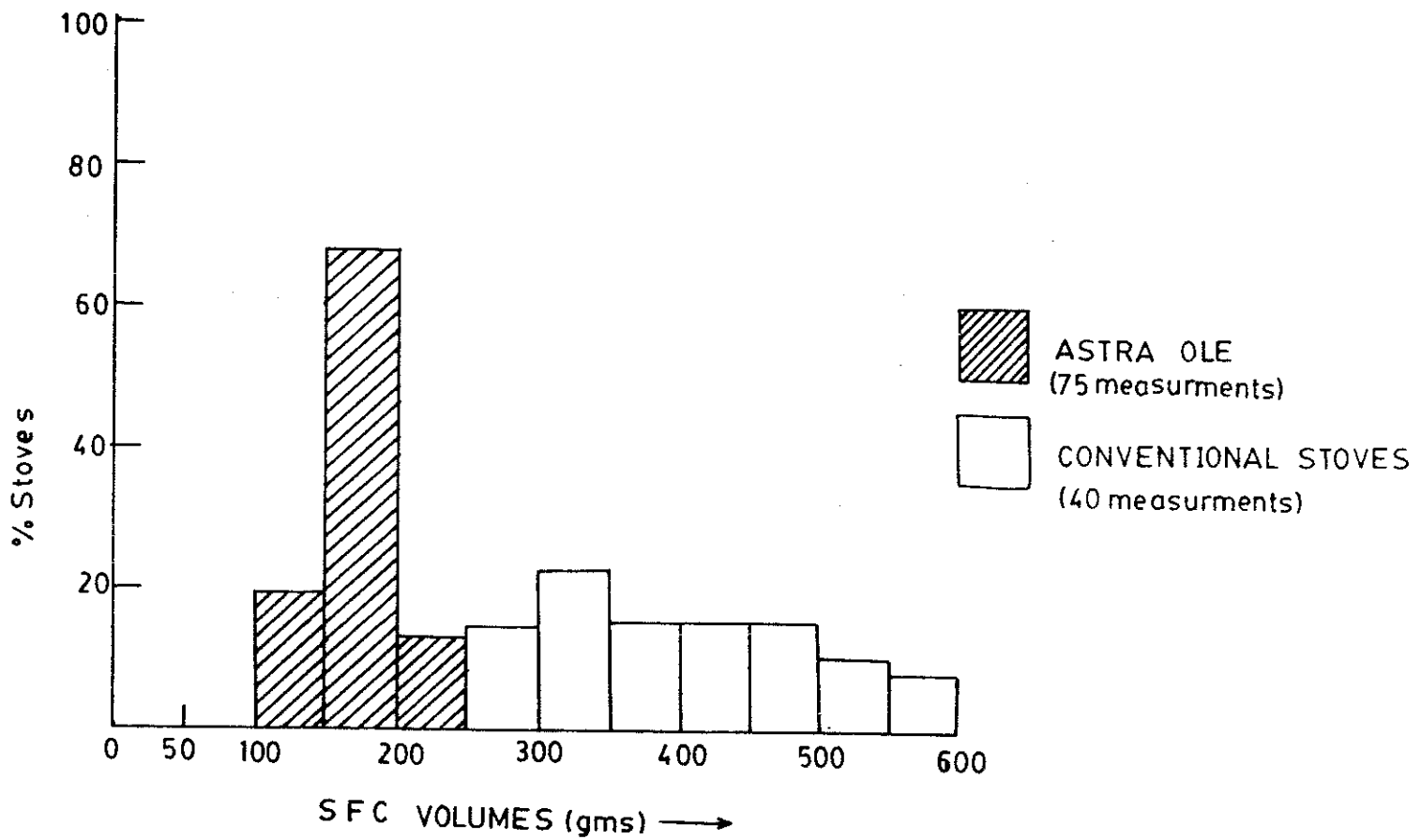

100
80
60
40
20
% Stoves
0
50
100
200
300
400
500
600
SFC VOLUMES (gms) ⟶
ASTRA OLE
(75 measurments)
CONVENTIONAL STOVES
(40 measurments)

Fig 7

for cooking was reduced due to the fact that three dishes could be cooked simultaneously. These were considered as important as fuel saving for its acceptability in these villages.

57% Saving in fuel can be considered very good when the SFC values are compared between the conventional and the Astra Ole, taken only one time cooking measurement. It was of interest to see if the average saving could be as high as 57%. Therefore, a study of fuel needed for cooking food for a period of one week in a conventional stove was compared with the values when Astra Ole is used. This was carried out in 3 sets of houses. The result showed that in houses where conventional (B and C type) is used, the average fuel consumption rate was 1.31 kg/person/day. In Astra Ole for the same period of study in 3 houses the fuel consumption rate was 0.91 kg/day/ person. SFC values in the conventional stove was 410 gm/kg as against 280 gms/kg in houses having Astra Ole. Therefore actual fuel saving is only 1.31-0.91/1.31 = 31% i.e. 0.4 kg/day/person.

Families having similar fuel with similar food habits were chosen for this study. The result thus shows that only 31% of the fuel is saved. This could be considered as a realistic saving of fuel in Astra Ole, compared to the conventional stoves. It was quite intriguing that in the same Astra stoves in one time cooking experiment 57% of fuel can be saved when three pans are used but the long term saving was only 31%. On enquiry we found that not all the time all the three pans are used for cooking. Amount of cooked food to uncooked food varied largely and the need of three

pan stove was itself was questioned by the users. Therefore a study on the food habit, number of dishes cooked per meal and the quantities per meal were collected in 100 houses having conventional stoves and 100 houses having Astra Ole. These studies were not confined to the houses of Unchagi alone.

People in this region take a heavy breakfast with one cooked dish and generally tea with milk and sugar as beverage before 8 a.m. in the morning. For breakfast dosa, idli and such dishes made of rice and black gram pulse flour are cooked. In addition milk is boiled. After the morning work, a heavy lunch is taken before 1 - 2.30 p.m., which is generally the most important meal of the day. In the evening, tea with light snacks are taken around 5 to 6 p.m. Last meal of the day is supper, taken after 8 p.m. Thus the cooking is carried out 4 times a day. The food during lunch and supper generally consists of rice, vegetable curry (boiled pulse + vegetables + spices) and cooked vegetables. In addition, dishes prepared out of yogurt is taken but this does not need heating except for boiling milk before making yogurt.

In figure 8 percentage of the number of dishess cooked at a time in the conventional stove and Astra Ole are given for all the 4 meals. In the conventional stove when they cook 3 dishes at a time, more than one stove is used. However, in Astra Ole all the three dishes can be cooked simultaneously (see figure 8). Also, the practice of cooking 3 dishes simultaneously seems to have gone up after having Astra Ole. However during the evening tea, essentially only the first hole in Astra Ole is used.

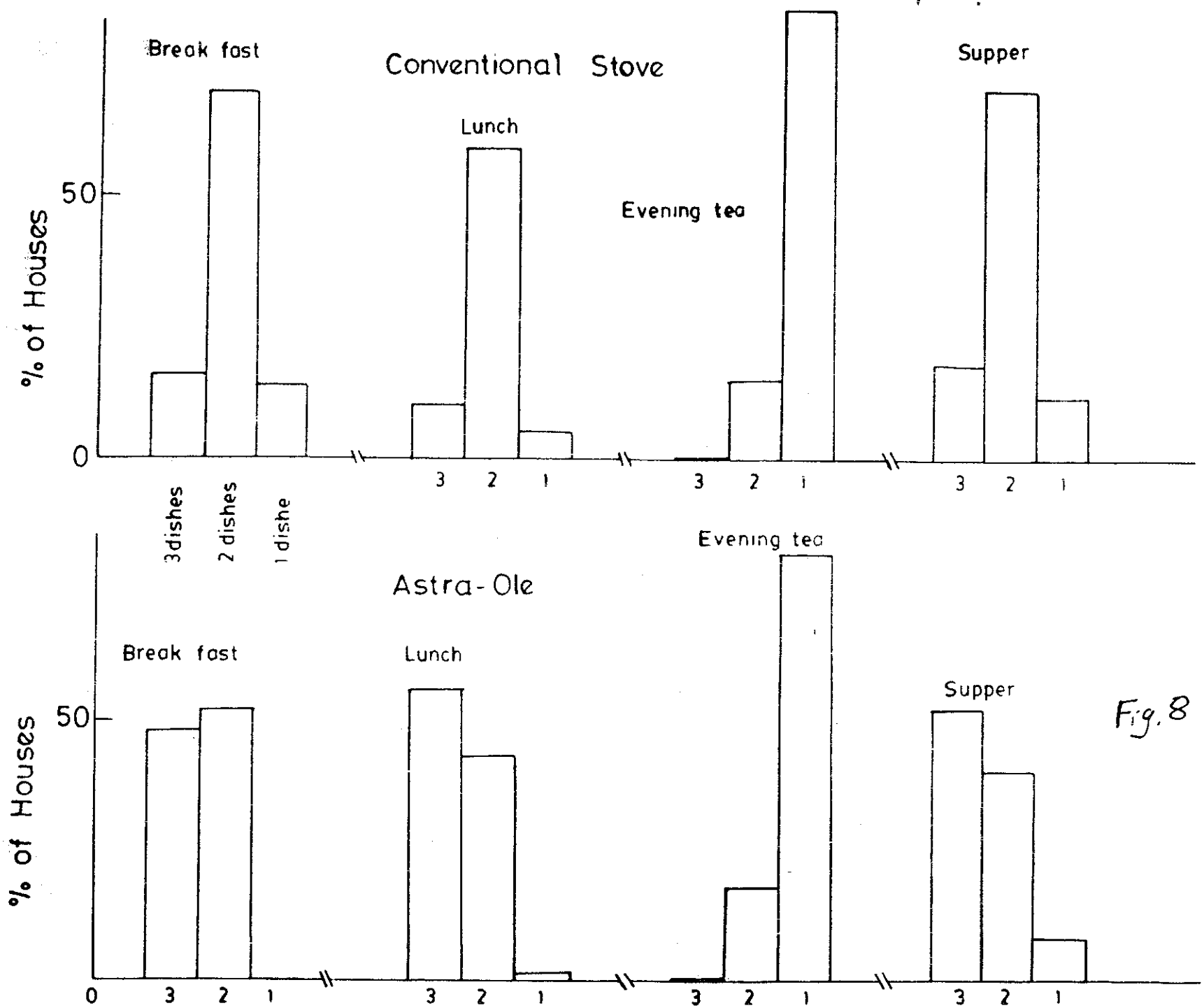

Conventional Stove
Break fast
Lunch
Evening tea
Supper
% of Houses
50
0
3 2 1
3dishes
2 dishes
1 dishe
Astra-Ole
Break fast
Lunch
Evening tea
Supper
% of Houses
50
0 3 2 1
3 2 1
3 2 1
3 2 1

Fig. 8

Quantity of food cooked per meal also varied greatly. Daily per capita cooked food during lunch, supper, breakfast and evening tea were 1 kg, 0.8 kg, 0.75 kg and 0.3 kg respectively. Based on these data a realistic estimate of fuel saving in Astra Ole for this region is estimated.

10. Fuel conservation - an analysis

SFC values for one time cooking during lunch hours is found to be 172 gms/kg in Astra Ole when all the three pans are used for cooking.

$$\text{Let } Ef_i = \frac{\text{Efficiency of } i^{th} \text{ pan}}{\text{Efficiency of the 1st pan}}$$

In Astra Ole, $Ef_1 = 1$, $Ef_2 = 0.68$ and $Ef_3 = 0.4$ (see table 4). So maximum efficiency factor $E = \sum Ef_i = 2.08$. Let C_j = daily per capita consumption of cooked food for j^{th} meal. Also, let P_{ij} = proportion of families cooking i number of dishes in one meal at a time. It has been observed that if it is one dish, only 1st hole is used, for two dishes 1st and 2nd holes are used and if it is three, all the 3 holes are used in Astra Ole. Then, the effective efficiency factor:

$$= \left[\sum_{i=1}^{3} \sum_{j=1}^{4} Ef_i \times C_j \times P_{ij} \right]$$

Substituting the values given above, effective efficiency factor in Astra Ole has been found to be 1.35 as against the maximum value of 2.08. Hence the reliable percentage fuel saving in Astra Ole is 37% (1.35 x 57/2.08).

This value can now be compared with the actual 31% fuel wood saving observed in one week long measurements.

11. Fuel saving in Unchagi valley

From our study, it is clear that 0.4 kg of fuel is saved per day per person. Taking 140 houses in this project with 840 people, the annual saving in fuel is 120 tonnes. This would mean atleast 180 cart loads of wood. Present cost for one cart load of wood in Unchagi is Rs.140/- and thus, in terms of money, a saving of Rs.25,000/- is clearly achieved. The momey invested on these 140 stoves is Rs.21,000 (140 X 150) and thus, in just 10 months of the construction of this stove (May 31, 1985 construction was over) ie. by March 31, 1985 the entire money invested in the stove construction is essentially recovered by the state in terms of fuel saving.

In reality, the people in this village are buying less of cut wood from Chadavar forest which were to come in bullock carts. An enquiry in all the 140 houses shows that atleast 120 cart loads (about 80 tonnes) are now saved annually. These are the figures as told by houseowners. The agricultural residue such as coconut tree products, arecanut husk are being regularly used as fuel for cooking in Astra Ole. This answers why there is a lesser intake of cut wood in addition to saving fuel through higher efficiency.

TABLE 4

VARIATION OF THE THERMAL EFFICIENCY OF ASTRA COOKING STOVE

WITH CHANGES IN DISTANCES

Sl. No.	Experiment	Distance below the pans			% Thermal efficiency in			Total
		1	2	3	1	2	3	
1.	Round bottom vessels of Al	13.0 cm	4.5 cm	2.8 cm	20.1	15.0	10.1	45.2
2.	Shifting of 1st vessel to 3rd after 1st is boiled	13.0 cm	4.5 cm	2.5 cm	12.3	12.1	14.0	38.4
3.	Al.flat vessels on the same stove as in expt.1 above	16.5 cm	9.5 cm	7.5 cm	14.0	5.3	3.4	22.7
4.	One round and two Al flat vessels	2.8 cm (Round)	4.5 cm	4.0 cm	17.3	9.7	6.9	33.9
5.	All flat Al.Vessels with optimum distances	11.0 cm	4.0 cm	2.5 cm	20.2 1.0:	13.8 0.68:	8.2 0.4	42.2 2.08

12. Fuel efficient bath room stove - Hosa Bachhala Ole

It is common knowledge that people in India take hot water bath. Hot water is known to give comfort after a hard work. Children are invariably given hot water bath. Therefore, we need energy to heat water for bath. We considered it worthwhile to take up the problem of saving energy in this domestic sector. It was committed in the project that attempt will be made for new innovation to save fuel. A brief description of conventional stoves and the design and development of the new fuel efficient bath room stove is described here.

13. Conventional Bath room stoves

Efficiency: Fuel efficiency of a stove is generally evaluated by water heating test. Heat gained by a known amount of water is measured by burning a measured quantity of wood. Hard fuel wood such as casurina, sun dried for 30 days, contain about 10 percent moisture. Calorific value of this type of wood is 3800 kcals/kg. Efficiency is obtained as follows:

$$\% \text{ heat utilisation} = \frac{(\text{wt. of water in kg})\ (\Delta T)}{(\text{wt. of wood burnt in kg}) \times 3800} \times 100$$

where ΔT is the rise in water temperature after burning. Generally, bath water is heated to 60° and bath is taken after mixing fresh water. We have also heated water to about $60^{\circ}C$ in our experiments.

Conventional Bath room stoves

A survey of bath room stoves in these villages showed that no family used more than one vessel. Mainly, 4 types of

stoves are found in these areas which are shown in Fig.9. Efficiencies of each of these types were measured and the values are given in Table 5 along with percentage occurrence of each type and their brief descriptions. Invariably, a round bottom copper vessel is used. Size of this vessel varied depending upon the family size. For a family of 6 members, 50 to 60 litres capacity vessel is in usage.

From table 5, we can see that efficiency of the stove increased with usage of a chimney. Highest efficiency of the bath room stove we measured is only 22 percent. However, in these villages, no bathroom stove had any chimney. Yet another observation is that these stoves are smoky. Bath room walls and roofs are generally covered with dark tarry layers. It is uncomfortable to take bath while stove is burning. Smokeless bath room stove is considered desirable by these villagers in addition to fuel saving. Thus, there was a clear demand by the villagers for a new smokeless, fuel efficient bath room stove.

14. Design considerations of a new bath room stove

Based on the observations on the conventional stoves and the discussions we have had with the villagers, the criteria for a new stove desired were:

(a) in the new stove the existing single vessel be used,

(b) locally available material be used for construction,

(c) the stove be easy to construct, easy to light, easy to extinguish and smokeless,

(d) rate of burning be such that in about 30 minutes about 50 litres of water be heated to 50^{o}C,

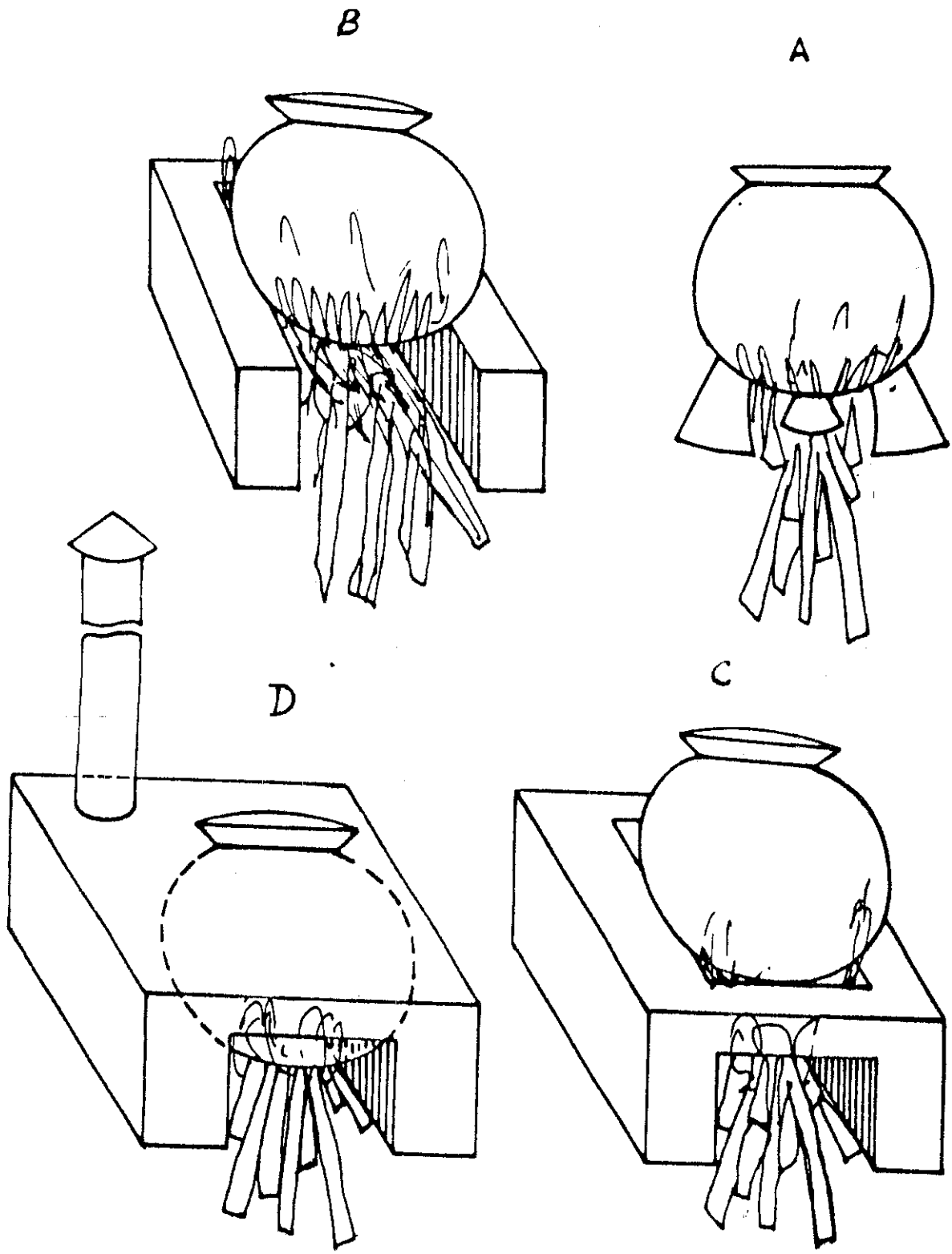


Fig. 9

(e) cost of the stove be kept at a minimum, and

(f) high fuel efficiency be achieved.

With these constraints in view, design parameters are calculated as follows:

Unlike in the conventional stoves, fuel is allowed to burn over a cast iron grate. Air required for burning is allowed through the grate so that combustion is controlled. Taking 50 litres round bottom vessel to be heated from 25°c to 50°C in 30 minutes and assuming 35% efficiency, quantity of wood to be burnt is calculated. Calorific value of wood is taken equal to 3800 Kcals/Kg. Thus 1250 kcals of heat is required for heating 50 litres of water from 25 to 50°C and the wood required for this is 1250 (3500 x 0.35) = 0.940 Kg. Now, this much wood should be burnt in 30 minutes. It is known that about 2.5 kg of wood can be burnt in one hour over a grate area of 15 cm x 15 cm (6 in x 6 in). Hence a kg of fuel can easily be burnt in about 30 minutes over this grate area and hence a 15 cm x 15cm cast iron grate is fixed. Flue gas generated has to be taken out through chimney and 10 cm x 2 meter chimney is considered adequate for this purpose. Standard 4" x 10' asbestos cement pipe available in market is close to this requirement. The fuel is to be laid on the grate and the fuel can be kept closed so that air required for burning is allowed only through the grate. Thus, the final design parameters were:

(a)	Grate	15 cm x 15 cm
(b)	Chimney	10 cm x 2 m
(c)	Vessel size	50 lit. capacity
(d)	Distance between the grate and vessel bottom	experiments.

TABLE 5

EFFICIENCY AND PERCENTAGE CONCURRENCE OF THE CONVENTIONALL BATH ROOM STOVES+

Type (see fig.9)	Percentage occurrence in a typical village Unchagi	Efficiency %	Special features
A	25	10-12	No chimney
B	35	12-15	No grate No chimney
C	40	14-16	No grate No chimney
D	0 (one from city is shown in fig.9)	16-22	No grate chimney of 3 in-4 in dia. 10 ft. height

+ Efficiency presented here is an average of 5 stoves of each type studied.

Efficiency of an experimental new stove

In order to examine the effect of various stove parameters on efficiency, an experimental stove was constructed at Mr.S.R.Hegde's house, Unchagi. The stove was constructed out of laterite stone and mud. Over 30 efficiency measurements were carried out by varying (a) the distance between the grate and the pot bottom, (b) distance between the wall of the vessel and the stove wall, (c) duct size for flue gas. The air gap below the grate was kept the same, viz., 12 cm x 2 cm by partially closing the hole below the grate which also serves as ash removing hole. The result of these experiments are summarized in Table 6. We can see from the results that the most important parameter is the

distance that the grate and the pot bottom. At 12 cm, the highest efficiency of 40 percent was achieved when the wall gap was about 4 cm. The duct size was only 10 cm x 10 cm. We have also measured the variations of water temperature, flue gas temperature and the temperature of the combustion zone (2 cm above the grate) as a functioning time. The stove can be operated at as low a flue gas temperature as 130°C. The results also show that in about 35 minutes, 0.9 kg of wood can be burnt and 50 litres of water can be heated from 28° to 55°C with 40 percent efficiency. These reults indeed satisfy the criteria considered in the design of the new stove. The stove was smokeless. The cooling rate of water was less than 1° per hour at 60°C initial temperature.

TABLE 6

VARIATION OF EFFICIENCY WITH VARYING THE CRITICAL PARAMETERS

AIR GAP BELOW THE GRATE (2 CM X 12 CM)

Sl. No.	Distance between pot bottom and grate	Annualar space between vessel and wall of the stove	Efficiency %
1.	18 cm	5 cm	25
2.	15 cm	5 cm	32
3.	13 cm	5 cm	36
4.	12 cm	5 cm	32
5.	12 cm	4 cm	40

Steps to construct the stove are given below:

(a) Measure the (highest) diameter of the vessel which we call dia. Consider the wall thickness of about 10 cm. Then

accordingly, mark the space as shown in Fig.10(a). Mark the positions of the grate such that the grate is placed from the centre towards the fuel feed hole.

(b) Construct a platform of 12 cm height leaving the grate mounting place along with ash removing place as shown in Fig.8b. Place 15cm x 15 cm grate on the channel. Make sure that channel direction in the grate is perpendicular to the fuel feeding direction. This is shown in Fig.10(b).

(c) Now construct the walls as shown in Fig.10(c). Keep the inner distance between the square walls equal to dia + 8 cm for vessel and the air gap. Keep the channel for ash removing free and also for fuel feed as shown in Fig.10(c). Continue to increase the wall height by keeping about 25 cm x 25 cm gap for fuel feed. This can be seen in Fig.10(c).

(d) Give a brick support at the bottom at the centre (towards chimney side) and keep the vessel such that the bottom of the vessel is only at 12 cm and adjust the height of the wall. Then remove the vessel.

(e) Shape the bottom and the inside of the stove exactly as that of the vessel keeping 4 to 5 cm gap uniformly between the vessel and the inside wall. This is the most important step in the stove construction. The filling should be done with mud and rice husk mixture (50:50). Support the vessel by giving the packing on the wall side and the bottom brick such that the distance between grate and the bottom of the vessel be 12 cm (5 in). Then at the

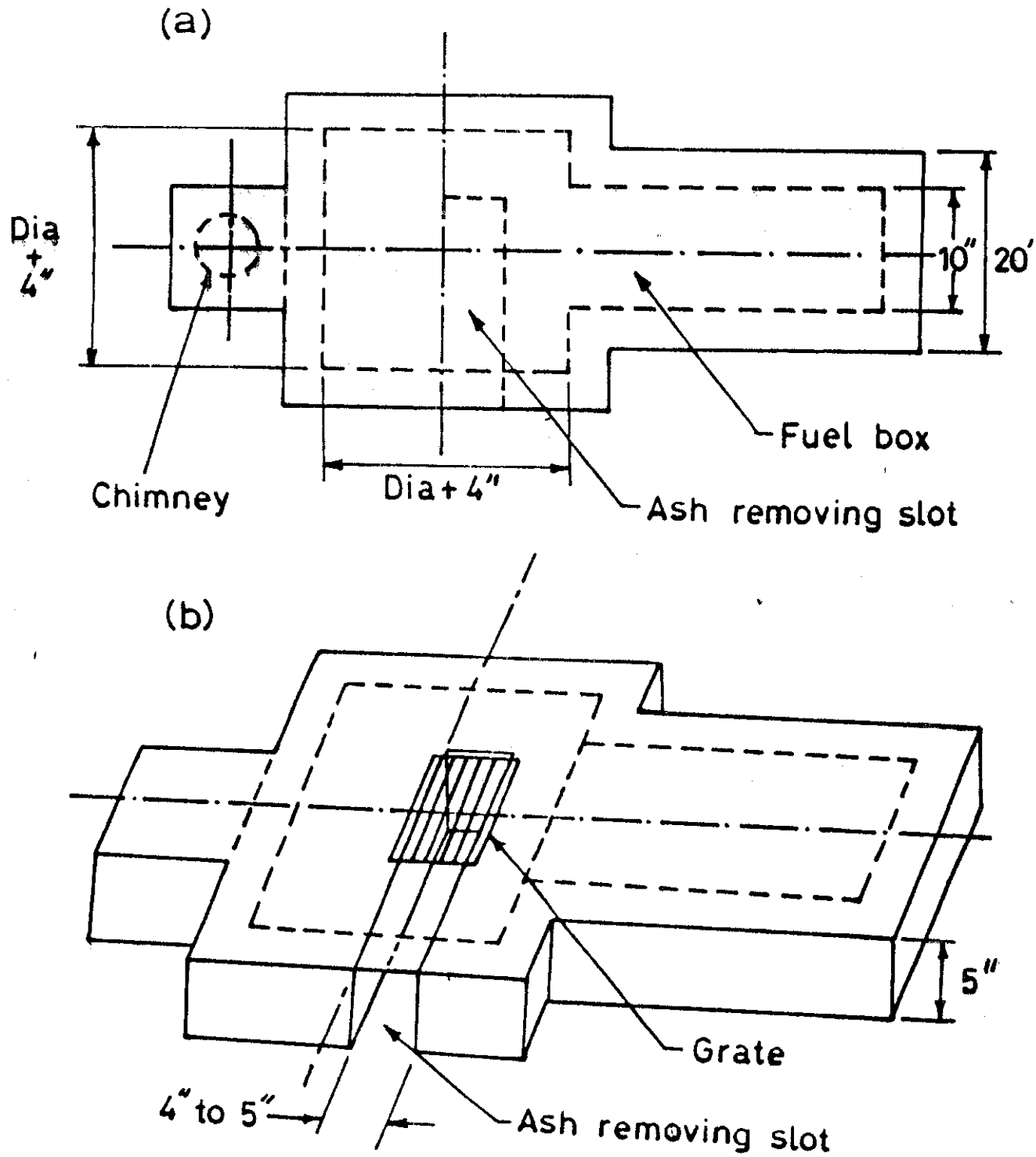
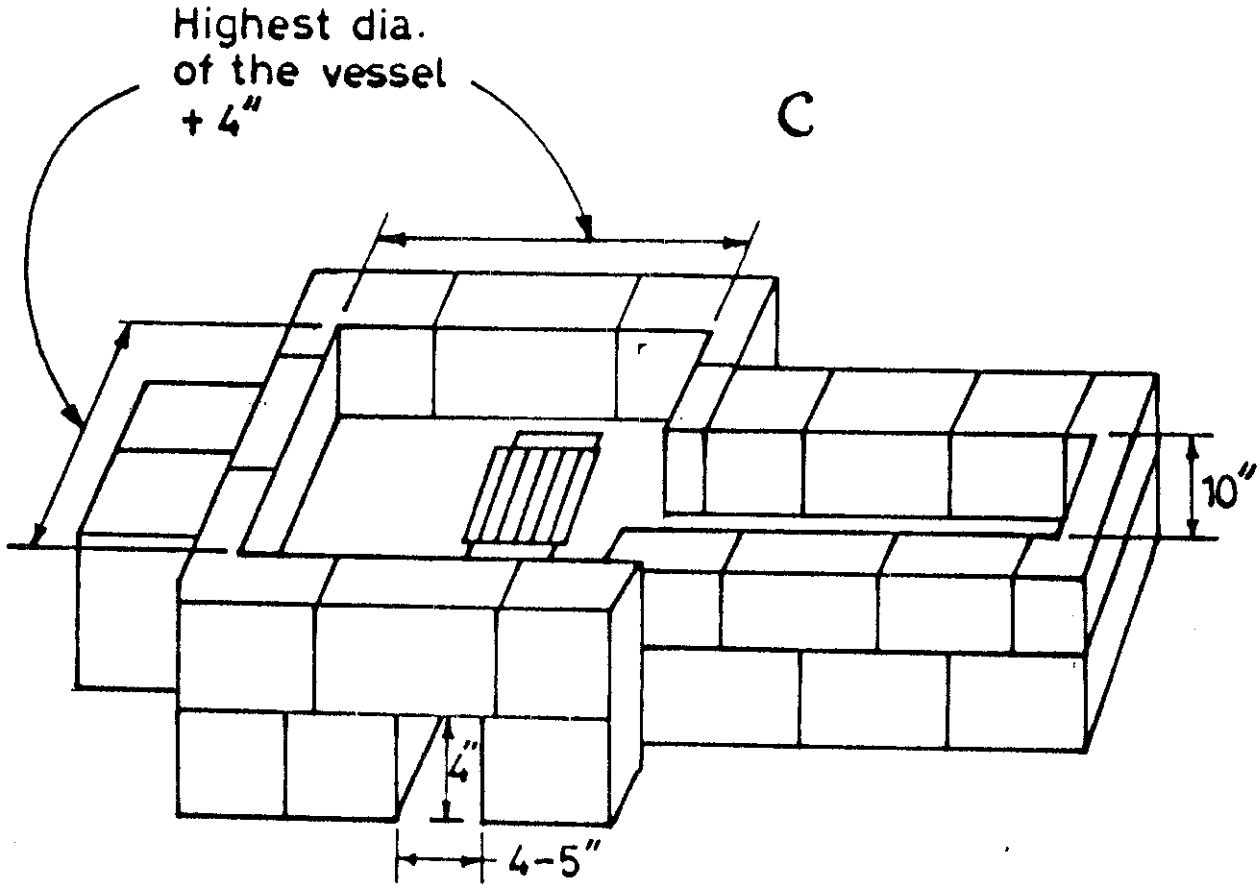

(a)
Dia + 4"
10"
20'
Chimney
Dia + 4"
Fuel box
Ash removing slot
(b)
5"
Grate
4" to 5"
Ash removing slot

Fig. 10


Highest dia.
of the vessel
+ 4"
C
10"
4"
4-5"

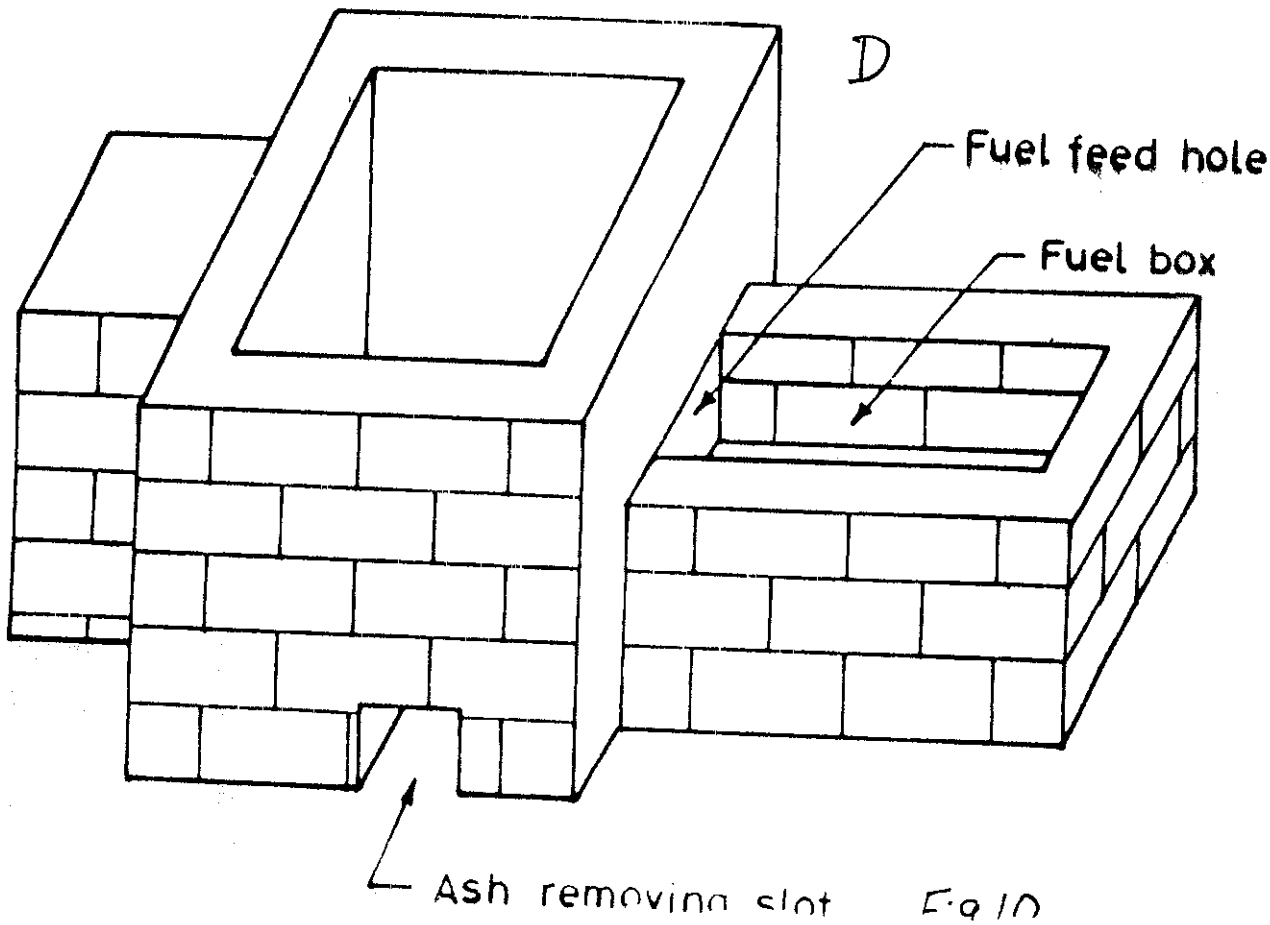

D
Fuel feed hole
Fuel box
Ash removing slot

Fig 10

chimney end, keep a 10 cm x 10 cm gap and lead it to chimney. Close the top now by covering with tile or asbestos piecess and finally with mud. The cross-section of the stove now looks as in Fig.11. One can provide a lid in the flue gas duct path to remove the carbon collected over a period of time. This is shown in Fig.11.

(f) Another way to construct is to support the pot from the maximum diameter of the vessel itself. The wall height can be reduced and construction is easy. The cross-section of this modification is shown in Fig.12. Although the efficiency of this is about 1% lower, construction is easy and it is suited for villages.

(g) Make the fuel box of about 25 cm wide, 30 cm long and make a lid of 18-20 guage G.I. sheet to cover it.

(h) Finally plaster the outside walls and top of the stove with mud, sand and lime mixture with a final coating with cement. Fuel box also needs plastering. Make sure that when the fuel box is covered with lid, no air gap is left. Top part of the stove needs no cement plaster because water should not enter the stove.

Firing procedure

The stove be allowed to dry for 8-10 days; put plam leaves or any light material on the grate and put fire. Cover the fuel box with the lid. Flue gas starts going out through the chimney. Put smaller sticks on the grate now and finally, use cut wood or any other fuel for burning. Keep the fuel box closed and

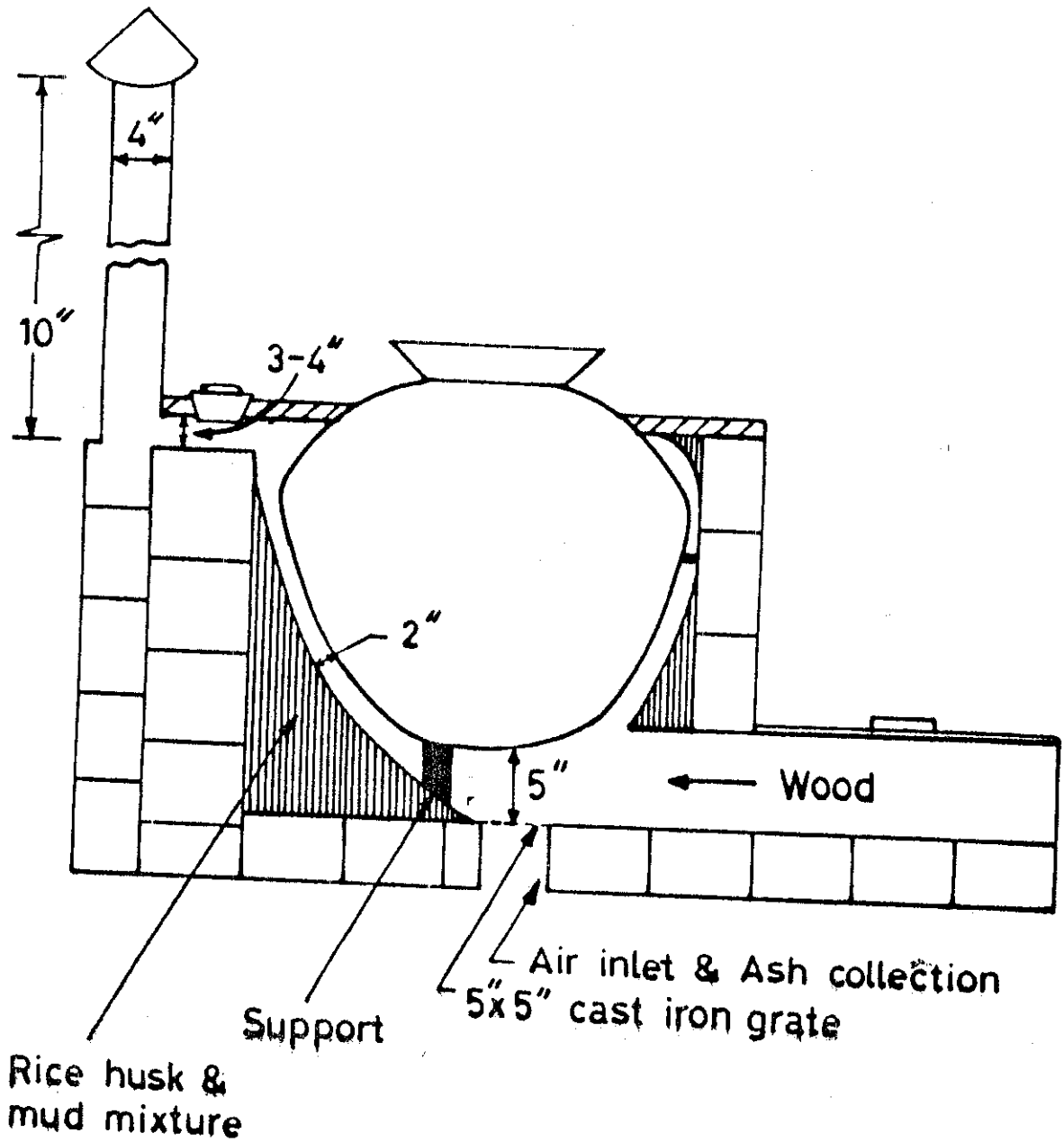

4"
10"
3-4"
2"
5"
Wood
Air inlet & Ash collection
5"x5" cast iron grate
Support
Rice husk &
mud mixture

Fig. 11

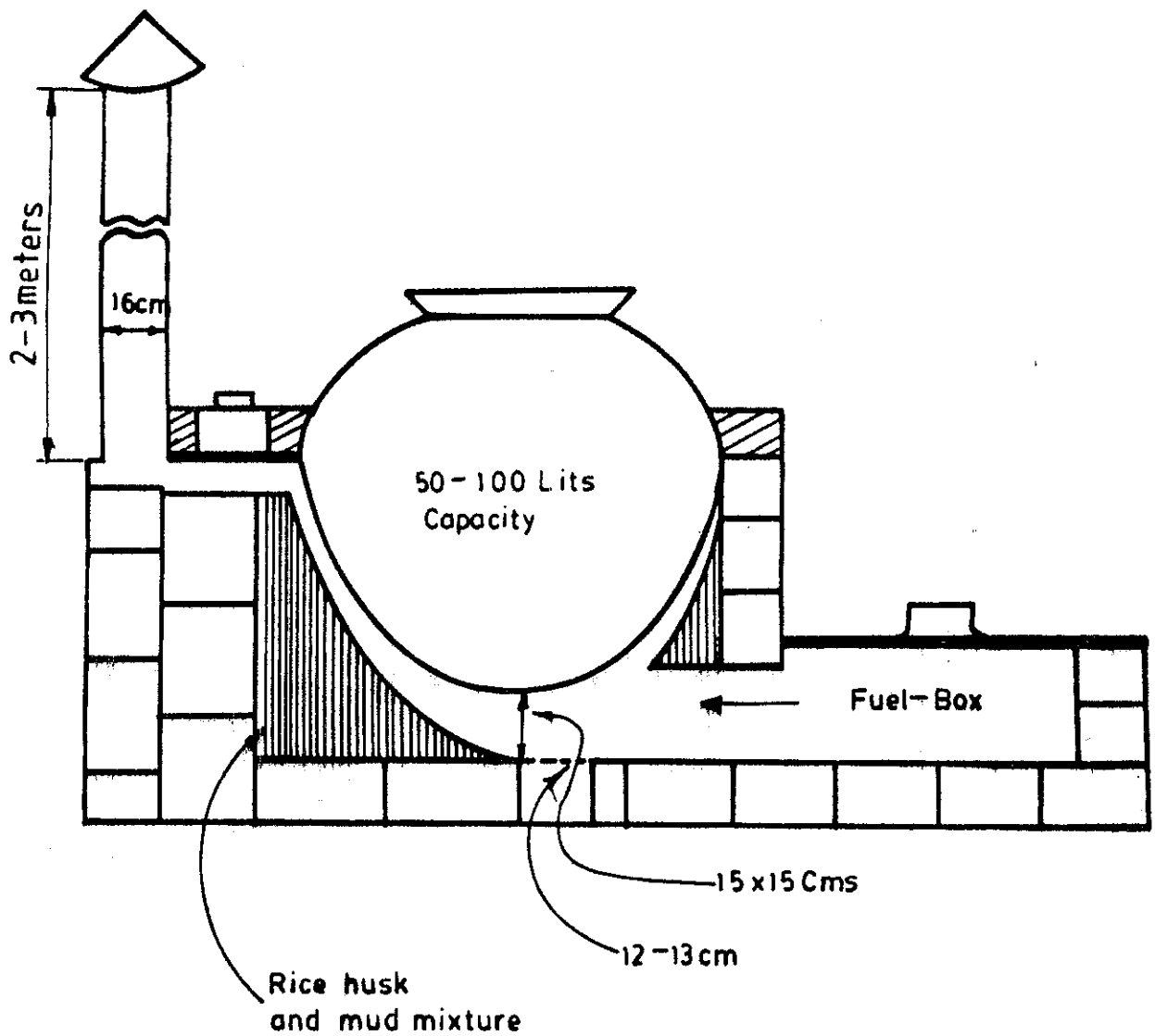

2-3meters
16cm
50-100 Lits
Capacity
Fuel-Box
15x15 Cms
12-13cm
Rice husk
and mud mixture

Fig. 12

air shall enter only through the grate. Once in 10-12 min. tend the fire.

15. Comparison of the traditional stove with the new stove

In order to evaluate the new stove about its utility, a comparison between the old and the new is in order. This is given in Table 7. In over 10 villages of Uttara Kannada, the new stoves are working and the method of construction is found satisfactory. Efficiencies are uniformly above 38 percent. The new bathroom stove has relevance even in cities like Bangalore. A simple modification of the old stove with chimney (Fig.1d) to the new one is possible which saves 50 percent of the fuel. This has been done in one house in Bangalore (A-43, CII colony, Sanjay Nagar, Bangalore 24). The results show that 1 kg. of fuel is sufficient for bath for 4 people which works out to be cheaper than electricity.

TABLE 7

COMPARISON BETWEEN OLD AND NEW BATH ROOM STOVES

Details	Old stoves	New stove
a) Materials for construction	Stone/brick, mud chimney (if there is one)	Stone/brick, mud, rice husk, chimney 25 cm x 23 cm cast iron grate, wood box cover
b) Fuel	Wood, twigs, dry leaves, dung cakes	Wood, twigs, dry leaves, dung cakes, coconut husk, arecanut husk
c) Comfort	Types A, B, C are smokey only Type D emits less smoke	Totally smokeless, easy to light, easy to maintain fire (by fanning through ash removing space)
d) Cost	Cost is due to bricks/ stone chimney I (if there is one) and labour	Same as traditional ones except the grate, chimney if it is not there, flue box cover
e) Efficiency	10-22	40
f) Fuel saving	-	Over 60
g) Time for heating	About 60 min to make 50 lit. of water ready for bath	Only 25min. to make 50 lit. of water ready for bath
h) Cooling rate	About 2^{o} per hour (initial temp.60^{o}C)	Less than 1^{o} (initial tem.60^{o}C)
i) Fire hazard	High	Nil

16. Diffusion of new bathroom stove

The method of construction is essentially similar to Astra Ole and this fact could be realized by Mr.R.S.Hegde, R.S.Bhat and others in Unchagi. They have readily accepted the design and could propagate at several places in Uttara Kannada. In Unchagi under the present project a few stoves have been built and their

efficiency was 39% which is completely satisfactory. They have been built in the following houses in Unchagi.

1. Sri Gopala Shastri
2. Sri Manjunatha Shastri
3. Gopala Shiv Bhat
4. Umesh Hegde
5. Gopala Narayana Hegde

There is a clear demand for this and over 50 families have come forward to pay Rs.50 and asked us to help in construct the stone.

A training camp was held at Yadalli under the Ecodevelopment Camp programme organised by Prof.Madhav Gadgil at Yadalli. The participants would take bath using hot water in this new stove. Here in Sirsi, the arecanut husk is used as a fuel. The cut wood is entirely replaced by arecanut husk which had almost no usee to these farmers. The stove can be efficiently used with area husk.

At the moment over 200 new bath room stoves are working in Uttara Kannada district. The work was carried out by Mr.R.S.Hegde, Unchagi, during Astra Ole Training Programme.

It is possible to train the artisans during the Astra Ole training programme to construct Bachhala ole also. Some steps havee to be taken at the DRDS level to include this as part of the fuel saving programme. It is hoped that secretaries at the government level notice this new innovation that is being practiced with almost no art of development.

References

1. A.Kumar, M.S. Heyde, K.S.Jayadish and S.S.Lokras, Annual Report of KSCST, (1980-81) p.34-36

2. M.S.Heyde, S.S.Lokras, K.S.Jagadish and R.Kumar, 'A Community Jagery Unit using bagasse as fuel', ASTRA, KSCST, IISc. (1981)

3. R.Kumar, M.S.Heyde, K.S.Jayadisn and S.S.Lokras, Annual Report of KSCST (1981-82) p.31-34

4. S.S.Lokras, D.S.Sudhakar Babu, Ms.Svati Bhogle, K.S.Jagadish and R.Kumar, Development of an improved 3 pan stoves, Changing Villages, 5, Sept-Oct.1983.

APPENDIX - A

ASTRA OLE CONSTRUCTED DURING THE TRAINING CAMP

UNCHAGI - JAN.26, 1984 TO 4 FEB.1984

26.1.1984

1. V.G.Bhat Gore
2. Narayana Bhagvan Shet
3. Gopal Narayan Hegde
4. Gajanan Narayan Hegde
5. Ganesh Thimmanna Hegde
6. Seeta Ram Hegde
7. Narayan Ganesh Hegde
8. Krishna Ganesh Hegde
9. Vishnu Parameshwar Shanbhag
10 Ganapathy Gajanana Hegde
11 Shivarama Vishnu Bhat
12 Manjunath Vishnu Bhat
13 Shanakaranarayan Parameshwar Hegde
14 Parameshwari Subraya Shastry
15 Gopala Vishnu Shastri
16 Manjunath Vishnu Shastri
17 Parameshwar Vishnu Shanbhag
18 Shivaram Ganapathi Achari
19 Dattaraya Vishnu Achari
20 Venakataramana Vishnu Achari
21 Ganesh Narayana Bhat
22 V.G. Hegde Thamti
23 Krishna Ganesh Pandit
24 Parameshwara Ram Pandit
25 Gopal Shiv Bhat
26 Thirumula Bhat
27 Prabhakar Shankar Hegde
28 Ugra Bhatru
29 Subrya Bhagavatha
30 Ganesh Achari
31 Giridhara Vernekar
32 Venkatachala Shet
33 Ramakrishna Ganapathi Shet
34 Shukru Shiv Gowda
35 Narayana Beera Gowda
36 Ganapathi Lakshminarayana Hegde
37 Ramachandra Gopalkrishna Bhat
38 Krishna Narayana Hegde
39 Parameshwara Venkataramana Bhat
40 Kamalakara Narayana Bhat Keregedde
41 Vishnu Hegde, Manee Kotegudde

APPENDIX B

LIST OF ASTRA OLE OWNERS, HOSA HERAVATTA, UNCHAGI, VALAGALLI AREA CONSTRUCTED IN THIS PROJECTS

	Name	Place
1.	Narayan Ramachandra Bhat	Unchagi
2.	Seetaram Ganapathi Bhat	"
3.	Kamala Mahadeva Kodiya	"
4.	Kuppa Hanmant Gadig	"
5.	Laxman Vajru Shet	"
6.	Santayya P.Shet	"
7.	Mahadev Ram Madival	Hosaheravatta
8.	M. Nagaraja Shet	"
9.	Narahari Ramakrishna Kamath	"
10.	Narayan V. Hegde	"
11.	Govinda Ganesh Hegde	"
12.	Nagappa Puttu Shet	"
13.	Manjunath Ganapathi Shet	"
14.	Vasant Panduranga Shet	"
15.	Sathyanarayana G. Bhat	"
16.	Shivaram Ganapathi Hegde	"
17.	M.G. Shetty	"
18.	Vishnu Subrahamany Shastri	"
19.	Varadeshwar V Bhat	Kotegudde
20.	Kashinath Sadashiv Shastri	"
21.	Ganapathi Narayana Hegde	"
22.	Ganapathi S. Shastri	"
23.	Ganapathi Ram Naik	"
24.	Mahabaleswar V. Shet	"
25.	Ramachandra Narayan Shet	"
26.	Harishchandra M. Shet	"
27.	Venkatraman N Achari	"
28.	Ramkrishna P Achari	"
29.	Parvati Krishna Bhat	"
30.	D.M. Lokeshwar	"
31.	Shankar Parama Bhat	"
32.	Ganapathi Jattappa Naik	"
33.	Narasimha Krishna Shanbhag	Valagalli
34.	Subraya Narayan Shabhag	"
35.	Rama Tai Phani	"
36.	Subray Gopal Shanbhag	"
37.	Ramachandra V Shanbhag	"
38.	Gajanan P Shanbhag	"
39.	Gajanan V Shanbhag	"
40.	Anasuya S Shet	"
41.	Annappa Ganapathi Bhat	"
42.	Parameshwar Jatta Gadig	"
43.	Babu Jattu Gadig	"
44.	Narayan Gadig	"
45.	Jattu Narayan Gadig	"

46.	Nagu V Gadig	"
47.	Parameshwar V Gadig	"
48.	Suresh Ganapathi Shetty	"
49.	SShridar Vishnu Shanbhag	"
50.	Rama Gadig	"
51.	Gangadhara Gadig	"
52.	Jatti Gadig	"
53.	P.D. Patgar	"
54.	Damodar Pundlik Goli	Hosa Hervatta
55.	Govind Anant Hegde	Kotegudde
56.	Narayan Ganapathi Hegde Kolli (Keregedde)	Kotegudde
57.	Jattappa P Naik	Valagalli
58.	M. Madhav Verun	"
59.	A. Hari Pai	"
60.	Keshav Manjunath Shet	"
61.	N.B. Kamat	"
62.	Gajanana Shivram Hegde	"
63.	Venkatram V Shanbhag	"
64.	Timmanna Kadabu Gowda	Unchagi
65.	Ganesh M Shet	"
66.	Krishna Devu Mukri	"
67.	Parameshwar G. Bhat (Kavverakka) (Kattikai)	"
68.	Ganapathi Ramakrishna Bhat	"
69.	Narayan Ganessh Hegde	"
70.	Nagu thimmu Makri	"
71.	Nagu Krishna Gowda	"
72.	Nagu Goydu Gowda	"
73.	Ramu Tolsu Gowda	"
74.	Shridhar Goydu Gowda	"
75.	Jatti Shivu Mukri	Valagalli
76.	Kania Kania Mukri	"
77.	Kania Maru Mukri	"
78.	Mahadev Kelsi	Unchagi
79.	Shridhar Govind Gowda	"
80.	Subraya Madivala	Valagalli
81.	Suresh Ganapathi Shet	"
82.	Giriya Maru Gowda	Unchagi
83.	Gajanan Shivaram Hegde	Kotegudde
84.	S.R. Hegde	Unchagi
85.	Tulusu Jattu Gowda	"
86.	Subraya Maru Gowda	"
87.	Kasne Gowda	"
88.	Nagu Goydu Gowda	"
89.	Shivu Shivu Mukri	"
90.	Krishna Parameshwar Shanbhag	"
91.	Venktraman Narayan Pandit (Keshava Panditara Mane)	"
92.	Venkatsubba P Shanbhag	Valagalli
93.	N.B. Kagal	Angadikeri
94.	Jattu Devu Gadig	
95.	Anant Pavaskar	
96.	Venktraman Bhat	Valagalli
97.	Gindi Rama Naik	"
98.	Jattu Gadig	"
99.	Sadanand Venkataraman Naik	"
100	Manjunath Ganapath Kundanagar	"

APPENDIX C

HOSA OLE - ASTRA OLE CONSTRUCTED BY R.S. HEGDE AND OTHERS

FROM YAVAK MANDALI - UNCHAGI

(240 in this list have paid Rs.150/- per stove;
the rest paid by Forest Department, Karwar)
(Except the names with * mark)

1.	Thimmanna Ganesh Hegde	Malgere
2.	Jattappa Shivappa Naik	Kalabhag
3.	R.V. Gunaga	Baggona
4.	Nagappa Patagara	Kalabhag
5.	Vasudeva Kamat Kagal	Kagala
6.	Hari Pai	Heravatta
7.	Vasudeva Parama Shet	Hosahittala
8.	Hegde Relatives	Nellekere
9.	R.S. Hegde	Nellekere
10.	Shivararam Krishna Bhat	Hegde
11.	Dr.Ramadas Pandit	Murur
12.	Gajanana Venkatramana Hegde	Maniru
13.	Vishnu R.Bhat	Murur
14.	Shankar Manjunath Bhat	Murur
15.	Satyanarayan Ganapathi Hegde	"
16.	R.T. Bhat	"
17.	Temple's Bhatru	"
18.	G.N. Naik	Agrahar
19.	Bhadran Hegde	Murur
20.	Kapasi Ganapathi Hegde	Murur
21.	Venkatpathi Seshu Naik	Agrabhara
22.	Narayana G Naik	Agrabhara
23.	Ganapathi Ganesh Hegde	Varnakere
24.	Mableshwar Ganapathi Bhat	Hebbarnakere
25.	Venkatesha Narasimha Shabhag	Kumta
26.	Narayana Master	Kujali
27.	Devi Ganapathi Kujali	Kujali
28.	Ganapathi Naik	Kalabhaga
29.	Ganapathi Krishna Bhat Abbe	Oorakeri
30.	Narayana Seetharama Bhat Kodlakere	Kodlakere
31.	Shankara Janardhana Bhat	Kodlakere
32.	Gopala Mableshwara Bhat	Kallebbe
33.	Kamali Venkatramana Hegde	Murur
34.	Venkatramana Hegde	Haraneeru
35.	Satyanarayana Shivarama Hegde	Kallabbe
36.	M.H. Ahmed	Kumta
37.	Ganapathii G Hegde	Chithrigi
38.	Eshwara Rama Bhat	Kallabbe
39.	Eshwara Subbraya Hegde	Kallabbe
40.	Narayana Ganesh Hegde	Kallabbe
41.	Narayana V Avadhani	Kallabbe
42.	Manjunatha Krishna Bhat	Kallabbe
43.	Satyanarayana Ramakrishna Hegde	"
44.	Ramachandra Anantha Hegde	"

45.	Thimmanna Vishweshwara Hegde	"
46.	Narasimha Gopala Bhat	"
47.	Ramachandra Satyanarayana Hegde	"
48.	Satyanarayana Mableshwara Hegde	"
49.	Satyanarayana Vishnu Bhat	"
50.	Vishweshwara Hegde	"
51.	P.D. Naik	Kagala
52.	P.R. Naik	Kumta
53.	Anantha Venkatesha Shanbhag	Kagala
54.	Dr.Ravi Clinic	Bada
55.	Gopal Vittal Pandit	Masura
56.	Rama Shopa Patagara	Masura
57.	Jattappa Gunaga	Masura
58.	Narayana Gunaga	Masura
59.	Uppa Patagara	"
60.	Mahadeva Patagara	"
61.	Shankara Thimmappa Patagara	"
62.	Mahabaleshwara Pandit	"
63.	G.V.Hegde, Lawyer	"
64.	Ramakrishna Hegde	Murur
65.	Thimmappa Shankara Gowda	Harodi
66.	Jatte Shivu Mukri*	Valagalli
67.	Gangadhar Venkappa Chandavarkar*	Valagalli
68.	Rama S Chandavarkar*	Valagalli
69.	Shivu Jatti Mukri*	Valagalli
70.	Kania Maru Mukri*	"
71.	K.R. Hegde	Kujali
72.	Gopala Bhat	"
73.	Kanya Kanya Mukri*	Valagalli
74.	R.S. Bhatta	Kumta
75.	S.R. Hegde	"
76.	Narayana Naik	"
77.	Kamala Kodanda Naik	Hiregutti
78.	Nagappa Shankar Naik	"
79.	Umesh Naik	"
80.	Sitaram Lakshmana Naik	"
81.	R.M. Naik	Kumta
82.	Ramdas Shanbhag	Alvekodi
83.	Lakshminarayana Bhat	Konalli
84.	Vishweshwara Mableshwara Hegde	Murur
85.	Sripada Subraya Hegde	"
86.	Narayana Govinda Bhat	Baragadde
87.	Mahadeva Govinda Bhat	"
88.	Nirmala Convent	Kumta
89.	V.N. Hegde	Kumta
90.	Mahadeva Varuna	"
91.	R.K. Hegde	Navilagona
92.	S.S. Hegde	"
93.	G.V. Joshi	Kekkar
94.	Vishnu Rambhat	Hebbarnakere
95.	S.G. Hegde	Kottina Kodlu
96.	M.S. Hegde	Gummekeri
97.	S.M. Bhatt	"
98.	V.G. Bhatt	Kanewane
99.	Subraya Ramachandra Hegde	Gengolli

100	Narayana Subraya Bhatt	Hebblekere
101	Ramachandra Ganapathi Hegde	"
102	Krishna Narayana Bhatt	"
103	Raghupathi Krishna Bhatt	"
104	Narasimha Rama Bhatt	"
105	Shankara Shiva Hegde	"
106	Manjunatha Kuppaiah Hegde	"
107	Narayana Vishnu Bhatta Kanchi	"
108	Rajarama Sridhara Bhatta	Kadathoka
109	Sripada Shiva Hegde	"
110	Madhukara Shiva Hegde	"
111	Shambu Bhatt	"
112	Shankara Parameshwara Bhatt	Kekkaru
113	Suryanarayana Bhatt	"
114	Krishna Janardhana Bhatt	"
115	Vishweshwara Shiva Bhatt	Kademane
116	Ganapathi Gopala Bhatt	Hakki
117	Subraya Shivarama Bhat	Hulimane
118	Vigneshwara Shankara Bhatt	Navilagonu
119	Manjunatha G Bhatt	"
120	Gajanana G Bhatt	"
121	M.R. Bhatt	"
122	Dr.V.V. Bhatt	Kadethoka
123	T. Dinakara	Haladipura
124	Krishna G Naik	"
125	G.G. Naik	"
126	M.S. Naik	Kadle
127	M.G. Hegde	Magodu
128	G.S. Hegde	Handimoole
129	Krishna V Hegde	Honnavara
130	Gopala Krishna V Hegde	Saralagi
131	Narayana Hegde	Basavabette
132	R.L. Hegde	Kadethoka
133	Masti Kanya Mukri*	Kadethoka
134	Ganapu Masti Mukri*	"
135	Nagu Kanya Mukri*	Chandavar
136	Manjunatha Bhatta	"
137	Sripada Narayana Bhatta	"
138	Narayana Bhatt	"
139	G.N. Chandavar	Badagani
140	Narayana V Bhatt	Haladipura
141	Ganapathi Naik	"
142	Janardhana Naik	Honnavar
143	R.M. Naik	Hulasankolli
144	R.K. Bhatt	"
145	G.R. Bhatt	Kadethoka
146	Sudhakara S Hegde	Boodhi
147	Thimmanna Bhat	Hulasankolli
148	M.G. Hegde	Haladipura
149	Dr.S.M. Naik	
150	Narayana Devaru Hegde	Karwar
151	Narayana Hegde	Gokarna
152	Vanitha Mahila Sangha	Murur
153	M.M. Hegde	Kasargod
154	Sneha Kunja Trust	

155	Ramakrishna Kamat	Shirali
156	Bhaskar Bhatt	Shirali
157	Subraya Harihara Bhat	Abbe
158	Subraya Ganesh Bhat	"
159	Ramakrishna Shastri	"
160	Narayana Vijna Bhat	"
161	Ganapathi Bhat	"
162	Kamalakara Bhagavatha	Hegde
163	Ganapathi Ganapathi Vaidya	"
164	G.S. Hegde	Moolethota
165	Eshwara Hegde	"
166	U.S. Chandavar	Kumta
167	H.K. Naik	Gangolli
168	G.R. Bhat	Thudimane
169	Moole Bhattu	"
170	Shiva Krishna Bhatt	Bethageri
171	Ramu Jatti Naik	Holegadde
172	S.V. Hegde	Hattigeri
173	Subraya Narayana Shanbhag	
174	Ramakrishna Bhat	Janasale
175	Angadi Ganesha Bhat	"
176	Venkatramana Hegde	Murur
177	Sarvodaya Sahakari Sangha	Ankola
178	Govinda Ramachandra Shanbhag	Kodkani
179	Shankara Bhat	"
180	Uppunda Prabhu	"
181	Padmanabha Satyashastri	Siddapura
182	Gode Narayana Hegde	
183	Shambhu Hegde	Keremane
184	Gowri Co Vishnu Hegde	Neelakoda
185	Subraya Bhat	Hosthota
186	Ganapathi Hegde	Kirekota
187	Gopala Eshwara Hegde	Mugwa
188	Ganapathi Ramakrishna Naik	Haladipura
189	Dinesh Rama Bhandari	Kolegadde
190	G.R. Bhat	"
191	G.S. Hegde	Kadle
192	Harihara Patagara	Holanagadde
193	Venkatesh Shanbhag	Angadi
194	Subbraya Parama Hegde	Gali
195	Subbraya Sambayya Hegde	"
196	Venka Rama Hegde	Ablimane
197	Rama Subraya Bhat	Gali
198	Thimmanna Subba Hegde	Guddebala
199	Narayana Hegde	Gainamane
200	Vishnu Ganesha Hegde	Mugwa
201	Narayana Hegde	Beranki
202	Rama Aghera	Hiregutti
203	Gutya Sanku Aghera	"
204	Goydu Aghera	
205	Thimmaiah Aghera	
206	Ramakrishna Aghera	
207	Eeru Beergowda	Thalagodu
208	Venkappa patagara	"
209	Chandrashekara Bhat	"

210	Shantharama Shastri	Shirali
211	Ramadas Shivaram Karnad	"
212	Krishna Narasimha Adi	Katagar
213	Panduranga Bhat	Shirali
214	Mahadeva Kariya Naik	
215	Srivasa Janardhana Kamat	Shirali
216	Ganapaiah Manju Naik	Tidakura
217	Venkatramana Narayana Bhat	"
218	Eshwara Dodhara Hegde	Kabre
219	Kamali Nayappa Shet	Shirali
220	Venkatiah Jattaiah	
221	Harish Chandra	Chithrapur
222	Nagappiah Venkatramana Bhat	"
223	Manjunatha Prabhu	Thengina Gudi
224	Achutha Naik	"
225	R.B. Naik	Shirali
226	Ramanath Pai	
227	Madeva Naggapiah Hebbar	
228	Vasudeva Nayappa Hegde	Guddekeri
229	Manjaiah Subraya Katagara	
230	Narayana Venkatramana Hebbara	Hallandi
231	Nagamma Shaniyar Chitrapur	Chitrapur
232	Vijaya Ninda Raikar	"
233	Chaya Narasimha Prabhu	"
234	Vasantha Bhat	"
235	Balakrishna Mabala Gunaga	"
236	Masti Sirur	"
237	Sushila Nagesh Shet	"
238	Kamala Sundara Shirali	"
239	Lakshmana Narayana Naik	"
240	Chaitanya Bhavani Shankara Pandit	"
241	Vishnu Narayana Moger	"
242	Mallu Manjayya Moger	"
243	Sarojini Ratnakar Shet	"
244	Krishna Bhandari	"
245	Ramanatha Shanbhag	"
246	Ganesh L Shet	"
247	Subraya Hegde	Badlakoni
248	Gajanana Hegde	Bichchala
249	Polytechnic	Karwar
250	S.R. Hegde	Murur
251	Krishnaiah Shivarama Chipageri	Chipageri
252	Gopalakrishna Venkatgiriyappa	"
253	Parameshwara Rao Venkatgiriyappa	"
254	Dr.V.G. Hegde	Mundagod
255	Shivarama Seetharamaiah	Manchikeri