Working Paper No. 248

CONSTRAINTS ON THE DIFFUSION OF INNOVATIONS IN KERALA - A CASE STUDY OF SMOKELESS CHULAHS

P. Mohanan Pillai

Centre for Development Studies
Thiruvananthapuram
March 1992

CONSTRAINTS ON THE DIFFUSION OF INNOVATIONS IN KERALA - A CASE STUDY OF SMOKELESS CHULAHS -

P. Mohanan Pillai

It has been suggested[1] that the failure to diffuse innovations across productive sectors may be a major factor for the long drawn stagnation in the growth of Kerala economy during the last two decades.[2] However, so far no serious attempt has been made towards identifiying the major constraints to the diffusion of innovations particularly in rural parts of Kerala. While this question has been raised in some studies on agricultural development of Kerala, however the focus has been confined to the linkage between research laboratories and extension centres.[3] The examination of the constraints in the diffusion of such rural innovations as low cost housing and fuel efficient chulahs which can generate significant changes in the agrarian economy of Kerala has been inadequate.

The technology of smokeless chulahs is considered 30 percent more efficient as compared to the traditional one. These chulahs are available at a subsidised price (to the extent of 50 per cent of the total cost) so that even the poorer households who rely on market for the purchase of firewood may be able to reduce the quantum of purchase and should thus be able to gain monetarily. The diffusion of smokeless chulahs would thus not only restrict

1 See K.N. Raj, Natural Resources and Decentralised Development in Kerala, paper presented at the Annual Conference of KSSP, Calicut, 1985.

2 K.N. Nair, Agricultural Growth in Kerala, Constraints and Policy Implications, Centre for Development Studies (mimeo), 1985.

the rate of depletion of our forest wealth but importantly also protect large numbers of women and children from serious healt and environmental hazards emanating from the smoking chulahs of the traditional types.

It may be pointed out in this connection that the initiative in Kerala for the diffusion of these technologies and in particular the fuel efficient smokeless chulahs, was taken vigorously by the Kerala Sastra Sahitya Parishat as a major programme to bring "the fruits of science to the door steps of poorer households".[1]

However, the available evidence on the extent of diffusion both in Kerala and other parts of India presents a dismal picture. Out of almost 48 lakh 'households' (including small, medium hotels and tea shops) in Kerala potentially eligible for chulah installation only as many as 212993 representing 4% of the total households have gone in for improved chulahs.

Given the simplicity of the technology and its active propagation by a major science movement in a state renowned for its high level of social awareness, this slow diffusioin appears somewhat paradoxical. Therefore, we have attempted in the following pages a study of nature and pattern of diffusion of this technology so as to throw light on the major factors constraining its spread in Kerala.

[1] Cited from one of the Pamphlets 'Science for Social Revolution', circulated by Kerala Sastra Sahitya

Diffusion Perspective

In the literature technology diffusion is understood in different perspectives.[4] These can be broadly classified into three groups viz. (1) Adoption Perspective, (2) Market and Infrastructure Persoective and (3) Economic History Perspective. The main analytical question regarding the three approaches mentioned above relates to the key factors that influence the time path of the spread that determine the rate of diffusion. The first approach underlines the relaive profitability and the required investment: the more profitable (advantageous) the innovatioin and smaller the required investment the greater the rate of diffusion. The adoption/ epidemic perspective considers diffusion in terms of demand for new technology (products and process) and ignores supply.

In contrast, the market and infrastructure perspective emphasises the supply side of diffusion and shows concern with the ways by which innovations for adoption are made available to the firms (or users). Here, it is not the individual but the government and public institution which establish and control the constraints set for the individual to make choices. Therefore, the difference in diffusion path can be accounted for by looking at the institutional rather than individual behaviour.

[4] See for a review of literature P. Mohanan Pillai and K.K.Subrahmanian, Diffusion of micro electronics technology (a study of application of microelectronics in Indian capital goods industry), Centre for Development Studies (Mimeo), 1989.

In the two perspectives outlined above, the innovation is assumed to be same the throughout the diffusion process. In variance with this, the economic history perspective emphasises the changes that can be brought about through local adaptation and improvement. The diffusion process, according to this perspective is characterised by innovation-diffusion interaction: there is a continuity in the innovation-diffusion process in the sense that the diffusion requires the development of the capability to acquire, adapt, improve/produce and make available the technology consistent with the local conditions.

A review of the recent experience of energy technology diffusion (biogas, gasifiers, windmills, hydropowered mills, water heaters) in a wider range of developing countries added more dimensions to the general literature on the diffusion perspectives. Such perspectives range from socio psychological concerns to concers about the nature of technology political economy of users and producers and the role of participation on the process of technological change itself. All these provided greater understanding of how energy technology interests with rural societies.[7] In relation to smokeless chulahs, recently, a comparative international evaluation of the fuel efficient chulahs have become available which focuses on regional specific constraints such as technical, social and economic factors

[7] See for details Andrew Barnett "The diffusion of energy technologies in the rural areas of developing countries, a synthesis of research", World Development, Vol.18, No.9, 1990.

conditioning the diffusion of chulahs.[6] Needless to say such factors differ from region to region. Regretfully chulah programmes have largely failed when they were introduced on a large scale in rural communities, whereas adaptation requires closer interaction of the designers with local artisans and the users of chulahs.[7] Therefore, in the present study we take a position that one can not investigate the diffusion of new technology without considering the innovation diffusion interaction. Furthermore, it may also be useful to integrate the question relating to the suppy demand sides of the technology along with the intervention strategy of both the state and the local organisations such as science movement. The intergrated approach has the advantages of evaluating the role assigned to local organisations in particular the voluntary organisations in diffusion process i.e. "With the capability to learn, teach, cajole, mediate, advise and organise particularly in rural areas".[8]

[6] See for details Art Van de Laar, Rural Energy Problem in developing countries, diagnosis and policy approaches. A review of major issues, Working Paper 98, Institute of Social Studies, Hague, Netherlands, 1991.

[7] See, SEARET, Have planners understood the poor peoples energy problems? Socio-economic aspects of energy technologies, a literature review, University of Twente, Euschede, 1987.

[8] Litchman Rob, "Organisational man power and institutional aspects of biogas programmes, Lessons Indian experience", in Romesh Bhatia and Armanand Pereitra (eds.) Socio Economic Aspect of Renewable Energy Technologies. World Employment Programme, Geneva, 1986.

The Strategy of diffusion of improved chulah technology - Lessons from all India experience

The Government of India launched the diffusion programme of smokeless chulah technology as early as 1983. In the overall strategy of diffusing the chulahs, Govt. of India has given special role to voluntary organisations on the basis of the logic outlined above. To make this innovation increasingly accessible to poorer sections of the population the programme involved subsidy to the extent of 50 percent of cost of installed chulahs.[7] To facilitate rapid diffusion around 5000 training courses were held specially for village women to learn to build improved chulahs under the auspices of Department of Non Conventional Energy and in collaboration with voluntary organisations. By 1994-85 around 7.56 lakh chulahs were supposedly built saving six million tons of fuel wood valued at Rs. 24 crores.[8]

However, a detailed evaluation study conducted on improved chulah programme has a different story to tell. In the words of an evaluator, "As some one involved in working with number of voluntary organisations in spreading the Nada chulah (one of Department of Non Conventional Energy approved models) . Since

[7] Total cost of smokeless chulahs is estimated to be Rs.170, 50 percent of it is subsidy.

[8] Madhu Sarin "Improved Chulah Programme Boon or disaster?" Economic and Political Weekly, September 20-27, 1986.

1980, three years after NPOIC (National Project on Improved Chulahs) was launched; I see the picture on ground being the opposite of what Department of Nonconventional Energy claims to be. A lot of chulahs have simply not been installed as materials for them is lying around in different villages. Out of the chulahs actually installed, a very high percentage are already out of use or broken. Many are used only part of the time. Out of chulahs still in use many have increased fuel consumption rather decreased it as they have been built by untrained trainees during the training courses. Many do not remove smoke from the kitchen. Many chimneys do not go above the roof thereby releasing the smoke inside. And out of the so called agency of now four lakh women trained to build chulakhs, it will be surprising if even 20 percent ever built a single chulah after being trained".[1]

This kind of depressing account of the state of affairs raises fundamental questions about the diffusion of this new technology. The major problem according to the study cited above, was the absence of a wide network of voluntary organisations with deep involvement that is sufficient enough to induce adaptation among the households. This weakness must have reduced to the minimum the feedback mechanism that may help in upgradation and modification of the chulah technology. Our study proposes to examine whether the presence of active voluntary organisation is in fact a sufficient condition favouring diffusion of rural technology.

Involvement of Science Movement in Kerala

The above account on the limitation diffusion of chulahs may not be entirely valud in the case of Kerala, in the light of a major commitment to developmental ethos generated by a popular science movement called Kerala Sasthra Sahitya Parishat (KSSP). We may mention here the major differentiating aspects between a pure voluntary organisation whose activity is mostly confined to social work whereas as the science movement like KSSP trying to combines social work along with conscientization process through the diffusion of science literature, involving in political struggles, campaigning against the pollution prone projects etc. Though the former also develops conscientization, the art of combining it with intervention goes to science movements. We may consider the following possibilities favouring more intense diffusion if taken up by a science movement. (1) science movements can sensitise the technology options according to social needs leading to the generation of more appropriate technlogies; (2) the user innovator interaction may be more intimate than usual. For, not only that there is concentration of scientific temper and talents among members of science movement but also the feed back mechanism from the users will be stronger on account of the scientific knowledge of the members of the movement.

The notion that voluntary organisations in particular the science movements are the most appropriate nodal agencies creating the pre conditions for diffusion with the ability to

issue that has not been examined closely. This is among one of the issues we propose to take up in our study.

Setting the stage

In view of the impending energy crisis KSSP decided to take up the cause of energy efficiency by designing fuel efficient wood burning smokeless chulahs, the adaptation and development of which was undertaken with the help of Department of Science and Technology. KSSP took up the energy conservation programme, a major activity in the 80s and the chulah programme in the middle of 80s much latter than the all India experiments mentioned earlier. An appropriate form of chulah was designed by a process of experimentation. KSSP decided to diffuse it through its own network. This network is something unique for KSSP, for, no other voluntary organisation in Kerala has got as big a network as KSSP. Therefore, the task of diffusion was expected to become easier.

The task necessitated a multi pronged approach with the following strategic steps (1) diffusion through conscientization of scientific literature, conveying the message of conservation through art, songs, skits, street plays, folk art etc.
(2) Production and diffusion of smokeless chulahs through its network. It needs to be mentioned in this context that among the multipronged strategies were skill formation and local employment generation by designing and manufacturing of stoves, once the demand was generated by conscientization. Through a scheme of procurement of clay baked chulahs, the unemployed rural artisans engaged in pottery could be rehabilitated. This was another major

objective of the programme. It was also envisaged that a group of people can be entrusted with the repair and maintenance activities for specific regions.

KSSP, it is claimed, is said to have drawn useful lessons from the experience of non-diffusion of this technology elsewhere and developed a prototype model by 1983-84. While designing the model the KSSP technical team is said to have taken note of all possible technical options to arrive at an appropriate design for a smokeless chulah with higher levels of efficiency. To start with, four different geographical areas were selected keeping in view the variations in the quality of firewood and local clay, type of houses, ventilation, cooking habits etc. Having distributed 800 chulahs in four locations, 160 KSSP activists were assigned the task of constant monitoring of field efficiency. Five homes were allocated to each KSSP activist. The data generated were carefully analysed and by 1986, a uniformly acceptable model of a smokeless chulah was developed. One unique feature of the KSSP model unlike the models developed elsewhere is that it has incorporated pottery linings in order to ensure the dimensional accuracy such that the heat efficiency is maintained at a higher level.

Another major element of the strategy was the intensive training of the volunteers in technical and organisational matters. Those who were closely associated with the development of chulahs were subsequently absorbed as instructors to the major training programmes. The training programmes also involved the task of procuring materials and fitting the chulahs. To start

with, 20 volunteers were selected by the District Committees for training at the KSSP headquarters in Trivandrum. It was noted that that those trained would in turn train the Taluk and village level volunteers and thereby develop a chain of skilled personnel. This kind of top down and vertically integrated network was intended to facilitate the transmission or flow of information regarding the constraints from the local level to higher levels for suitable upgradation and modernisation of the technology.

The Trends in Diffusion

For a meaningful assessment of the overall trend in the diffusion of this technology it is necessary to have a quantitative profile of the number of eligible households[17] for chulah installation. Unfortunately, the data relating to the number of households, shops and hotels eligible for chulah installation are available only up to 1980-81. Though census figures for population is available for 80s, however household figures have yet to be published. In the absence of the latter, we have attempted to project the total number of eligible sites for installation; on the assumption that the family size in Kerala remained unchanged for the 80s. This assumption derives strength from the fact that there has been very little variations in the family size during the three preceding decades inspite of the decline in growth rate of population. On the basis of this assumption and using the population data the following formula

[17] Eligible in the sense of having a kitchen to cook

was used for estimating the growth rate of households.

$N^t = No\ (1+n)^t$

N^t = Number of households at time t.

n = annual growth rate

and

$$n = \frac{r - h}{1 + n}$$

Where r and h are the annual growth rates of population and average household size respectively.

r from 1981-91 census and h is based on 1971-81.

Similarly we have also attempted to project the other potential users of chulahs. Thus using the housing census we were able to identify five other categories of residences where traditional chulahs may be in use. These include (1) hotel and sarais, (2) Dharmasalas, (3) Tourist homes, (4) inspection houses, (5) restaurants, (6) sweet meat shops and eating places. In addition to this there are also other two categories of residences such as shop cum residences and workshop cum residences. Though they are also listed under the category of "residences" in the Census we have however omitted them from the calculations as we were not certain whether these residences have cooking facility. The question in this context is how to generate numbers for the six categories mentioned above for 1980s in the absence of census data. Unlike households it is problematic to project service sector growth, as it is linked to the pattern of economic growth rather than of population growth. Since the growth rate of the economy remained more or less steady, we have taken the growth rate of 70s as the base for

projecting for the 80s. On the basis of this method we have estimated the total number of eligible places for chulah installation as given in Table I.

Table 1

The Trend in the Diffusion of Smokeless Chulahs in Kerala

Year	Increase in the stock of households (1)	Increase in the stock of other types of residences eligible for chulah installation (2)	Total (3) (1+2)	Increase in the chulahs installed (stock) (4)	Of which installed by KSSP (stock) (5)	Percentage No. of household under chulah installation (6)
1980-81	4059540	96455	4155995			
1981-82	4121448	97295	4218793			
1982-83	4184134	98134	4282268			
1983-84	4248194	98976	4347170			
1984-85	4313021	99816	4412837			
1985-86	4378838	100655	4479493	5154	3000	0.16
1986-87	4445659	101496	4547155	12078	7000	0.27
1987-88	4513550	102334	4615884	38424	27000	0.83
1988-89	4582376	103176	4685552	78451	45000	1.67
1989-90	4652304	104016	4756320	144735	59000	3.84
1990-91	4723297	104857	4828154	212993	70000	4.41

Source: Column 1, 2 generated from housing census 1980-81, column 4 and 5 taken from Agency for Non Conventional Energy Technology, Vazhuthacauo, Trivandrum.

As is evident from table I six years of intensive efforts resulted in installation of chulahs in a mere four percent of the total households in Kerala. Infact, the chulahs installed annually do not even cover the incremental year-wise increase in the number of (newly formed) residences, not to speak of the increase in the existing houses of around 45 lakh households in the beginning of 1985!

Column 5 of table I gives year wise stock of chulahs installed by KSSP. From the table it is seen that the incremental increase of KSSP chulahs have come down over the years and hence is a matter of great concern. This is because as already been stated, KSSP possess the institutional capabilities to build up production, delivery and maintenance and also adapt to changing user needs. The increasing withdrawl of KSSP, therefore, casts shadows on the further prospects of diffusion of this technology.

In order th capture the multiple dimensions of the process of diffusion we felt it imperative to undertake a case study approach incorporating both the supply and demand sides. On the demand side, the major factors to reckon with appear to be the appropriateness of technology and socio economic structure of the households. On the supply side, the entire gamut of organisational factors such as availability, maintenance personnel motivation etc. are the crucial determinants. The nature of constraints imposed by these factors have to be analysed in order to develop a strategy of diffusion of this new rural technology. In the following pages a modest attempt in these lines has been made.

A Sample Village Study

We ventured to examine these parameters with reference to a village located in the outskerts of Trivandrum. The choice of Kazhakuttom was not only a choice of convenience. But KSSP was in fact asked to recommeded by KSSP a village for survey to

suggested, for, the presence of large number of KSSP volunteers located in the village was another consideration as it would help for our investigation. Kazhakuttom has a total population of 25574 while the total number of households were estimated to be 4592 in the year 1980-81. The major occupation of the village is agriculture supplemented by coir making, copra processing and fishing.[17]

Following the method used earlier regarding the number of households eligible for chulah which in the case of Kazakuttom was estimated to be around 5500 households in the year 1990. From 1986 to 1990 the total number of chulahs installed in the Kazhakuttom village was only around 500; out of these 450 were installed by KSSP. The record of diffusion is rather unsatisfactory and raises alarming questions about the constraints and the fultilment of socio-economic objectives of integrated to this programme.

In order to identify the major constraints in the way of diffusion of this technology, We have surveyed around 100 users. In addition 50 non-users of this innovation were also deliberately included in our survey in order to understand the potential economic socio-political constraints to adaptation. Among the user households we surveyed all those who had installed smokeless chulahs in the year 1987-88. This was done in orde to allow sufficient time to the households for familiarisation with the use of this technology. Moreover, all the chulahs we surveyed

[17] Census 1981, Housing volume.

had been installed by Kerala Sastra Sahitya Parishat.

Socio-economic characteristics of Adopters

Who are the adoptors of this technology? Our survey revealed that in terms of the occupation-wise of the head of the housholds the majority belonged to the category of service.[14] This was followed by agriculture. A significant point that seem to emerge from our survey is that the diffusion of this technology is getting restricted to the relatively more privileged sections whereas agricultural labourers, coir construction and fishing workers who constitute the major proportions of the work force in the village are wider represented in the population[15] (see Table II) are outside the sphere of influence of this process.

Needless to say, occupation is a poor indication of socio economic stuatus. A more appropriate indicator appears to be the income status of the households however this is not free of problems either. As is well-known, there is a natural tendency to underreport information on income when an investigator confronts the households. Therefore, we have taken consumer expenditure as a proxy for income. Details of which can be seen from table IV.

[14] The categorisation is on the basis of major source of income.

[15] Occupation-wise the distribution of the population of the village the distribution showed the majority of the category of agricultural workers followed by coir and fishing workers. See also details census 1981, op.cit.

Table II : Distribution of the Household according to the occupation of the head of the households

Occupation	No. of households
Agriculture	30
Agri. labour	6
Others (construction, fishing and coir)	3
Services	55
Business	6
	100

Before examining this issue let us present details regarding the distribution of the households according to the size of land holding. Logically it was hoped that those who buy the firewood from the market may adopt the technology somewhat faster than those who can afford to procure it from their garden land. (see Table III) This we have included to ensure an important dimension from the point of view of firewood availability, for, the original scheme of chulah diffusion envisaged substantial economy in fuel use among the households to rural and urban poor.

Table III : Distribution of Households According to the size of land holdings and occupation

Holding size	Agr.	Agr. labour	Construction and other workers	Services	Business	No. of households (%)
Landless	-	1	1			2
Below 10 cents	2	4	2			5
10 - 25	3	1				25
25 - 50	10			43	2	41
50 - 1 acre	15			10	2	23
1 - 2 acres	2			2	2	3
Above 2 acres						1
Total	30	6	3	55	6	100

Table III reveal that the majority of the households have an area size above 25 cents which in the context of Kerala can be

considered as average holding size. Interestingly enough, the majority of the heads of such households have also indicated service as their major occupation. However, the poorer households having a limited range of 5 cents, who have been relying exclusively on buying firewood have by and large were excluded from the diffusion process. The charateristics outlined above can be roughly taken as proxy for the socio-economic status of households.

However, we need to reckon with several other variables among these, the major one appear to be the relationship between expenditure on food, fuel consumption and fuel cost. The data collected on these aspects are presented below. As is clear from the table IV there exists an inverse relationship between fuel availability from garden land and chulah installation. Thus while there is heavy reliance on the market for fuel for those households whose monthly expenditure is less than Rs.550. However those with income Rs.500 are found to be depending on their own garden land.

Table IV : Market Dependence for Fuel and Diffusion of Chulahs

Food Expenditure (Rs.)	No. of house-holds	Fuel availability from garden land (%)	The extent of purchase of firewood from open market (%)
Below 150	5	-	100
150 to 250	8	-	100
250 to 350	16	10	90
350 to 450	2	20	80
450 to 550	6	37	73
550 to 650	28	70	30
650 to 750	16	65	15
750 to 850	10	90	10
850 and above	9	92	8

We also found from the survey that the installations tend to favour households with higher olinth area (as in Table V). May be the chulah installations constrains the kitchen space of the households.

Table V : Distribution of households according to the floor area of the house

Area (floor)	Households %
Below 500 sq. ft.	6
500 - 750	15
750 - 1000	25
1000 - 1500	41
Above 1500	13
Total	100

We also observed a certain linkage between chulah installation and a relatively larger size of land holdings, higher levels of consumption expenditure, bigger size plinth area of households etc. Our sample study also reveals the same linkage extends to education. As table VI reveals the number of households according to the education of the head of the households having educational qualification (S.S.L.C. and above) constitute around 67 percent. This was found to be true in the case of female head of the household as well whose opinion have been a decisive factor in the adaoption of this new technology. From the above discussion of the socio-economic status of the households it can be concluded that this technology has tended to favour those with "critical minimum" of socio-economic status. It is this factor, that posed as barriers to entry of this technology.

Table VI : Distribution of Households according to the education of the head

Educational level	No. of households %
Illiterates	2
Std. 1 - 5	2
Std. 5 - 9	29
SSLC	35
Pre Degree	12
Degree	15
Post Graduates	1
Professional	4
	100

Communicating the technology

In addition to the role of science movement in communicating the usefulness of this technology to prospective adopters, the Government of Kerala has also given sufficient importance to the project by providing publicity through the print and non print medias.

However, our study suggests that it was not so much the important channels but the personnel channel which were the principle source of information of new technology. Only a limited number relied on the print or non print sources. The details on the sources of information are given in table VII confirm this observation.

Table VII : Classification of information sources

Sources	No. of households(%)
I. Impersonel (print & non-print)	6
II. Personel	
(a) activists of voluntary organisations	65
(b) extension agents village level workers	3
(c) Friends and relatives	26
	100

From the above table, it is evident that the major source of communication was activists of KSSP and the friends and relatives, examples of non-institutional personal communication. The village level extension workers, despite their fairly widespread social contacts, appear to have been lethargic in communicating this new technology. When asked whether subsidy was a major inducement for adapting of this technology, only 15 percent of the households gave positive reply. These households belonged to less privileged among the sample households. The implications of this we shall discuss in detail later; meanwhile, let us discuss the marginalisation process of this technology as reflected in the supply constraints.

I. Supply Constraints

As already underlined, some sort of initial 'push', was found to be necessary to induce the adoption of this technology. But subsequently, as a result of demonstration effect the knowledge about the technology spreads and gain a momentum of its own. As the demand increases, the availability of the technology may also have to increase commensurately. The following section examines the supply constraints relating to technological diffusion.

The inherent problems confronted by the users are a pointer to the supply components. The chulah using households complained of enormous problems confronted by them. In fact, of the 100 chulahs installed, only 75 were 'in operation' and the rest were

abandoned and in its place the traditional chulahs were built.[16] The following table provides details about the major reasons for abandoning the technology.

Table VIII : Major Reasons for Abandoning of Chulahs

Major reasons	No. of house-holds	Expenditure status (range)
1. Chulah platform broken	1	below 150
2. Chulah constraining space	1	"
3. Exhaust pipe broken	16	550
4. The greater initial time taken for lighting up high	7	500 & above

These ranged from the breaking of installed chulahs, cracking of pipes, to difficulties in starting etc. (See table VIII). The significant point that emerge is the correlation between the incidence of abandonment of chulahs with the low expenditure and low educational status of the households.[17] In fact, we observed one instance of chulah being removed due to lack of sufficient space; this household belonged to the lowest social ladder in terms of income, household 'space', and educational status.

[16] A more comprehensive survey conducted by KSSP came to the conclusion that abandonment rate is 20 percent. See for details M.N. Sudhakaran, Diffusion of Improved chulahs : A Study with reference to Kerala, M.Phil dissertation, Centre for Development Studies, 1991.

[17] The educational status of the majority of the households is below S.S.L.C.

Replacement and Repair

From the above, it does not however necessarily follow that the rest of the households had no complaints with chulahs. On the contrary, another 20 households had faced similar set of problems. But these households had managed to overcome such problems by replacement of damaged parts such as pipes and chulah basements. However, our enquiry revealed that it was only after considerable efforts and time that they succeeded in locating the personnel for replacement and repair. This is because the team was distantly located and do not have any monetary incentive for the technical team to attend on the repairs. Clearly, the installation work was said to be more remunerative than repair and replaement. This clearly suggests that the development of local expertise in installing and repairing chulahs have been absent; though the original intention was to develop a small 'nucleus' of people who will forge two way links with the local artisans on the one hand and with households on the other. The survey has brought out this major missing link.

The reason has been that the transfer of skills of the personnel through training and retraining of district to taluk and further down to villages did not take place as expected mainly because the installations did not get the necessary momentum. Even those who got initial training in installing chulahs therefore dropped out when they found better opportunity for employment. The demand for new chulah installations are presently met by importing the materials from distant places (around 20 kilometers away). This was not related to the absence of potters but had more to do with lack of sufficient momentum

from the region and consequently the linkages contemplated could not be atiached. The same phenomenon has resulted in undue delay of repair and replacement.

The damage of the various parts of the chulah, the abandoning of the chulahs and difficulty in replacement and repair on the other appeared major constraints to the diffusion of this technology. However, there were a whole lot of problems related to the use of the technology which are in no way less important. These have been serially listed along with the responses against each problem (see Table IX.)

Table IX : The major problems confronted by the Chulahs using Households

Major problems	No. of households
1. Frequent crack of pipes and platforms	60
2. The locally available fuel other than wood (such as coconut remidues, dry leaves etc.) can not retain heat	60
4. Soot accumulation and the difficulties in the removal of accumulated soot in the cooking vent	70
4. Absence of pot holes to suit vessels of different dimensions pose problems	65
5. For chulahs dry firewood has to be split up into small pieces which is a time consuming process	58
6. The initial lighting up is a big problem	50
7. Heat from the main stove can not be transferred to other two stoves and therefore cooking takes considerable time	60
8. Lack of space and the accompanying difficulty in using long firewood and also the problem in drying up rice water	61
9. The smoke from traditional chulahs enabled the drying up of copra and fish during the rainy season this is not possible with chulahs	68

Constraints cited above and faced by the majority of the households is clearly reflection of the lack of "good will" for this technology.

Coexistence of the traditional and the improved chulah

At the time of survey we come across another strange phenomenon. At least in 25 households the traditional chulahs are kept along with the smokeless chulahs. of the 25, 10 are having serious problems like soot accumulation, breaking up of platforms etc. and awaiting maintenance and replacement and therefore traditional ones have to be retained. The households reported that even after the repair the arrangement will continue due to the uncertainity regarding the steadiness of the new technology. Another 15 hohseholds gave the reasons reported in table IX. In effect the total reliance on smokeless chulahs are limited to a mere 50 households.

The response of non adopters

Though major lessons about the slow diffusion of chulah technology can be drawn from the above, yet we have drawn another small sample of non adopters with a bias in favour of more vulnerable households from the same region. This we felt would facilitate a better appreciation of their attitude and also understanding about this technology and thus bring out the major reasons for their disinclination. The details of the sample is given in table X. The households were randomly selected keeping their proximity to user households as an important consideration in the selectin process.

Table X: Household Distribution of non-users according to major occupation, consumption expenditure and educational levels

Occupation	House-holds	Average land size (in acres)	Average monthly consumption expenditure (in Rs.)	Educa-tional level	Plinth area the house-hold (in sq.ft.)
Agriculture	10(20%)	1.5	550	5 to 9	500 to 750
Agricultural Labour	22(44%)	0.10	350	1 to 5	below 500
Mason and Construction and other workers	7(14%)	0.15	450	1 to 5	below 500
Services	10(20%)	1.00	600	SSLC and above	750 to 1000
Business	1(2%)	1.20	750	Degree	Above 1000
	50(100)				

The non user households economic profile appear dissimilar to those of adopters. The question to be asked in this context is what prevented them from adopting the new technology. Our thinking opened up few possibilities. (1) The awareness and conviction gap (2) organisational weaknesses (3) socio-economic disabilities. In fact, non diffusion of this technology is the outcome of the combined effect of all these factors.

To illustrate, the households upper strata defined in table X have expressed different view points regarding the new technology. Almost the entire households wanted to save firewood, for, its cost has been escalating fast. When asked about the new technology only 70 per cent of the households did express their awareness about chulahs. In fact, socially and

labourers, masons and carpenters and those agriculturists with land size below 0.50 cents) only 26 percent of the households had any knowledge about the chulahs whereas, among the upper sections the percentage is around 80 percent.

As for the sources of information about chulahs the situation was dissimilar to that of adopters. Unlike the adopters, the majority of the non adopters in the sample (80%) had received the information about this technology from relatives and friends and only a tiny minority (8%) had been informed about chulahs by the voluntary workers of K.S.S.P. and other institutions. The only observation that can be made on the information dissemination channel is that the voluntary workers influence is becoming limited even in respect to imparting information to prospective users of the technology.

Table XI: The Number of Households information about chulahs and sources of such information

Total no. of households surveyed	50
No. of households having information about the existence of chulahs	35
(a) Of which households belonging to the upper strata	28
(b) Households belonging to the lower strata	9
	(in percentage)
Sources of information	
1. Relatives and friends	80%
2. Print and non print media	6%
3. Village Extension workers	6%
4. Voluntary workers	8%

Why is that this information is not getting translated into installations? Part of the answer to this complex problem has already been brought out in the earlier section relating to the constraints facing the users. In fact, our interviews with the non users have been more or less a repetition of the constraints voiced by users. The major difference has been in terms of perception of technology moulded by interaction with users. Table 12 gives the reasons for not installing chulahs.

Table XII: Reasons for not Installing Chulahs

Major Reasons	Percentage of the households
1. No Knowledge	30%
2. Difficulty in locating the installation team	60%
3. Initial cost difficulty	40%
4. The report about the working is not encouraging	65%
5. Friends and relatives did not recommend	65%

From the above table it is clear that the non adoption of this technology is explained by strong inbuilt constraints such as

(a) in targetting the vulnerable section

(b) difficulty in arranging men and materials

(c) failure in maintaining an organic link with craftsmen (or technical personel) belonging to the local population so that the repair and maintenance can be taken care of

(e) the inherent defects of the chulahs which failed to respond to users need.

From the demand side, the major problems as discussed earlier are those emerging from the socio-economic background that defines certain conditions of entry.

Concluding Observations

We conclude this study with the following observations. The chulahs designed by KSSP, though an upgraded version, fell sort of being an appropriate choice for the users. From the supply side the inappropriateness arose from its inflexible deisgn characteristics which precluded the efficient use of any fuel other than wood. The efficiency dimension of the other types of natural fuel scenario has been overlooked. This is significant given the diverse fuel use pattern in Kerala. The whole gamut of problems associated with the use of smokeless chulahs such as breaking up of platform and pipe, inappropriate pot holes, soot accumulation, difficulty in heating up etc. on the one hand and the lack of adequate personnel for maintenance on the other poses serious problems in the assimilation of this technology by those who can afford it. On the demand side, we found that the majority of the poorer households were getting isolated. Such households are characterised by low income, limited plinth area of the households and low educational standards etc.

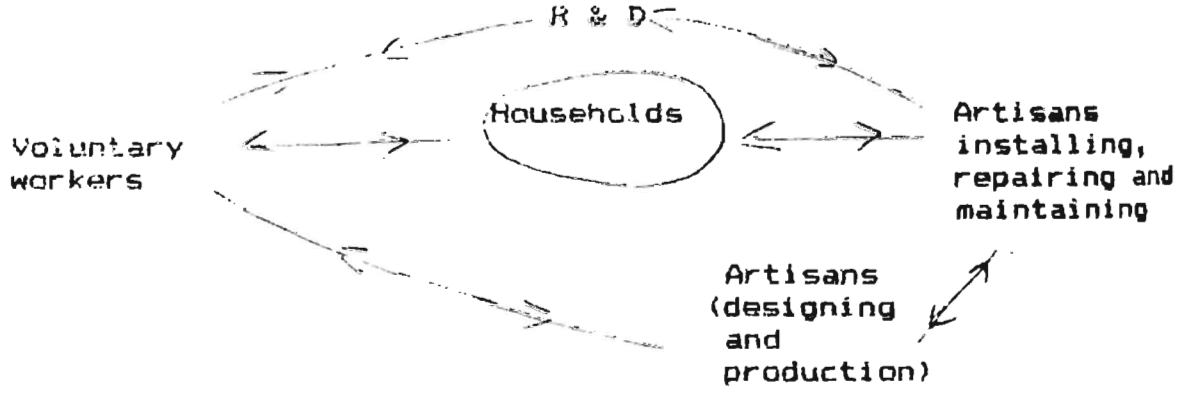
The perceptible decline over time in the number of chulahs installed by KSSP is in itself a reflection of the crisis in the process of diffusion and of technical change. Some of the constraining factors cited above could well be true of other

general innovations.

If inspite of heavy subsidy and the inherent possibilities of direct monetary gain to the users and the active involvement of a popular science movement in hastening its diffusion, this technology is far from gaining popular acceptance, it does seriously call into questioin the appropriateness of the strategy of diffusion. KSSP can perhaps partly absolve itself of this on in the light of its preoccupation with other programmes and also in line with a general shift in its priorities. However, in a fundamental sense it does suggest an inadequate appreciation of the complexities inherent in the process of diffusion. To illustrate, the need for incremental technological change characterised by a process of flows and counter flows of informatioin could not be carried forward by the Science movement and consequently technology remained static trapped in a situation. Incremental technical change and adoption is a continuous process of interaction among four major agents within a given strucature namely, R & D, voluntary workers, artisans (who are engaged in designing and production), artisans engaged in installing the technology in the user households.

Figure I

Flows and Counter flows of technology information system



In this situation as the chart reveals the information about the new technology is disseminated through volunteers who in turn arranges its production by a special set of artisans and followed by its installation in the households by the local artisans (masons). The experience of the households in the use of new technology is ascertained by voluntary workers directly as well as indirectly through the local artisans engaged in installation. This information transmitted to central R & D system where further design changes are undertaken and transmitted back to users as indicated by the arrows in the figure. The process continues until the technology becomes appropriate to the environment. Unfortunately, our study would seem to indicate that the first round of circuit was complete when a few households received the technology. However, the second reverse flow was short circuited because discontinuities developed between household and maintenance workers and further between artisans and voluntary workers. Even if such a reverse flow had occured, there was no centralised effort to bring in incremental adaptations and improve performance and efficiency. Innovation-diffusion is a continuous circular process, the failure of diffusion would indicate the short curcuiting of this process.

We may also point out in this context that there is a need for developing a certain sensitivity towards user needs of the relatively underprivileged sections of the society. The unintended bias of the technology towards the more privileged sections stands to be corrected. Having said this we would however still maintain that KRSP is perhaps the most appropriate

sections. Moreover the technology demand innovation and diffusion is a continuous process which other voluntary organisations limited to a few regions may find it difficult to carry forward. KSSP with its strength heritage and credentials is capable of meeting such challenges on proper realisation of economics of diffusion of this technology whose widespread use has in the long run bear the potential for transforming the rural society of Kerala.

[Sundaresan helped in collecting the village level data. K.K.Subrahmanian, D. Narayana and Raman Mahadevan offered helpful comments. However, for errors that remain, the author alone is responsible].