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DIFFUSION OF IMPROVED CHULAHS-A STUDY WITH REFERENCE TO KERALA

Dissertation submitted in partial fulfilment of the requirements for the Award of the Degree of Master of Philosophy in Applied Economics of the Jawaharlal Nehru University, New Delhi

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I hereby affirm that the research for this dissertation titled "Diffusion of Improved Chulahs-A Study with Reference to Kerala" being submitted to the Jawaharlal Nehru University for the award of the Degree of Master of Philosophy in Applied Economics was carried out entirely by me at the Centre for Development Studies, Thiruvananthapuram.

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Certified that this dissertation is the bonafide work of sri M.N.Sudhakaran and has not been considered for the award of any other degree by any other University.

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CHAPTER I

INTRODUCTION

Wood is regarded as the earliest source of domestic energy. Even though the relative importance of this traditional source of domestic energy has declined over time, it continues to be the most important source of household energy in developing countries.

It is in this context that the worsening woodfuel crisis assumes significance. The woodfuel crisis reminds us of the need for evolving a use pattern for wood which is sustainable. As other sources of energy are beyond the reach of majority of households in developing countries, the pressure on the sources of woodfuel is likely to continue. Therefore, the only plausible way out to make the exploitation of woodfuel sustainable is to ensure more efficient use of this source of energy. Diffusion of improved fuel efficient chulahs can certainly play an important role in making the use of woodfuel sustainable.

The present chapter serves as a background to our study of diffusion of improved chulahs in Kerala. Section 1 deals with the importance of woodfuel and the woodfuel crisis in Third World countries. In this context, Section 2 examines the importance of improved chulahs and briefly describes the programme for diffusion of the same in India. In Section 3 we shall explain the significance of a case study of improved chulah programme in Kerala, in the context of ambitious targets set for the national programme. And finally in Section 4 we shall summarise the key questions taken up in the subsequent chapters.

Section 1

Woodfuel Crisis

Woodfuel is generally considered as a conventional, sustainable and non-commercial source of domestic energy(NCE)[1]. Interestingly, the evolution of the woodfuel economy during the past few decades has rendered some of these attributes meaningless. In most parts of the world firewood is no more a free good that is localy collected free of cost. The forces of commercialisation have already made firewood a commodity which is sold and purchased. Similarly the alarming increase of deforestation has raised serious doubts regarding the renewability of woodfuel resources.

Commercialisation and over exploitation are indicative of the excessive dependence on woodfuel as a source of energy. The total annual global consumption of biomass fuels which include firewood, agricultural residues and dung is in the range of 1.5 - 2.0 billion tonnes (Foley 1987). The dependence on the traditional fuels is higher in the case of rural people and the urban poor who cannot afford the non-traditional sources, viz., kerosene, gas and electricity. Practically the whole of the rural poor in the Third World countries depend on woodfuel.

The situation in developed countries however, is significantly different. The transition from firewood to modern sources of energy viz., kerosene, gas and electricity is more or less complete in developed countries. Relative importance of biomass fuels has declined sharply and an overwhelming majority of the households in these countries now depend on commercial sources. In the case of developed countries, only 1 per cent of their total energy requirement is met by biomass sources whereas it is 43 per cent in the case of developing countries. (Hall, Barnard and Moss 1982). The shift from traditional to modern sources of energy can be attributed to the interplay of a variety of forces, a detailed discussion of which is beyond the scope of our study. It may, however, be noted that apart from reasons such as growth of income, availability of modern fuels at reasonable prices, relative advantage of modern fuels, etc. firewood shortages and woodfuel crisis would have also contributed to the shift.

Table 1.1: Proportion of Total Energy Needs Supplied by Wood in Selected Developing countries.

Country	Wood as a % of total energy	GDP per head (1984)
Mali	97	140
Rwanda	96	280
Tanzania	94	210
Burkina Faso	94	160
Ethiopia	93	110
Central African Republic	91	260
Somalia	90	260
Burundi	89	220
Niger	87	190
Benin	86	270
Sudan	81	360
Madagaskar	80	260
Sierra Leone	76	310
Ghana	74	350
Guinea	74	330
Kenya	74	310
Senegal	63	380
Sri Lanka	54	360
Ivory Coast	46	610
Honduras	45	700
Tunisia	42	1270

Source: Adapted from `The Energy Question', Foley, Gerald (1987) Page 199.

A comparison of per capita income and relative importance of woodfuel among different countries suggests an inverse relationship between level of income and dependence on woodfuel (See Table 1.1). This relationship between level of income and dependence on woodfuel can be delineable from individual country experiences also. Even in U.S., upto 1850, 75 per cent of its energy requirement was met by woodfuel and by 1900, it became 25 per cent and fell to 2 per cent in 1972 (Smith 1981). Notwithstanding the general rule of transition from traditional to modern sources of energy, it may be noted here that after the oil crisis many developed countries have witnessed a renaissance in the use of woodfuel. As oil prices mounted, many in developed countries have returned to the woodfuel for space heating and even for other domestic purposes[2]

As fossil fuels are becoming scarce and more costly, importance of woodfuel for developing countries and generally for poor households can hardly be exaggerated. Wood continues to be the fuel of the poor. The dependence on woodfuel reflects lack of other options. In developing countries, only the elite minority can afford electricity or gas even if they are available. For the overwhelming majority of people in these countries, the age old tradition of cooking, heating and lighting have scarcely changed, and woodfuel remains the most important source of domestic energy. The rural industries like brick making, tile making and rural enterprises such as tea shops, and bakery also depend on woodfuel. Another important area where woodfuel is extensively used is rural food processing; for eg. drying of copra and fish. In urban areas also, woodfuel is widely used and a good part of it is in the form of charcoal due to its high thermal efficiency and easy transportability.

Household Energy Situation in India

Coming to the household energy situation in India, one would require more information and details so as to arrive at a clear picture than the available studies can provide. However, the results of available studies[3], of which some are presented here, are more than enough to illustrate the excessive dependence of our households on fuel wood.

The consumption of fuelwood in this country is estimated to be in the region of around 150 million tonnes per annum and is likely to be 180 million tonnes by the end of this century. Of the total consumption of fuel wood in 1975-76, 49 per cent came from known sources such as natural forest or social forestry and the rest was from unauthorised felling of trees (Advisory Board on Energy 1986).

Table 1.2: Distribution of households - Primary Sources of Energy for Cooking

	Coal	Fire-wood & chips	Gas oil	Gobar gas	Dung	Charcoal	Kero-sene	Electri-city	Others	All
Rural	2.39	76.70	0.24	0.22	14.47	0.07	0.82	0.03	5.06	100
Urban	16.62	45.88	10.29	0.23	2.91	0.56	16.71	0.46	6.34	100

(Source: NSS 38th Round).
Sarvekshna - Oct - Dec 1988 PP S169, 208.

In India, 77 per cent of households uses firewood for cooking in rural areas, 14 per cent use dung and the use of commercial sources is negligible (See table 1.2). In Assam, Karnataka, Kerala, Mizoram, Pondicherry, Tamil Nadu, more than 95 per cent of rural households depend on firewood. Even in the urban areas fuel wood contributes to 46 per cent of the cooking energy. Only 13 per of the fuel wood in the rural areas is purchased and 64 per cent is collected by the users from outside their own households. In contrast, in the urban areas 74 per cent of the woodfuel is purchased from the market (See Table 1.3).

Table 1.3:Energy consumption in Households Share of Fuels and Sources of Supply

Energy forms	Rural Per capita Energy				Urban Per capita Energy			
	Percentage Share	Purchased	Collected	Own	Percentage Share	Purchased	Collected	Own
1. Electricity	0.6	100	-	-	5.9	97	3.0	-
2. Oil products	16.9	100	-	-	30.2	100	-	-
3. Coal products	2.3	65.1	34.9	-	13.7	95.6	4.4	-
4. Firewood	68.5	12.7	64.2	23.1	45.5	73.7	14.8	11.5
5. Animal dung	8.3	5.1	26.2	68.7	3.2	49.1	12.3	38.6
6. Others	3.4	8.9	61.0	30.1	1.5	71.2	28.8	-

Source: Report of the Working Group on Energy Policy 1979. pp.29.

Woodfuel Crisis

The woodfuel crisis received world wide attention with the publication of the book *The Other Energy Crisis - Firewood (1975) by Erik Eckholm.* The crisis in fact predates the oil crisis but got scant attention. This was because the fuel wood crisis was a problem of third world whereas the oil crisis also affected the developed countries. Further, even in developing countries burden of the woodfuel crisis was felt more by the poor than the elite minority. Moreover, there was little research to conserve fuel wood, but much attention was given to research in the saving of commercial fuel. Cooking gadgets using commercial fuels were rapidly improved; but those using the traditional fuels did not change much.

Even though the worst affected sections are not articulate enough to attract attention, woodfuel crisis has become too severe to be overlooked. Millions of people in developing countries already suffer from acute shortage of woodfuel. According to an expert panel that advised the 1981 U.N Conference on new and renewable sources of energy, by the turn of the century, 2.7 billion people will live in firewood deficient areas primarily in semi arid regions and high lands (See table 1.4).

Table 1.4: Fuel wood Shortage in Developing Countries[4]

Region	1980 Acute Scarcity	1980 Deficit	2000 Acute Scarcity	2000 Deficit
	(Millions of people affected)			
Africa	55	146	88	447
Near East & North Africa	*	104	*	268
Asia Pacific	31	645	238	1532
Latin America	15	104	30	523
Total	101	999	356	2770

Source: FAO, Report of the Technical Panel on Fuel wood and Charcoal to the UN Conference on New and Renewable sources of Energy Nairobi August 1981. (Adapted from Dudney & Flavin 1983PP.109).

* Figures not available.

Impact of the Crisis

The crisis manifests itself in the form of rising firewood price, increased time spent on collection and transportation, use of low quality substitutes, intake of uncooked or half cooked food and related health problems. The impact of the crisis, however, is not evenly distributed. As was mentioned earlier, fuel wood crisis is more of a developing country problem. Even among the poor in the developing countries, women and children are the worst affected.

The impact of the crisis has got socio-economic, gender and regional dimensions. Apart from the social cost of deforestation, and related problems, it affects seriously the poor people, who are depending mainly on firewood for cooking. Talking of Indian energy crisis, Bhagavan (1986) said "The energy crisis in India is the crisis of the 80 per cent of poor, most of whom lives in rural areas". The rich can go for commercial substitutes like kerosene, electricity and gas. Even a rise in the price of woodfuel will not affect them seriously. A study in Bangalore city revealed that the poor and casual labourers mainly used firewood, while 90 per cent of those having a monthly income over Rs.1,000/-used commercial fuels. (Reddy & Reddy 1983). In parts of India, West Africa, and Central America certain urban households spend one forth of their meagre income on wood or charcoal for cooking. Another study on the rural fuel consumption in a coastal village in Kerala revealed that on the average 18 per cent of the earnings of the village is used for the purchase of fuel, and the lowest strata spent as much as 24 per cent (Balachandran 1983). Briscoe (1979) has shown that possession of fuel producing assets depends on the social structure, therefore, there is inequality in the use and source of fuel.

Most part of the woodfuel is obtained without any `private cost in the rural areas. Therefore, a better indicator of scarcity is the time spent on woodfuel collection. In poor countries a man day's labour is needed to collect fuel wood for a day. In Tanzania, a family's annual firewood requirement takes 250 - 300 days of labour (Dudney & Flavin 1983). In parts of Sudan, over the past decade or so, the time taken to collect firewood has increased over four fold. In Nepal, a whole day is needed to gather firewood and fodder, and a generation ago it took only an hour or two. In

Bihar 7 - 8 years ago, women of poor rural houses could get enough wood for self consumption, within a distance of 1.5 to 2 kilometres, and they now have to walk every day 8 - 10 kilometres, (Bina 1986). The costs of this mounting burden show up not in conventional economic indicators, but in indices of infant mortality, disease, and illiteracy.

In areas where biomass is non-commercialised, time spent for collection is considerable. The impact of the crisis is felt more by the women, because in the third world countries the collection of fuel wood and cooking are usually done by women. Moreover, the scarcity necessitates more time in collecting woodfuel which reduced the leisure of the people which affect health. Carrying firewood over a very long distance with heavy weight may lead to spinal problems. In many cases, the expenses on fuel takes away a considerable share of income which could have been used for food. The fuel scarcity may force poor to use uncooked or half cooked food which is harmful to their health. Moreover, cooking for the whole day is done at one time and cold food is served at other times. Even children have to go for collection of firewood which adversely affect their education.

The crisis also affects the consumption pattern of fuel, forcing the poor to use low quality fuels like, twigs, bushes, rice husk, saw dust etc. which need constant attention. The scarcity increases the time spent for cooking since they have to adapt to fuel saving ways of cooking. The rise in the price of fuel wood makes free collection difficult, due to its increased commoditisation.

World wide use of livestock dropping as fuel is thought to lower grain production by some 20 million tonnes. Burning dung cake is a loss of manure, causing loss of soil fertility. Fuel scarcity may force the use straw as a fuel rather than as a fodder. The crisis creates another social problem of poaching firewood and unauthorised cutting of trees which contributes to forest depletion

Fuelwood is a renewable source of energy and this can be exploited perennially, if the annual use is limited to the rate of regeneration (Gupta 1988, WCED 1989). Increased attention has been given now a days to the conservation of renewable sources of energy. As a result the focus has now shifted to the development of fuel saving devices and alternative sources of energy. The social forestry schemes, the development of solar energy, biogas plants and the improved wood burning stoves are aimed at conservation of energy.

Section 2

The Improved Chulahs.

The growing demand gap in respect of woodfuel in the third world may be solved either by increasing the supply or managing the demand. The woodfuel supply can be increased by reforestation. The farm and social forestry[5] are attempts in this direction. But these schemes have only a few success stories to tell (see Bina 1986, Echolm et al 1984). The enhancement of fuel supply through other non-conventional energy sources has not yielded considerable result and at the present state of knowledge can have only limited application (Reddy & Presad 1977).

Consequently the demand management is proving to be a more viable policy option. The fuel use in rural areas in poor countries for cooking is higher than that of many U.S. households, since the energy is used inefficiently. The woodfuel, for example, is burned either in open fire or in inefficient mud stoves. Only a small fraction of the heat of combustion actually serves the purpose as most of the heat escapes the cooking pot. Studies have shown that firewood is the costliest fuel, if we take into account the efficiency of use and it is a paradox that the costly fuel is used by the poor (See The Steering Committee on Energy 1978. Dunkerly et al 1990).

The cost of producing one more unit of energy is higher than the cost of saving one unit and, in this context, the fuel efficient chulahs have an important role (Reddy 1988). The open fire or the traditional chulah is the least efficient, where only 8 - 10 per cent of the energy supplied by the fuel is utilised. Many developing countries are now popularising improved wood burning stoves, which have higher fuel efficiency. If the fuel use efficiency is doubled, the wood requirement could be halved. Improved chulahs have been accepted as a practicable measure, which reduce the demand for woodfuel by the poor in the Third World countries who are the vulnerable section in the society. This is considered as a clear case where a little application of science benefits millions of households.

The Three Stone Fire

The most common method of cooking in the under developed countries is over open fire. Usually the fire is enclosed by three stones or lumps of mud over which cooking pots are placed. In some cases, five stones are used to accommodate two pots. The fire is on the raised platform or on the ground. In some cases the earth is scooped out between the stones, so that fire is slightly sunk into the ground.

There is little to prevent heat radiating laterally outwards from burning fuel in the open fire. There is a loss of energy to the surroundings. Upward flow is unobstructed so a high proportion of hot combustion gases pass freely up around the pot without transferring heat to it. When wind blows, there is even greater loss of heat. The extra air increases the rate of combustion and thus the heat output. The wind blows the hot gases rising from the fire away from the pot.

But the open fire has many advantages. It has no cost, needs no training or tools. It is versatile in size, shape and type of fuel it can burn. It can be positioned wherever and can be changed and adjusted. Fire can be controlled by adding or pulling out fuel. Stones are good support for any pot of any size. The smoke from the fire preserves food, keep away termites, and increases the life of the thatch.

The Traditional Stove

The distinction between traditional stove and open fire is blurred. Simple stoves made in traditional ways are found in many countries (For detailed description of different chulah models see Foley and Moss 1985)

These traditional stoves have evolved over time responding to climate and the economic condition of the people using it. They represent an effective compromise between the often conflicting requirements of utility, economy, convenience, and general compatibility with the domestic environment. This is why for practical purposes, they are difficult to improve. However, most traditional stoves in use are deficient in terms of fuel efficiency and smoke in the kitchen.

The wood-burning stove group at Eindhoven University has classified the stoves - both traditional and modern - into three broad categories:

(a) shielded light weight (All portable-metal or ceramic)
(b) shielded Heavy weight (Fixed) (made of mud, brick, but without chimney) and
(c) closed heavy weight (Fixed) (made of mud, brick, with chimney).

Each of these has a further set of sub categories defined by the number of pot holes in the stove.

The term shielded refers to the fact that the fire is at least partly enclosed. This is what distinguished the traditional stove from open fire. Shielded light weight covers all portable metal and ceramic stoves. Shielded heavy weight consists of those constructed of bricks, mud, concrete and other heavy materials, but not equipped with chimney or draught control devices.

Closed heavy weights are similar to the above, but has chimney, fire doors, dampers etc. Cooking practices vary between countries from standing up (eg. Latin America) to sitting on the ground (eg., most of rural India).

The Improved Stoves

The improved stoves are adaptations of traditional stoves so as to save fuel by better combustion through better shielding of the fire and provision for air supply and removal of smoke. In stoves with auxiliary holes, the heat loss is reduced by channelling the hot combustion gases to the secondary pots. Most of the improvements are in fact borrowed from traditional stove practices in vogue but not widely popular. Conscious application of scientific principles is also made in the stove design.

The improved chulahs provide a number of benefits - private and social, financial and non financial:

a) The saving on fuel, due to higher efficiency, directly benefits the purchaser of woodfuel.

b) In the case of those not purchasing woodfuel, improved chulah saves the time needed for collection and this can be utilized for other income generating activities.

c) Besides, it reduces the health hazard and drudgery of women in the kitchen. The concentration of pollutants is often dangerously high in the kitchens in most developing countries[6]. Medical researchers are finding high rates of various acute and chronic respiratory diseases in places where cooking is done in enclosed spaces. The health impact of household smoke is a neglected area of research - but health may prove the strongest reason for promoting smokeless stoves (Echolm et al 1984). Moreover, it saves time and effort in cleaning smoke darkened cloth and utensils. Improved chulahs also save cooking time.

d) Improved chulahs with platform makes cooking less strenuous because it can be done standing up. There is less risk of burns.

e) The social benefits of chulah may also be considered as it reduces the pressure on vegetation.

Many institutes around the world are engaged in the design and research work in improved stoves. These include Eindhovan University in Netherlands and the Aprovencho Institute in Oregon. The Lorena Stove of the latter has been one of the most successful improved chulah popularised in Latin America. The Intermediate Technology Group (ITDG) in UK, the Tata Energy Research Institute (TERI) in India, the Ceylon Institute of Science and Industrial Research (CISIR) in Sri Lanka, the Bellerive Foundation in Geneva, the Yayasan Dian Desa Organisation in Indonesia, CEMAT in Gautemala and the Research Centre for Applied Science and Technology (RECAST) in Nepal are the other important institutions. Proposals for an international network on biomass fuelled stoves are being developed under the auspices of the Netherlands Ministry of Foreign Affairs and the US Agency for International Development.

The Indian models

India is perhaps the pioneer country in adopting improved stoves. In 1947, the Magan chulah was developed, by the All India Village Industries Association Maganwadi, with clay, straw and dung. A solid block was formed in the shape of the stove. After drying, the firebox, three pot holes and the flue were carved from the block. Another important initiative was in 1953 by S. Raju who developed the HERL (Hyderabad Engineering Research Laboratory) chulah made of brick, mud and fine earth. It consisted of `L' shaped duct with one, two or three holes for cooking pots. S. Raju emphasised the advantages of the improved chulah in terms of providing freedom from "Smoke, Soot, Heat, Waste, and Fire Risk".

In 1957, a portable Magan chulah was developed. This was very different from the original Magan chulah, which was of fixed type. The new model was assembled from ceramic parts made by local potters. The stove consisted of three ceramic cylinders placed in line with each other and linked with ceramic pipe at mid height. The third cylinder was connected to a chimney. The stove was assembled by fitting the various parts together and plastering the joints firmly. It was embedded in mud to provide insulation and protection for pottery. The pot rested on top of each cylinder and was heated by the fire which was lit in the cylinder farthest from chimney.

The PRAI chulah was developed by the Planning and Resource Action Institute in 1969 with two pot holes and chimney. Madhu Sarin developed the Nada Chulah, in which pot holes, size etc. were determined according to the user requirements and made with mud and other local materials and a damper is incorporated in front of the firebox as well as a chimney damper. The programme relies on women learning the method of making stoves and then building stoves in the nearby areas.

The National Programme on Improved Chulahs (NPIC)

A major turning point in the diffusion of improved chulah came in the Sixth Plan. Till then the improved chulah programme was largely confined to the initiatives of voluntary groups. In the sixth plan an Integrated Energy Planning Programme was proposed on a pilot basis, which would provide mix of energy options for meeting the diverse energy needs of rural areas, in the most cost effective manner. The Planning Commission started Rural Energy Planning Exercise and under this the Integrated Rural Energy Programme (IREP) was initiated in 1981 in selected states at the block level. The main thrust was on promoting renewable sources of energy like wind, solar, biogas and improved cooking gadgets. During the Seventh Plan the programme was extended to all the states and union territories. In September 1982, Department of Non conventional Energy Sources (DNES - under the ministry of Energy) was set up. The DNES initiated the National Programme on Demonstration of Improved Chulahs (NPDIC) in 1983. This programme has been renamed in 1986 as National Programme on Improved Chulahs (NPIC). The improved chulah programme is a unique example of an indigenous research, development and extension, appropriate to different types of kitchens in rural and semi urban area.

The minimum thermal efficiency for fixed and the portable chulahs has been fixed at 20 per cent and 25 per cent respectively. More than 20 models of fixed stoves are being promoted all over India.

Now the DNES emphasises the importance of using prefabricated inner linings which will ensure accuracy and durability. The DNES insists on popularising damperless chulahs, due to the fact that, most users are not properly using it which leads to lower efficiency.

Government gives financial support to the development of appropriate models and for the propagation of the improved chulah. The NPIC is directed to cover all categories of beneficiaries in towns, rural, semiurban and urban areas. Priorities have been fixed for implementation of the improved chulah programme. Preference has been given to the following groups of beneficiaries.

- Scheduled caste areas and the households (18 per cent of the target,)
- Scheduled tribes areas and households (7 per cent of target)
- Hilly areas, North Eastern region and islands
- Areas experiencing serious deforestation and fuel scarcity
- Community kitchens of hostels and military and paramilitary forces, religious and charitable institutions (Annual Report DNES 1989-90).

Table 1.5: Improved chulah targets and achievements in India (in lakhs)

Period	Target	Achieved
Sixth Plan		
Dec. 1983 to March 1985	5.00	8.12
Seventh Plan		
1985 - 86	10.00	11.22
1986 - 87	6.50	9.05
1987 - 88	12.00	15.18
1988 - 89	15.00	18.13
1989 - 90 (Upto Jan 1990)	11.76	11.88

Source: Annual Report DNES 1989-90 p.23.
* Includes portable stoves also.

The achievement has exceeded the targets fixed in quantitative terms (See Table 1.5). It encouraged DNES to have ambitious programme for the future. "The population of the country is expected to be over 1000 million by 2001. On an average, there are 5 members in a family, the number of households will be around 200 million, 150 million households are expected to use chulahs for cooking and hot water requirements. It is planned to set up 100 million improved chulahs in the country by 2001." (NCES 1987 p.9). By 2001, chulah is expected to save 79.80 MTCR which will be about 6-7 per cent of total energy requirement of the country at that time. The task is indeed daunting when we remember that the achievement so far is only around 5.5 million households. A careful review of past experience in the diffusion of improved chulah assumes vital importance in this context. It is surprising that very little has been undertaken in this direction.

Section 3

The Case Study of Kerala

For several reasons, Kerala would provide an interesting case study for examining the extent and pattern of spread of improved chulahs and factors that affect their diffusion.

First, Kerala is one of the most fuel wood dependent states in India. At the all India level, the share of firewood and chips for cooking in rural areas is 76.70 per cent, where as in Kerala, it is 97.89 per cent. In the urban areas, the all India figure is 45.88 per cent, whereas it is 82.92 per cent in Kerala (NSS- 38th Round, Sarvekshana Oct - Dec 1988 pages 19,20,S169, S208). Of the total domestic fuel used 35.41 per cent is fire wood, 36 per cent is coconut products, 22 per cent is twigs and leaves. A major difference in domestic fuel consumption pattern in Kerala from the rest of the country is the complete absence of coal. The fuel wood and other vegetative fuel dependency of Kerala is also confirmed by the data published by State Planning Board[7].

Second, there is a high level of commercialisation of wood-fuel. It may be noted that 56.7 per cent of the firewood is purchased while 75 per cent of coconut product is owned and 47 per cent of twigs and leaves is collected (See table 1.6). 85 percent of the agro wastes is used for cooking purposes (See footnote 7). These constituted the important source of fuel of the poor which use to be collected freely. Now, even the agro wastes to an extent are commercialised. The commercial dependency is inversely related to the level of income (See table 1.7).

The purchased component of vegetable fuels is 25.69 per cent and the this share is higher in the case of lower income group.

Table 1.6: Two Way Percentage distribution of total consumption of Energy (Households and Enterprises) by Fuel Type and Sources in the survey region.

Types of Fuel	Source				% Distribution of type of Fuel
	Own	Purchased	Collected	Total	
1. Fuel wood	26.7 25.3	56.7 63.2	17.2 34.8	100	41.2
2. Fuel wood from coconut/ palmyrah tree	74.7 57.7	14.3 12.7	11.0 17.8	100	32.9
3Twigs, leaves shells and other veg. Wastes	35.3 16.9	17.5 9.7	47.2 47.3	100	20.4
4. Kerosene		100 6.8		100	2.5
5. Electricity		100 5.0		100	1.9
6. LPG		100 0.3		100	0.1
7. Others	4.9 0.1	93.4 2.3	1.7 0.1	100	0.9
Total	100	100	100	100	100
% Distribution of Source	42.6	37.0	20.36		

Source: Rural energy generation and use pattern, Southern Kerala. State Planning Board, Trivandrum 1986 p.10.

* Values at the top of the cells are the row percentages, and values in the bottom of the cells are column percentages.

Table 1.7:Percentage of vegetable fuels by source.

Per capita monthly household expenditure (Rs)	Percentage of fuel Own	Purchased	Collected in other ways	Total
1. 0 - 30	48.56	31.93	19.51	100
2. 31 - 60	43.54	27.11	29.35	100
3. 61 -100	47.99	26.51	25.50	100
4. Above 100	56.46	23.46	20.08	100
All Classes	50.22	25.69	24.09	100

Source: Rural Energy Generation and Use pattern 1986 State Planning Board, Kerala, P.24.

Third, Kerala is an energy deficient state. The fast depletion and degradation of forest has reduced the availability of firewood. Although firewood from forest forms only a very small fraction of cooking energy needs, its supply decreased in Kerala, from 78474 tonnes in 1986-87 to 11111 tonnes in 1989-90 (Economic Review, State Planning Board - various issues). It is mainly due to the policy of ban on tree felling of forests. Increasing fuel wood supply through reforestation has only limited scope since there is already a very high pressure on land. Increasing the availability of commercial fuels is also limited. Kerala is deficient in electricity and there is no known fossil fuel source. Bringing coal to Kerala is difficult due to the long distance transportation required. Therefore, management of fuel wood demand is essential. The growing scarcity of firewood is reflected in its price. The price has increased by nearly 12 fold in 20 years (See table 1.8).

Table 1.8: Firewood prices (retail), Kerala (at the end of Dec)

Year	Price/Tonnes (In Rs).
1970	55.98
1971	60.42
1972	71.98
1973	85.89
1974	125.24
1975	126.57
1976	179.07
1977	181.19
1978	218.0
1979	289.63
1980	339.63
1981	395.92
1982	434.33
1983	483.11
1984	522.25
1985	605.04
1986	620.96
1987	671.5
1988	663.94
1989	631.4
1990	661.4

Source: Economic Review: Planning Board Kerala, Various issues.

Fourthly, a highly literate state like Kerala is expected to be most suitable for fast diffusion of a technology like improved chulahs. The higher status of women in Kerala, is also a favourable factor for better dissemination of this new technology.

However, the woodfuel use in Kerala is very inefficient. The overall efficiency of traditional three stone open stove is 5-10 per cent and that of the potter made shielded single and double pot hole stoves seldom exceed 10-15 per cent. Thus, there exists ample scope for saving of fuel wood by way of increasing the efficiency of use to 25 - 30 per cent.

The improved stoves in Kerala

The chulah programme started in Kerala as a part of the national programme from 1984-85 onwards. Agency for Non Conventional Energy and Rural Technology (ANERT) is the nodal agency for the programme. The fixed (family and community) and portable models are diffused.

The main types of chulah propogated in Kerala are known as Parishad chulahs. The parishad family chulahs are available in 3 models viz., Parishad 11, Parishad 21 and Parishad 12. The first number denotes the number of pot holes, and the second number denotes the auxiliary pot holes. These stoves were developed by the research divisions of Kerala Sastra Sahitya Parishad (KSSP) in 1983 and these are the first Indian chulahs with prefabricated inner pottery lining.

The demonstration and field trial recorded over 25 per cent efficiency (KSSP 1985). The improvement is achieved through the following techniques The chulah has an airspace, which provides sufficient air for best combustion. The hot combustion gas is utilised in the auxiliary pot hole before going out through the pipe. The heat loss from chulah to the outer space is controlled by covering the mould with sawdust or rice husk. The parishad 21 chulah has seven prefabricated pottery pieces, which are joined by the trained worker (called the Self Employed Worker - SEW) in a platform. There are two fireboxes and a second pot hole with tunnels leading into it from both fireboxes. The baffle in the auxiliary pot hole aids in controlling flow of hot flue gases.

Mix of clay, burnt rice husk and sand are used to cover the pottery linings. There is an asbestos pipe connected to this which keeps smoke away from the kitchen. The firewood pieces are put in the iron grate and ash is collected below it (See Picture 1).

The portable stove popular in Kerala was developed by the Central Power Research Institute (CPRI) Bangalore. The portable stove has got a thermal efficiency of 28 per cent, but it is not fully smokeless. This is simple and can be bought ready to use.

The programme started in 1984-85. Table 1.9 gives the year wise distribution of chulahs installed. Two points may be noted:

a) Total number of chulahs installed was 214330. It constitute only 3.6 percent of the households in Kerala.

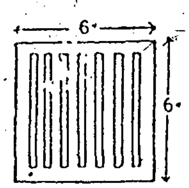
Table 1.9: The Chulahs Installed over the Years

Year	No.of chulah (Fixed + Portable)	Cumulative total	Percentage change over previous year
1984-85	1748	1748	
1985-86	4716	6464	269.8
1986-87	6924	13388	107.1
1987-88	26346	39734	196.7
1988-89	40527	80261	102.0
1989-90	65784	146045	81.9
1990-91	68285	214330	46.7

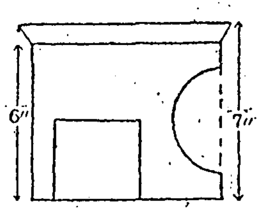
Source: ANERT Progress Reports Various Years.

b) Another disturbing trend is that between 1989-90 and 1990-91 there has been a sharp deceleration in the rate spread of chulah. While in 1989-90 65784 chulahs were installed. But in the year 1990-91 the number of chulah installed was 68285. A district wise analysis shows that in 6 of the 14 districts

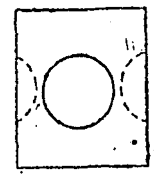
Picture 1. Parishad 21 Model Chulah and parts



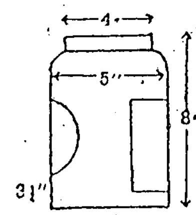
Grate



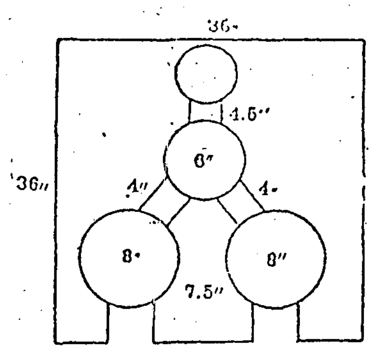
Pot-hole



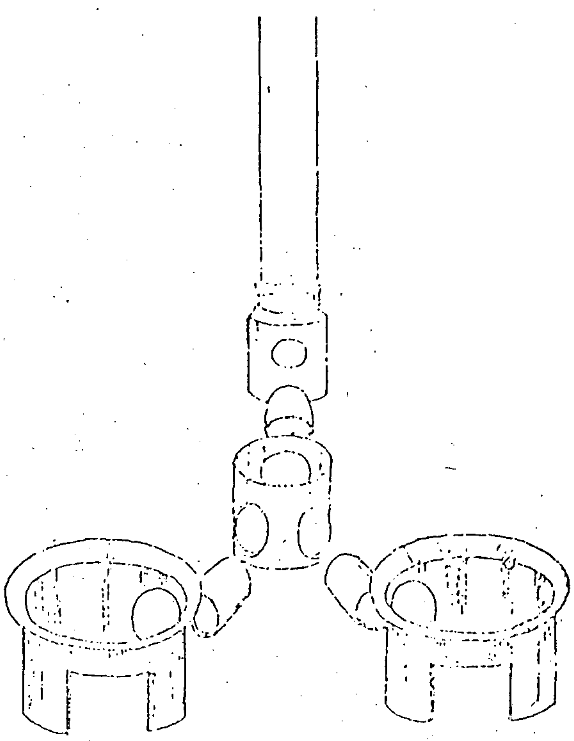
Auxiliary Pot-hole



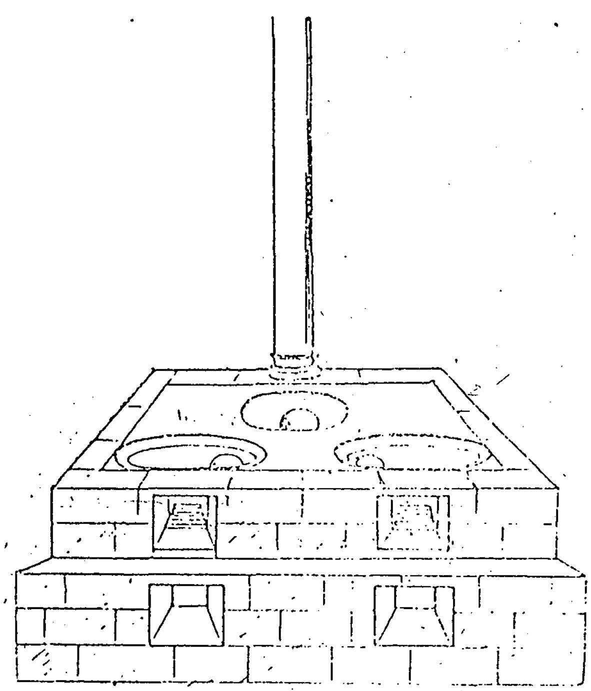
Jar (Connecting Mould with the Chimmeny)



Chulah Dimension



Mould



Chulah

the absolute number of total chulahs installed declined (See table 1.10).

Table 1.10: The district-wise diffusion of chulah for 1989-90 and 1990-91

District	No.of chulah in 1989-90	No. of chulah 1990 - 91	Change
Thiruvananthapuram	10325	6398	-
Kollam	2948	4943	+
Pathanathitta	1969	3463	+
Alappuzha	3409	4181	+
Kottayam	6735	1572	-
Idukki	7117	10541	+
Ernakulam	3097	3579	+
Thrissur	5750	6327	+
Palakkad	7051	3934	-
Malappuram	1967	4796	+
Kozhikkode	2009	1103	-
Wynad	8002	7699	-
Cannanore	1582	1291	-
Kasaragod	3823	8456	+
Total	65784	68285	

Source: ANERT Progress Reports

Therefore, it becomes important to understand why the overall spread is low and why the absolute number of chulah installed fell recently in many districts. This study primarily focusses on understanding the causes of the low diffusion of the improved chulahs in Kerala.

Section 4

Chapter Scheme

In the chapter 2 we shall survey the different perspectives on diffusion of technology viz. adoption perspective, market and Intrastructure perspective and the economic history perspective. The characteristics of chulah being significantly different from the usual industrial or agricultural innovations that normally constitute the subject matter of diffusion, the above cannot be mechanically applied in our analysis. We hope to move towards a framework to understand the process of diffusion of improved stoves incorporating the various elements drawn from the existing theoretical literature.

Chapter 3 is devoted to an examination of the inter regional variations in the incidence of chulah diffusion. The first problem we shall tackle is to enquire whether there is any regional pattern in the diffusion of chulahs. The second one is to examine the factors that affect the demand for chulah such as fuel scarcity, prices, of fuel and fuel composition, that could explain the regional variations. We shall also examine if the regional differences are not better explained with the supplyside factors such as the activities of the diffusion agencies in different regions.

In Chapter 4 an enquiry into the use status of the chulahs installed is undertaken. The technical and non technical factors that affect the use status of the chulah are discussed with help of primary data. After the discussion of the use status, we move on to an examatination of socio-economic background of the users. Is there an income barrier to adoption of the technology? Is its adoption circumuscribed by the size and type of house of the user? Is there any connection between use status and the complaints observed? These are some of the questions that we take up in this connection.

Chapter 5 is entirely devoted to the diffusion mechanism. After presenting the broad organisational structure we shall examine at some length the character of voluntary agencies engaged in the programme. What are the problems met by new organisations for entering the programme or the existing organisations in rapidly diffusing this technology. In the concluding chapter the various threads drawn in the above chapters are brought together and conclusions stated.

It may be noted here that we have not conducted any primary user survey but have relied on the primary data collecIted by various agencies and our own qualitative enquiries. A major lacunae in the data base was the absence of information regarding portable chulahs that constitute around 20 per cent of the chulahs installed in Kerala. Consequently, strictly speaking, our analysis has been confined to fixed family chulah diffusion in the state.

FOOTNOTES

1. Commercial energy (CE) consists of electricity LPG kerosene etc., which are obtained from the market at a price. Non commercial energy (NCE) consists of firewood, agriculture waste, cowdung etc, which are mainly obtained without any cash payment. But, now a considerable part is available only at a price and as such the term, non commercial energy is not suitable. Traditional fuels are the biomass sources, which can be derived from plant and animal material. These are wood, charcoal, crop residues and animal dung. The distinction is also made between conventional and non conventional sources. Conventional energy sources are the biomass and other commercial sources such as electricity gas etc. Non conventional sources are the solar energy, wind energy, biogas etc. Woodfuel comprises, firewood, charcoal, agro wastes etc.

2. See Dudney & Flavin 1983. p 112.

3. The periodic survey of NSSO, on rural energy is a useful source. NCAER has conducted a survey of different regions regarding fuel use pattern. Besides there are also a few policy oriented studies on energy like Energy Survey of India Committee (1965) Report of Fuel Policy Committee (1974). Working group on Energy (1979), and Advisory Board on Energy (1986). The latter two studies specifically examine the problems of rural energy also. Forcastes of likely future trends are also made. A micro level study made by ASTRA (1980) gives valuable information on domestic energy consumption pattern at the village level in Karnataka. Balachandran (1983) and State Planning Board (1986) provide information on domestic energy consumption pattern in rural Kerala.

4. Acute scarcity was defined as those with a very negative balance where the fuel wood supply level is so notoriously inadequate that even over cutting of the resources does not provide the people with a sufficient supply, and fuel wood consumption is therefore, clearly below minimum requirements. Deficit situations are those where the people are still able to meet their minimum fuel wood needs, but only by over cutting the existing resources and jeopardising future supplies.

5. Farm forestry usually implies individuals growing trees in private land for their needs. Social forestry on the other hand implies planting of trees in government or commercial land, for meeting the needs of the rural for fuel and fodder. It is also called community forestry.

6. It is estimated that in most Third World Countries women cooks are inhaling as much as if they smoked 20 packs of cigarette every day.

7 Table 1.11: Two Way Percentage Share of Household Consumption of Fuels by Source and Purpose

	Cooking	Lighting	Water heating	Space heating	Other domestic uses	Other uses	Total	Percentage distribution of fuels by source
Firewood	(89.8) 38.3		(3.1) 15.4	(1.0) 78.5	(1.9) 27.1	(4.2) 40.5	(100)	35.41
Coconut Products	(84.0) 37.4	-	(10.7) 54.9	(1.0) 7.6	(27.1) 31.6	(40.5) 31.1	(100)	36.99
Twigs,leaves & other Agro waste	(85.3) 23.2	-	(9.3) 29.5	(0.3) 14.2	(3.9) 36.1	(1.1) 7.0	(100)	22.65
Kerosene	(20.6) 0.70	(75.1) 66.4	(0.2) 0	(0.5) 20.7	(1.5) 0	(2.1) 1.6	(100)	2.8
Electricity	(2.6) 0.4	(86.4) 33.5	(0.5) 0.1	(0.3) 0.7	(4.5) 2.2	(5.7) 1.9	(100)	1.2
LPG	(100) 0.1	-	-	-	-	-	(100) 37.21	0.12
Others	(9.8) 0.9	-	(0.7) 0.1	(0.1) 0.1	(3.9) 4.2	(85.3) 17.8	(100)	0.93
Total	100	100	100	100	100	100	100	100

Source: Compiled from Rural Energy Generation and Use pattern (1986) State Planning Board Kerala Pp.43-49.

* The values at the top of each cell are row percentages and the values in the bottom of each cell are column percentages.

The per household energy requirement including lighting was estimated to be 2750 kg. of Firewood Equivalent (FWE). The number of households in the region was 2413880.

CHAPTER 2

PERSPECTIVES ON TECHNOLOGY DIFFUSION

Our discussion in the previous chapter highlighted the domestic fuel crisis in the developing countries. Given the unequal access to resources, the crisis is felt more by the lower strata of society. The solution to this crisis, it was pointed out, lies in the diffusion of energy efficient technologies. In the present chapter an attempt is made to review the different perspectives on technology diffusion.

The diffusion of technology is only one of the phases in the process of technological change. The technological change as conceived in literature, following Schumpeter, is a process comprising of three phases, invention, innovation and diffusion. The existing literature on invention, innovation and diffusion however, is mostly concerned with the industrial technologies which are fundamentally different from rural technological innovations like fuel efficient chulahs. Hence, the technology diffusion perspectives are here used to develop the broad contours of an analytical framework for studying the diffusion of improved chulahs. This chapter is divided broadly into two sections. The first section reviews the major perspectives in literature on technology diffusion and, drawing certain crucial elements from this, in the second section an attempt is made to develop an analytical framework for understanding the diffusion of improved chulahs.

Section 1

Theories of Technology of Diffusion

Invention is an idea, a sketch, or a model for improved device, product, process or system. An innovation in the economic sense is accomplished only with the first commercial transaction involving the new product process or system (Stoneman 1983). Technology diffusion refers to the spread of an innovation among the users of technology over time. Thus the diffusion is a dynamic process, with both temporal and spatial dimension. It takes place when the individual economic units (eg. firms, households etc) adopt a new product and/or a product embodying a new technology.

The literature on technology diffusion primarily analyses the determinants of rates, time path and post diffusion level of use of new technology. (Stoneman 1983). A distinction is made in the literature between process innovation and product innovation[1]. Yet another distinction is regarding intra firm and inter-firm diffusion[2].

The issue of technology diffusion has been approached from both demand and supply sides. The underlining logic behind the demand side approach is that the technology diffusion is guided by the demand for it from the prospective users. On the other hand, the supply side approach consider the availability of technology as crucial factor behind technology diffusion. It is difficult to make such a rigid distinction because a large number of studies have acknowledged the importance of both demand and supply side factors as affecting technological innovation and diffusion.

In effect, such a broad distinction, tends to overlook a number of subtle factors which tend to influence the process of technology diffusion. Hence, for the purpose of our discussion we may classify the diffusion perspectives, following Brown (1981) into (a) adoption perspective (b) market and infrastructure perspective and (c) economic history perspective.

The Adoption Perspective

This is the traditional and dominant approach focusing on the demand side of the problem. The analysis focuses on the time profile of the diffusion and the characteristics of the adopting units as well as characteristics of innovation. There is a general consensus in the literature that the diffusion path is sigmoid ie `S' shaped. (Rogers and Shoemaker (1971), Stoneman (1983). Coombs et.al 1987). The adopter distribution assumes a bell shaped normal curve, when plotted over time on frequency basis. The cumulative frequency of this will have an `S' shape (see fig. 2.1, 2.2).

The adopters are categorised into five groups, based on two parameters, mean and standard deviation. They are innovators, early adopters, early majority, late majority and laggards. When an innovation is made only a handful of innovators adopt it initially. Innovators are considered to be venturesome and eager to try out new ideas. They have cosmopolitan relationships and financial resources to take risk. Early adopters are an integral part of the community and tend to act as opinion leaders; the early majority tend to be deliberate in their actions. The late majority are always initially sceptical about innovation. The laggards are

Fig. 2.1

Categories of adopters

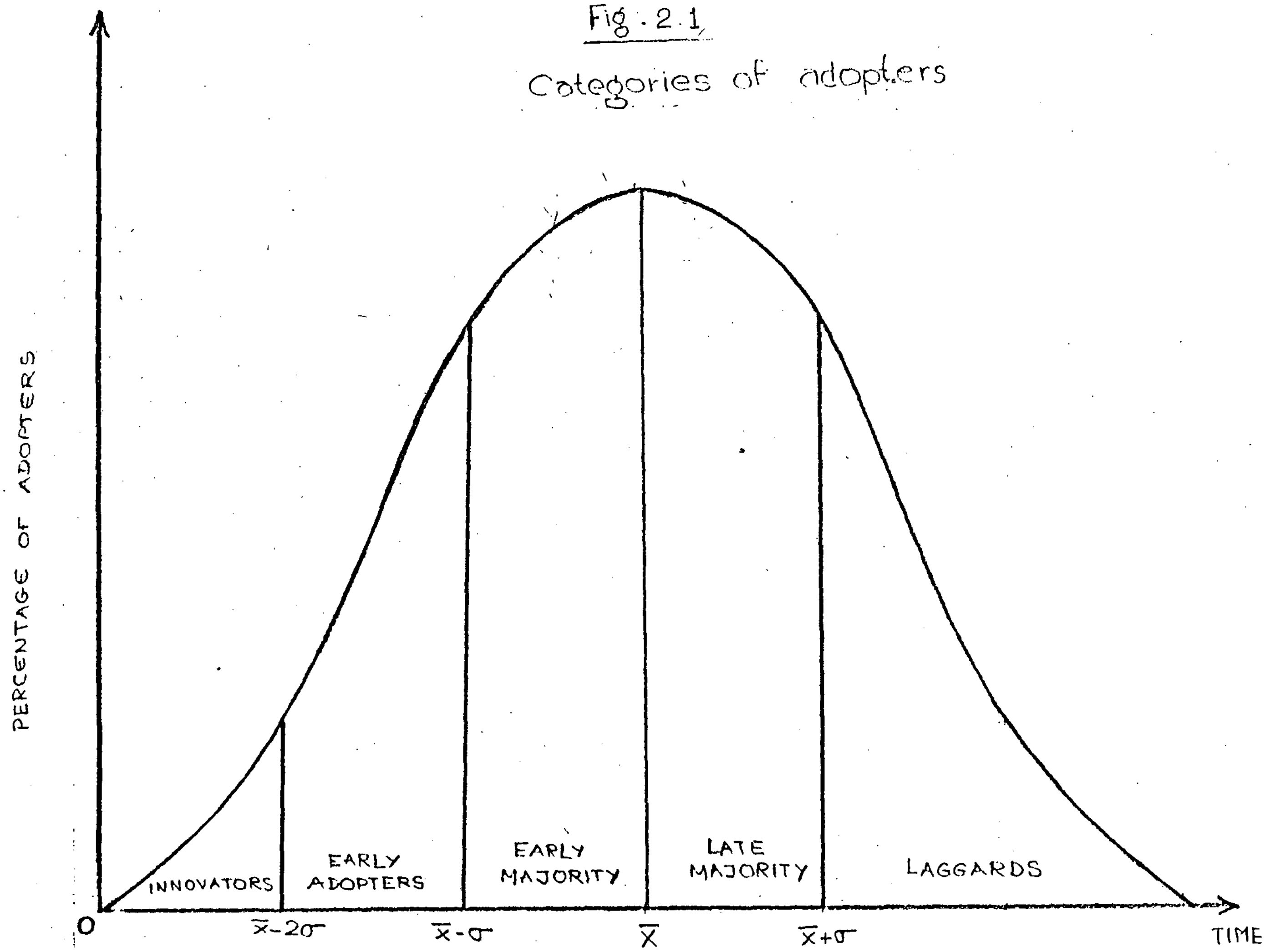
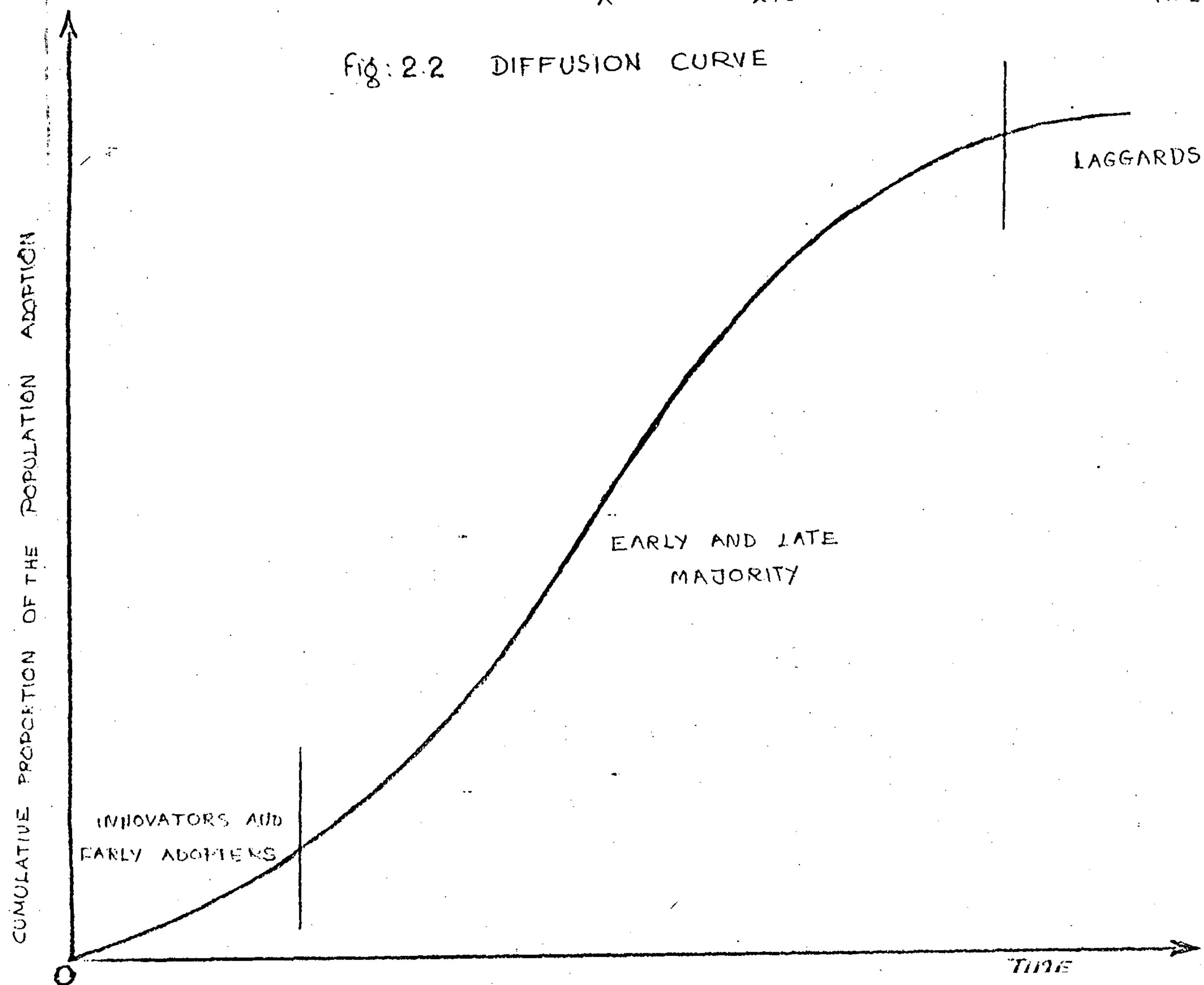


Fig: 2.2 DIFFUSION CURVE



highly localised and traditional. There is a lag between introduction of an innovation and its adoption. The time lag between awareness of an innovation and its adoption is called the `adoption period'. Length of this varies with individual practices. The `diffusion period' relates to the time lag between introduction and acceptance by all or most members.

The economists and sociologists interpret differently the above pattern of diffusion as depicted by the sigmoid shape. Economists consider relative profitability and associated risk as the determinants of the process of diffusion. Most important among the characteristics being its capability to bring about cost reduction. The cost advantage of the new technology should be significant to induce the users to take risk. The risk arises because of the uncertainty associated with the new technology which is not proved in the market. A new technology is replacing an old technology, and as such, the comparative characterstics of both, rather than of the new alone, has to be considered to explain the diffusion (Brown 1981). Stoneman (1983) holds the view that higher the expected profitability, higher will be the diffusion. The following are the four principal factors of diffusion (Mansfield 1968).

(1) Extent of economic advantage over the old method of production.
(2) Extent of uncertainty associated with diffusion.
(3) Extent of commitment needed to try out.
(4) Rate of reduction of initial uncertainty regarding the innovation.

The adopting unit is certain about the profitability of the old technology, but uncertainty exists in the case of the new technology. Expected profitability of an innovation is assumed to be directly related to the probability of its adoption. Uncertainty regarding profitability is a limiting factor of diffusion. The size of investment needed to try out the innovation is important, since the adopter will be cautious of making larger investments. Thus, technologies yielding higher profit with low initial investment will diffuse rapidly. The size of the firm is a critical factor in diffusion. Larger firms tend to adopt innovations earlier than smaller firms. The diffusion rates are influenced by certain industry characteristics, the most important being the degree of competitiveness (Stoneman 1983).

The flow of information is also important in diffusion, since it reduces the uncertainty. As time passes, the adopting unit can learn from the experience of other firms regarding the profitability and other characteristics of the innovation. The spread of the technology is like an epidemic. As epidemic spreads, the carriers increase until the healthy individuals become small. When the number of adopters are small, the potential adopters have very little information regarding the innovation, therefore, the associated risk is higher. As more firms adopt, the risk decreases and the rate of diffusion increases. Therefore, the diffusion rate will be small until some `critical mass' of information is reached. The `band wagon effect' in diffusion takes place only when this critical mass is reached.

The learning process, both by learning by doing and learning through information considerably influence the adoption of a technology, both for inter and intra-firm diffusion of technology. As time passes, a convergence of opinion is reached among the potential adopters regarding the characteristics of the technology and depending on this the innovation is accepted or rejected. The complexity or novelty and efficiency of information flow and communication associated with an innovation are also factors influencing diffusion. It should be noted that in the above approach to diffusion, it is implied that there is a linear progression from invention to innovation to diffusion, and that all potential users are treated identically.

The conditions of profitability and risk is relevant not only to the firms. The acceptance of a new technology by farmers also depends among other factors on the magnitude of profit to be realized from the change over - higher the stimulus, faster the adoption. Regarding the adoption of new hybrid corn, (Griliches 1960) says "almost no farmer planted 100 per cent of his acreage to hybrid seed, the first time he tried it". It took some time to get convinced that the new product is something superior. Profitability was found as an important attribute for adoption in a study of modern practices in agriculture in a Tamil Nadu Village (Raj S Arul and Knight 1977). In a study in Uttar Pradesh in which farmers were asked to mark eight attributes influencing adoption behaviour in terms of their importance, profitability, communicability and cost were ranked first three, followed by compatibility and complexity, durability, cultural compatibility and divisibility. (Thripathi and Daulath Singh 1974).

In the sociological approach, the diffusion process is explained primarily in terms of the effectiveness of the `communication systems' and the personality traits of the adopters. Thus the characteristics of the adopters, and the precise form in which knowledge about the technology is communicated are crucial to the effectiveness of the diffusion process. The important elements in the diffusion are (a) innovation (b) which is communicated through certain channels (c) over time (d) among the members of the social system (Rogers and Shoemaker 1971). The receivers of the communication are the members of the social system. The channels are the means by which communication spreads.

The sociologists also consider certain characteristics like utility, compatibility, complexity, communicability and divisibility as crucial in determining the diffusion[3] (Rogers and Shoemaker 1971). Utility, compatibility and complexity depend on the way they are perceived by the adopters. Communicability and divisibility are inherent qualities of the innovation. The social structure and the values and attitudes of the system, affect the pace of diffusion. In a progressive and change oriented society better spread takes place. Modern values such as scientism, risk bearing, rationality, profit orientation etc. facilitate rapid diffusion. A society where traditional values predominate is not suitable for speedy dissemination.

Sociologists consider the creation of awareness regarding the existence and characteristics of the innovation as crucial. An understanding of the diffusion process requires an identification and examination of the factors relating to the effective flow of information and the characteristics of the information flows, information reception and resistance to adoption (Brown 1981). The mass media and the extension agents play an important role in providing information. The inter-personal information is a major factor in the diffusion process. Rogers and Shoemaker (1971)[4] summarise the factors affecting adoption of innovation as (1) the perceived attributes of innovation (2) types of innovation decision (3) communication channels (4) nature of social systems (5) extent and promotional efforts by change agents.

The Market and Infra Structure Perspective

Earlier, innovation diffusion was treated as consumer behaviour phenomenon. In the adoption perspective there is an implicit assumption that the profitable innovations are readily available and the non acceptance of it is due to the lack of awareness or uncertainty attached to the profitability. In reality, diffusion is the result of the demand for and supply of innovation. As distinct from adoption perspective, the market and infrastructure perspective emphasise the supply side of the problem. Here also the flow of information and communication is important, but the same is looked at from the supply side. As Stoneman (1983) says one cannot appreciably investigate a technology without considering supply.

In the adoption perspective it is assumed that all potential adopters have an equal opportunity to adopt it and the difference in individual characteristics influence the diffusion. But in reality the opportunities to adopt are unequal. Therefore the means through which innovations are available to potential adopters - individuals, households, and enterprises are crucial factors (Brown 1981). The market and infrastructure perspective highlights two stages of the supply side, namely, the establishment of diffusion agencies (or outlets) through which the innovation (or information) is distributed to the population at large and the implementation of a strategy by each agency to induce adoption among the population in its service area. It is only after this that adoption occurs (Brown 1981).

The shifting of attention from the adopters to the suppliers makes the role of the diffusion agents, their strategy of diffusion and their pricing policies crucial in the process of diffusion. Spatial diffusion takes place only if the new technology is available in different space units. The diffusion strategy of the agents is a critical factor. The potential adopters will not be able to adopt the technology unless the diffusion agencies make available the things near the location of these adopters. An important factor in the spatial diffusion is the establishment of diffusion agency. Brown (1981) speaks of three structures of agency establishment. At one extreme, there is the centralised structure wherein a single propagator (or several propagators acting together as one) determines the number of outlets to be established at any given time and their location, size and other characteristics. Thus the pattern of diffusion is centrally controlled. At the opposite end there is a decentralised structure in which each diffusion agency is established independently by a different entrepreneurial or non profit motivated entity so that the gross pattern of diffusion comes about solely through the aggregation of individual actions and decentralised decision making.

In between these two extremes is diffusion in a decentralised structure with a co-ordinating propagator. In this each agency is established by a different entrepreneurial or non-profit motivated agency. But some aspects of this are controlled by the co-ordinating propagator. Thus the pattern of diffusion is influenced but not determined by the co-ordinating propagators.

A strategy suitable for diffusion has to be evolved and four activities are particularly relevant to spatial pattern (Brown 1981).

a) The development of infrastructure and organisational capabilities - for example, the adoption of tractors or pump sets necessitates the provision of bank credit, electricity, diesel etc.

b) Pricing - in general, higher prices will result in a lower density of adoption among the target population.

c) Promotional communication - the diffusion agency generates information to create awareness of the innovation and its characteristics. The impact of this information on adoption decision and resulting patterns of diffusion varies according to channel, source and content.

d) Market selection and segmentation - this involves identification of the characteristics of potential adopters and their division into homogenous sub groups. On the basis of those characteristics pricing and promotional communications have to be different for each market.

The market structure of the innovation generating industry is an essential element in the diffusion process (Stoneman 1987). The market structure of the suppliers will have a bearing on its price and the price will positively influence the suppliers and negatively affect the adopters. Thus the price of the innovation become a vital determinant. The number of suppliers is an important factor influencing diffusion. The more the suppliers, faster will be the diffusion (Mansfield 1968, Gort and Klepper 1982). The subsidy provided by the state, the expenditure incurred by the government or private agencies for communication flow, R & D etc., will also have an important influence (Stoneman 1987).

Griliches (1960) attributes the regional variation in adoption of hybrid corn to the availability of hybrid seeds in different regions. The innovators or the seed producers marketed the seed in those areas, where the expected profitability was higher.

The Economic History Perspective

The two diffusion perspectives examined above adopt a static approach to innovation in the sense that it assumes innovation to remain essentially the same throughout the diffusion process. It also assumes that the innovation is developed outside the adopters' environment. But, the innovation is a dynamic process implying continuous technological improvement and adoption to an increasing variety of uses, leading to adoption by an increasingly wider range variety of uses, leading to adoption by an increasingly wider range of places, persons and enterprises. As Rosenberg (1976 pp.73) puts it: "much of the literature on innovation diffusion simply assumes the existence of a profitable invention and then goes on to try to account for the lag in its adoption. Attention then naturally focuses on such factors as characteristics of potential adopters, flaws in communications net works, imperfect information flows, ignorance, attitudes towards risk, uncertainty, social and cultural factors producing "resistance to change" etc. Though they are important, the fundamental question is whether or not a profitable innovation exists or not .... The potential profitability of an invention, in turn, involves a careful examination of the cumulation of small technical improvements of the invention overtime, their implications for altered performance characteristics in economic terms and as a result, a cost comparison of the new technology with alternative technology already available". The economic history perspective treats innovation as a continous process and thus, brings into focus another dimension of the supply side. Even after the innovation has taken place and the diffusion process has started the technique is liable to be modified further - often as a result of experience gained in actual commercial operation. These further modifications are aimed at reducing or eliminating faults or disadvantages arising in application thus widening the scope of application, and increasing further the relative advantage of the new technique over the one it superseded. Thus the successive stages often overlap and the line of demarcation between them is blurred (Ray 1974).

The above view is also held by Brown (1981). As he puts it ".....innovation is a continual process whereby the form and function of innovation and the environment into which it might be adopted are modified throughout the life of innovation and these changes affect both the innovation and its market".

Innovations to be commercially viable need improvements to cater to the needs of the various sub markets. As a result, the distinction between innovation and diffusion is not sharp. Improvements are taking place after the initial introduction, taking the responses from the adopters. Thus we do not have the sigmoid diffusion curve for the same product or process in the strict sense since the product or process is continually being improved. Thus, "we need to approach this whole area of research with clearer appreciation of the continuance of inventive activity running from initial conceptualisation (the Eureka! I have done it stage) to establishment of technical feasibility (invention) to commercial feasibility (innovation) to subsequent diffusion. By concentrating attention upon sharp discontinuities associated with major inventions, we are misrepresenting the manner in which the gradual growth in the stock of useful knowledge is transformed into improvements in resource productivity" (Rosenberg 1972).

For example, Griliches (1957) explained the reasons for late adoption of improved corn in certain regions to the delay in the development of corn adaptable to those regions. Hybrid corn was not a single invention adoptable everywhere. Therefore, hybrid corn suitable to each region had to be developed.

The continuity of innovation delays the diffusion process. The expectation of improvement may delay the adoption. Likewise, with the development of a new technology the old technology may be improved. The expectation of improvement in the old technology may adversely affect the diffusion of the new technology. Expectations in improvement in quality and fall in price of the innovation will delay diffusion. Economic historians consider the following issues as important in understanding the process of diffusion.

a) Improvements in Invention after their first Introduction

Most innovations are relatively crude and inefficient at the date when they are first recognised as constituting innovation. They are badly adopted to many of the uses to which they will be put. Therefore, they give only little advantage over the previous one i.e., existing technique. Diffusion under such circumstances will be slow, because clear superiority of the new technique over the old one has not yet been established or perhaps, because the new technology or process alters the quality of the final product in unfortunate and unpredictable manner (Rosenberg 1972). The subsequent improvement in innovations will reduce the cost considerably. Therefore, subsequent improvement will have a strong impact on the rate of diffusion.

Based on the evidence from the petroleum refining industry it is pointed out that improving a process contributes even more to technological progress than does initial development. The improvements may find new uses for the innovation. Thus there is difficulty in predicting the use to which a thing will be put in future. This difficulty might have played an important role in slowing down the pace of diffusion.

Transition to a new technology is often slowed by extreme difficulty of breaking away from old forms and embracing the different logic of a new technique or principle.

b) Development of Skill Among Users

For effective exploitation of the new technology the development of human skills is important. There is a learning period and the length of this varies with the complexity of new technology and the extent to which it is novel. The use of the new technology may necessitate a break with the past and time is an important factor in this regard. Since it takes time to acquire new skills, it takes time to establish the superiority of the technology over the existing one. The slow initial diffusion is also due to this. The manner in which the skills are acquired is a relevant factor influencing the speed of diffusion. Large component of skill cannot be transferred through formal education or printed matter but requires the physical presence of qualified personnel. "Learning by using" begins only after the products or techniques are used.

c) The Development of Skills in Machine Making

Successful diffusion of inventions depends on the growth in the capacity to devise, to adopt, and of course to produce at a low cost invention which has highly specialised end uses. Many inventions have to sit on the shelves due to the absence of appropriate mechanical skills, facilities and design and engineering capacity required to translate them with a working reality.

d) Complementaries

A given technology, however useful, cannot fulfil its potential unless other complimentary inventions reduce or avoid various constraints which would otherwise hamper the diffusion. Therefore, a single innovation cannot be a complete innovation. Before the benefits of a new technology can be realised many other accommodations are needed. Rosenberg (1972) cites the example of growth of rail with the development of air brake and automatic couplers.

e) Improvements in `Old' Technology

Another important factor which influence the slow diffusion a new technology is the improvement in the `old' technology with the innovation. This postpones the introduction of the new technology. The rate of diffusion of the new technology is affected by the formers improvement.

f) Diffusion and the Institutional Context

Institutional factors such as public policy influence the pace at which the process of innovation takes place. These factors are treated as exogenous factors. Rosenberg (1972) says ".... productivity of any technology is never independent of its institutional context".

Perspectives on Technology - A Comparative Overview

The three major diffusion perspectives, namely, the adoption perspective, market and infrastructure perspective, and the economic history perspective provide us with certain crucial elements for a more comprehensive view of the innovation diffusion process. While the adoption perspective approaches the issue of technology diffusion from the demand side, the market and infrastructure perspective views it from the supply side. The economic history perspective may be broadly viewed as a variant of the infrastructure perspective, in the sense that, it views the technology diffusion as a dynamic process wherein the incremental improvements in the technology are treated as important. On the whole, these three approaches are not contradictory but complementary. For example, these perspectives provide alternative explanations for the `S' shape of the diffusion curve (Brown 1981). The sociologists will explain this in terms of the innovativeness characteristics or resistance to adoption. Economists would resort to profitability condition. The market and infrastructure perspective would attribute this to propagator and diffusion agency strategies. Finally, the economic historians will attribute the slow initial rate of diffusion to the time needed to improve the innovation and adopt it to a variety of potential markets or uses as well as delays and caution in adoption to the extent that such improvements are anticipated (Brown 1981).

For the 'band wagon' effect, similar alternative explanations can be given. The adoption perspective would link it to the lowering of the resistance to adoption through demonstration effects, social interaction and other communications and variance in the diffusion rates to different resistance level for each innovation. The market and infrastructure perspective would see this as the result of success of the activities of the diffusion agencies. The economic historian would attribute, it to the development of skill among users, development of complementaries, and the improvements effected in the innovation itself. (Brown 1981).

More specifically, the economic history perspective complement both the market and infrastructure and adoption perspectives. On the supply side, the time at which a particular innovation is adopted or improved for a given use, market or set of potential adopters has a direct bearing on where and when the innovation will become available and hence adopted. This is likely because adaptation is generally a location specific process. This explanation pertains to the availability of the innovation and thus complements the market and infrastructure perspective.

Section 2

Diffusion of Fuel Efficient Chulah-Towards an Analytical Framework

On the whole, no single perspective could, unequivocally, be considered as capable of explaining the innovation - diffusion process. However the three perspectives put together provide the broad contours of an analytical framework. More specifically, the relative usefulness of different perspectives would vary according to the nature of innovation. Drawing inferences from the different perspectives discussed earlier we may identify the following factors as relevant in influencing the innovation diffusion of fuel efficient chulahs.

There are significant differences between the industrial technologies and rural domestic technologies such as chulah. One major distinction is in terms of the source of generation of technology on the one hand and the character and motivation of actors involved in the innovation diffusion process on the other. In the case of industrial technologies the generator and the user of technology need not necessarily be different. There are thus many instances in which technology originates in the firm which is also the user of technology. Even if the technology is not generated by the firm, it will be capable of at least making minor or major changes in the technology to suit the technology to its specific requirements. On the contrary, in the case of fuel efficient chulahs, the users have hardly any role in the generation of technology. Also the households which are the users of technology may be incapable of adding any adaptation to it. Coming to the motivation behind innovation, it may be noted that generation of industrial technology is mainly guided by profit motive whereas profit considerations do not appear important for either the users or the generators of rural technology like improved chulahs. Further, the decision maker in the household where the chulah is to be adopted is normally man who has least involvement in the kitchen and thus not a direct beneficiary of many of the advantages of the stove.

The interaction of the following four sets of factors seems to determine the pattern of diffusion which we shall discuss below.

A. Characteristics of Technology

1 Level of fuel efficiency
2 Other benefits
3 Price of chulahs
4 Durability
5 user adaptability
6 Maintenance and repair needed

B. Characteristics of Users

1 Financial status
2 Access to information
3 Education
4 Gender of the user
5 Type of dwelling
6 Type of fuel used
7 Cooking practices

C. Macro Environment

1 Fuel wood scarcity
2 Price of firewood
3 Availability of other fuel
4 Price of other fuels

D. Institutional Context

1 Voluntary agencies
2 Area of operation
3 R & D
4 Motivating potential users
5 Infrastructure for repair, extension, evaluation
6 Approach to diffusion
7 Training

Characteristics of Technology

As we noted the Parishad chulah, the popular model in Kerala, have a fuel efficiency of over 22 per cent as compared to the open stoves efficiency of 8 - 15 per cent. The chimney attached to the stove keeps the kitchen smoke free. The diffusion is influenced by the extent to which a new technology meets the user requirements in comparison to the old. Innovations giving financial benefits spread rapidly, while those providing non financial benefits will diffuse only slowly (Bina 1986). The fuel saving of the stove positively influences diffusion but it is realised only by those who purchase it. Therefore, the diffusion may be higher among those buying firewood. But, it has to be remembered that, most users are outside the monetary sector in this regard. If the benefits are non-monetary the diffusion is much more complex, significantly influenced by factors such as cultural traits, education etc.

User adaptability is an important characteristic which facilitates easy diffusion. The cooking habits in different regions may vary and also the types of fuel used. Hence, if the new technology is adaptable to the type of fuel it may augment the process of diffusion. In some places, space heating is as important as cooking and some may find smoke useful in drying rubber, copra etc. Small improvements may greatly influence diffusion. Need for frequent repair and maintenance cost will adversely affect diffusion.

User characteristics

The positive influence of the characteristic of new technology could, however, be offset by the adverse material conditions of the users. The material conditions of the potential users are different which may have an important bearing on diffusion. Majority of the poor people are unable to spare even hundred rupees for an improved stove. The above problem could be further compounded by the lack of access to information education. Generally, technology which favours women is attached less priority, particularly when the decisions involving finance are made by the men. Failure of many chulah programmes has often been attributed to this gender aspect (Bina 1986).

The Macro environment

The environment in which the new technology has to diffuse is another factor that needs to be considered. The fuel scarce areas where the prices of firewood is high are a fertile area for the diffusion. Availability of other fuel substitutes and their prices influence the extent of chulah adoption.

The institutional Context

In the diffusion of rural technologies governments and the Non Governmental Organisations (NGOs) have an important role to play. The subsidy provided by the government facilitates the adoption even by those who can ill afford it at a market price. Extension and monitoring done by the government or by the NGOs facilitate rapid diffusion. Training imparted to the chulah workers and fund provided for R&D are other important factors. The approach of NGOs in diffusion of improved stoves is crucial. A top down approach (centre periphery model), where the promoters are superior and the adopters are passive inferior receivers of the innovation, is likely to fail. A participatory approach where the users are also involved in the process and their views are also considered is helpful to the spread of rural technologies. Co-ordination in the activities of the governments and voluntary agencies involved is essential.

On the whole, the macro environment wherein the fuel wood scarcity and increasing fuel price along with the energy saving characteristics of fuel efficient chulahs tend to induce the process of diffusion. This positive influence could, however, be offset by non-financial nature of benefits and by the user characteristics which involves the lack of purchasing power and lack of information. One has to examine the limitations imposed by the chulah in its use. Again, poverty of the user, nature of dwelling, type of fuel used etc. are important issues to be addressed in this context.

The role of institutional framework, more specifically, the role of the diffusion agencies assumes added significance. The strategies adopted by the diffusion agencies could lead to differing levels of access to the innovation depending upon the potential adopters economic, social and locational characteristics. Thus, the where and when of diffusion agency establishment could provide the general outlines of the diffusion pattern. Further, the diffusion agency strategy elements and various conditions of diffusion that offset their orchestration into an integrated strategy would provide considerable insight into the spatial pattern of diffusion.

NOTES

1. In machine making industry, a new machine may be a new product of one industry but at the same time it may be a new process for another industry using it. In some cases both are introduced simultaneously.

2. Intra firm diffusion is the intensive use of the technology with in the firm, and inter firm or intra-industry diffusion is the spread of the technology among the firms in the industry.

3. Utility (relative advantage) of an innovation refers to the degree to which it is perceived of useful and advantages by the users. Compatibility is the degree to which it is in agreement with ideas, values and practices of society. Complexity is the relative difficulty to understand the nature and use of an innovation. Communicability (observability) is the degree which the use and result of an innovation can be observed and communicated to others. Divisibility (Trialability) is the degree to which on innovation can be tried out in small scale before making adoption.

4. Rogers and Shoemaker 1971

Variables determining Rate of Adoption	Dependent variable to be explained.
I Perceived attributes of Innovation (a) Relative advantage (b) Compatibility (c) Complexity (d) Trialability (e) Observability	
II Types of innovation decision (a) Optional (b) Collective (c) Authority	Rate of Adoption of Innovations
III Communication channels (eg. mass media or inter personal)	
IV Nature of social system (eg. modern or traditional norm degree of communication integration	
V Extent of change agents Promotion efforts	

Type of innovation decision implies, whether official collective or authority. Authority implies that decision is taken by one authority. Here more rapidly it spreads, depending on the perception of the individual. Collective decision making makes diffusion difficult, since majority has to be convinced of it. Optional is next to authority.

CHAPTER 3

SPATIAL PATTERN OF DIFFUSION

We have already noted that the diffusion performance of the chulahs during the last seven years since the adoption of the programme has been very poor. Only 3.6 per cent households in Kerala has installed the improved chulahs.[1] Even this has not been uniform throughout the state. There are significant regional variations in the installation of improved stoves. The primary aim of this chapter is to bring out sharply the above regional difference and attempt to understand the underlying factors responsible. Such an analysis, it is hoped would give us important insights into some of the supply and demand side factors that exert influence on the diffusion of improved chulahs. We shall specifically examine the following four factors which could have influenced demand. Firstly, the natural geographical divisions could usefully be taken as a proxy for broad vegetation pattern and composition of household fuel basket. The nature of the fuel traditionally used may influence the demand for improved chulahs depending upon the latter's technical features. Secondly, the inter regional firewood prices may be taken as relative cost of fuel. One can expect that the demand for chulahs, which are energy efficient would be higher in regions with higher firewood prices. Thirdly, we shall also consider the inter regional differences in the literacy and the adoption rate. The assumption is that higher literacy would facilitate greater awareness of technology and hence higher adoption. Fourthly, we shall examine the regional differences in the price of chulah due to differential rate of subsidies on the rate of diffusion.

Section 1

Inter Regional Difference in the Incidence of chulah Adoption.

Table 3.1: District-wise Distribution of Stoves at the end of March 1991.

Districts	Total chulah	Percentage	Diffusion@ rate	Range of rate of adoption in taluks Max - Min
Thiruvananthapuram	29243	13.9	5.95	5.3-0.9
Kollam	13193	6.3	3.28	3.1-1.0
Pathanamthitta	8042	3.8	3.48	3.1-0.3
Alappuzha	14774	7.0	4.63	5.8-1.1
Kottayam	12959	6.0	4.32	3.8-1.1
Idukky	20442	9.8	11.06	34.0-2.3
Ernakulam	11827	5.6	2.69	3.9-0.9
Thrissur	18478	8.9	4.48	7.6-1.3
Palakkad	16432	7.9	4.47	5.1-1.9
Malappuram	12097	5.8	3.29	3.5-1.5
Kozhikode	6784	3.2	1.87	2.0-0.5
Wayanad	18638	8.9	18.09	26.4-2.8
Kannur	11983	5.7	4.02	5.5-2.4
Kasaragod	15455	7.7	10.75	10.2-0.5
Total	210347	100	4.8	34.0-0.26

Source: ANERT, Progress Report, various years.

* Chulah installed from 1985-86 onwards only was considered. In 1984-85, a total of 1748 chulahs were installed in Kerala. For the portable, district-wise data is available only from 1988-89. 2235 portable chulahs had been installed during three years prior to this. Thus total chulah installed was 214330. For the maximum and minimum rate of adoption only fixed chulahs have been considered.

@ Diffusion rate has been worked out on the basis of 1981 census data on number of households. The ratio of 3.6 quoted earlier is on the basis of estimate for total number of households in Kerala for 1990-91.

We shall first examine the regional distribution of installation of chulahs in Kerala. In terms of absolute numbers Thiruvananthapuram has the highest share of 13.9 per cent of total chulahs installed. Idukki and Wayanad are seen to follow the rank order. Kozhikode is in the bottom with 3.2 per cent share.

An analysis of regional difference in terms of absolute number is not meaningful, since there is difference in the size and population of different districts. A realistic comparison is possible only by relating it to a common denominator. Therefore, in our further analysis, the incidence of adoption of chulah is expressed as a ratio of total chulah to number of households in district or taluk. In this way among the districts Waynad has the highest rate of diffusion of 18.09 per cent followed by Idukki. Kozhikode continues to be at the bottom of the rank order. (See Column 4 Table 3.1).

However it is felt that district is too large a geographical unit to bring out the variation in the rate of adoption of chulahs as can be seen from Column 5 of Table 3.1. Within each district, there is a wide range in the incidence of chulah adoption between the taluks. The variation is particularly marked in Wayanad and Idukki districts that rank highest in the rate of diffusion. In Idukky district, Devicolam taluk has an incidence of 34 per cent whereas Peermed taluk has only 2.3 per cent. Similarly in Wayanad district, Manthavady taluk has a diffusion ratio of 26.4 per cent while, Vythiri has only 2.8 per cent. In general, the range of variation in the adoption rate is greater within the districts than between them.

Therefore, in the rest of our analysis, we shall be adopting taluks as our unit of analysis. It must be admitted that the taluks are also administrative division that cut across ecological and economic zones. But we have to be satisfied with this because adequate data is not available at the village level. Another limitation is that data on distribution of portable and community chulahs are not available even at the taluk level. Therefore, only the fixed family chulah is considered for the taluk level analysis. The taluk data is obtained from the lists of beneficiaries attached to the completion certificates, submitted by the implementing agencies to the ANERT for claiming subsidy. A few lists could not be traced, and in some, the taluks are not mentioned. Such lists are not considered here. Therefore, only 91.4 per cent of the beneficiaries could be identified by their taluk wise location[2] We assume that the beneficiaries in the missing lists are spread across the taluks and hence do not seriously affect the inter-taluk comparison and analysis of rates of adoption.

The list of taluks in Kerala, the number of chulah installed, the ratio of chulah to household, etc. are presented in appendix 3.1. The relative rate of diffusion in each taluk is measured by dividing the total number of chulah in each taluk up to 31st March 1991 by the total households enumerated in the 1981 census.

As can be seen from Table 3.2, 69 per cent of taluks has a rate of diffusion of less than 3 per cent (accounting for 37.66 percentage of chulahs) and another 18 per cent of taluks has rate of diffusion between 3 and 5 per cent (accounting for 21 percentage of chulahs); only 13 per cent of taluks has a greater than five per cent rate of diffusion (accounting for 41 percentage of chulahs). Thus there is a large degree of variation in the rate of adoption of the improved chulah across taluks. The 8 top ranking taluks account for 41 per cent of the chulahs installed.

Table 3.2: Frequency Distribution of Taluks and Chulahs by Rate of Diffusion

Diffusion Ratio	No. of taluks	% of taluks	No.of chulah	Percentage
Less than 1%	9	14.7	3808	2.78
1 - 2 %	18	29.5	24772	18.07
2 - 3 %	15	24.6	23061	16.82
3 - 4 %	10	16.4	26347	19.22
4 - 5 %	1	1.6	2665	1.94
5 - 10%	5	8.2	28585	20.84
Above 10%	3	4.9	27870	20.33
Total	61	100	137108	100

* Only fixed chulahs are considered.

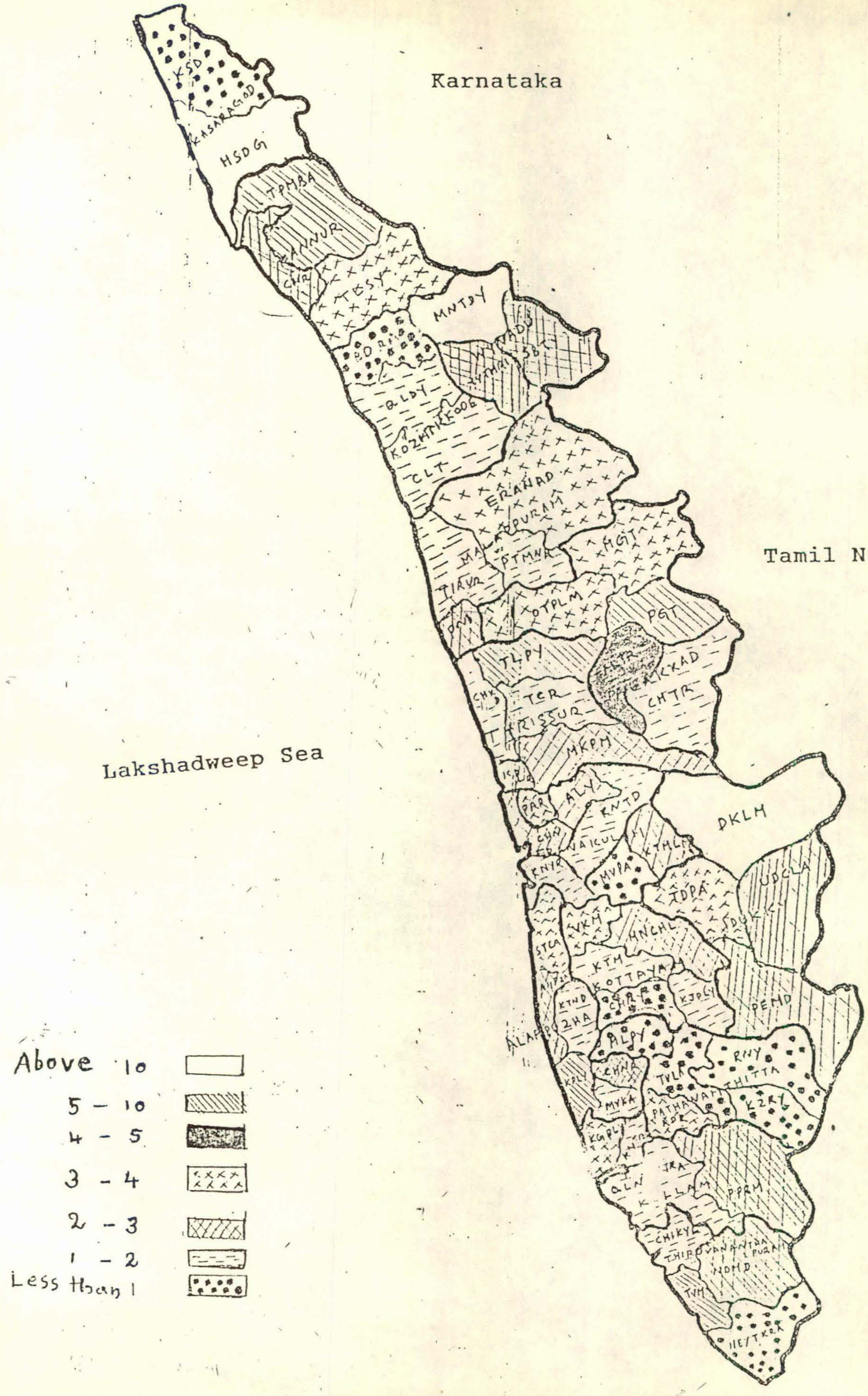
Section 2

Geographical Division and Diffusion

Topographically the state can be divided into three natural regions - the low land skirting the Arabian sea, the high land bordering the Western Ghats and the midland lying in between. In the coastal belt the lands are plains with paddy and coconut as the major crops. Its total area comes to 3979 sq. km. The hilly region is characterised by steep hills and deep valleys, and is covered with dense forest, tea, coffee and cardamom estates. The total area is 18654 sq.km. The midland is of undulating terrain of smaller hills and valleys. All the valleys have been made into paddy field and higher lands for cash crops like pepper, tapioca, fruit tree and rubber. The area estimated is 16231 sq.km.

The data presented in appendix 3.1 has been depicted in Map 3.1. The taluks have been graded into 7 groups depending upon the incidence of chulah adoption. It has to be admitted that the map apparently does not reveal any systematic pattern of the regional

Map 3.1 : Map Showing the Spatial Diffusion Ratio



diffusion of chulahs. However, when the data is tabulated as in Table 3.3 and 3.4 a pattern does emerge. The 31 hilly taluks are those that have been declared hilly by authorities, qualifying them for special incentives in chulah programme. Rest of the taluks have been divided by us into coastal and midland, depending on their geography. It may be noted that this three fold division of taluks does not fully correspond to the natural geographical division. This is particularly true of hilly taluks. Some of them extend into the midlands and even to the costal plains. This limitation may be borne in mind during our subsequent discussion.

Table 3.3: Distribution of Taluks by Rate of Diffusion and Geographical division.

Region\ Diffusion ratio	Hilly	Coastal	Midland	Total
Above 10	3	-	-	3
5 - 10	2	2	1	5
4 - 5	-	-	1	1
3 - 4	5	2	3	10
2 - 3	9	4	2	15
1 - 2	7	5	6	18
Less than 1	5	1	3	9
Total	31	14	16	61

The Table 3.3 shows that the average incidence is higher in hilly taluks. Majority of the taluks with a relatively higher rate of diffusion falls within the hilly region. Thus of the 8 Taluks having adopted more than 5 per cent, 5 are in hilly tracts. As a result the average adoption rate in the hilly region is 3.51 per cent as against 3.09 per cent at the state level (Table 3.4).

Table 3.4: Region-wise Rate of Chulah Diffusion

Region	Total household	Total chulah	Diffusion ratio
High land	2238418	78488	3.5064
Mid land	1075633	27587	2.5647
Coastal	1118027	31033	2.7756
Total	4432078	137108	3.09

But equally striking feature is the existence of low diffusion taluks even in the hilly taluks (See Map 3.1) for example there are five hilly taluks where the diffusion ratio is less than 1 percent. Also, in the coastal region where the diffusion rate is relatively low, there are 2 taluks with more than 5 per cent. In the midland region also, the intra divisional variation in chulah adoption ratio is sharp.

Thus, there are two issues to be explained (a) the inter divisional differences in the diffusion rate and (b) intra-divisional differences in the diffusion rate.

The Resource Endowment and Rate of Diffusion

We have already noted that the vegetation pattern and consequently the fuel composition varies between geographical divisions. The highlands with abundance of forest and waste woodlands is better endowed with fuel wood. In contrast the fuel wood is relatively scarce in the densely populated and intensively cultivated coastal plains. In the midland, by products of tree crops and various agrowastes would be relatively more important source of fuel. The micro level study in 3 villages by Balachandran (1983) indicates the relation between the fuel types used and the resource endowment of the geographical division. (See table 3.5).

Table 3.5: Energy from Different Types of Fuel Materials as a Percentage of total NCE consumption

Name of Village	Firewood	Coconut products	Others including agro wastes
Puliyur (Hilly)	62.03	32.53	5.45
Kunnummel (non hilly)	42.63	45.37	12.00
Puthiyathura (non hilly)	48.97	48.57	2.45
All villages	51.2	41.4	7.4

Source: Balachandran (1983 pp.101)

In Puliyur, a village in Nedumangad Taluk (hilly) near to a forest, the firewood availability is higher. Firewood meets 62 per cent of the domestic energy requirement. While it is 42 and 48 per cent respectively for Kunnummel and Puthiyathura in the other two villages. Coconut products is a relatively more important source of energy in the midland and coastal taluks.

A major weakness of the Parishad chulah is that it can produce best results only when splints of firewood are used as fuel. Utilisation of the agrowastes is difficult given the small opening of the fire chamber. Further, the Parishad chulah is installed on a raised platform and therefore the fuel feed has to be cut into convenient length that can be accommodated on the platform. Therefore, it is difficult to use any coconut leaf ends, an important source of fuel byproduct of coconut, in Parishad chulah, unless some one holds the former till it burns down to convenient length. One may speculate if the regional difference in the fuel composition and the above limitation of Parishad chulah have any correlation. Parishad chulah diffusion would be better in region that predominantly use firewood splints as fuel.

But one should not stretch this argument beyond a limit because even among the hilly regions there are taluks with very low rate of adoption. The higher ratio is confined to a few taluks such as Devicolam, Mananthavady and Hosdurg. Likewise, a number of the coastal and midland taluks have high rates of diffusion. Given the wide intra divisional differences it is even debatable if it is a meaningful exercise to derive regional averages of diffusion rate at all.

Firewood Prices and Rate of Diffusion

The relative scarcity of firewood is reflected in the relative price. The average price of firewood in the hilly taluks in the first quarter of 1989 was Rs.532 as against Rs.615 in coastal taluks. But as we have seen it is hilly taluks with lower firewood price that have recorded the best performance. Regional difference in the firewood price seems to exert little influence on the diffusion of chulah. The taluks in Table 3.6 have been classified on the basis of the level of firewood prices in the first quarter of 1989. The number of taluks in each price bracket according to the rate of diffusion is also given.

Table 3.6: Diffusion Rate and the Price of Firewood

Rate of Diffusion\ Price of firewood in Rs\tonne	Above 10%	5-10%	4-5%	3-4%	2-3%	1-2%	<1	Total
300 - 400						1		1
400 - 500				3	2	4	3	12
500 - 600	1	1		6	5	8	4	25
600 - 700		4	1	1	5	4	1	16
Above 700	1					1	1	3
NA								4
Total	2	5	1	10	12	18	9	61

Note: Price data for four taluks could not be obtained.

The higher diffusion rate of over 10 per cent, as well as the lowest rate of less than 1 per cent, are both seen in the taluks with highest price bracket of over Rs.700 per tonne. In general, higher firewood price is not associated with a higher rate of adoption.

Thus, regression coefficient for the price of firewood and rate of adoption of chulah shows a poor dependence.

x Coefficient = 0.003376; R^2 = 0.006935

Literacy and Rate of Diffusion

Higher literacy may favour better diffusion, since it generates better awareness regarding the characteristics of the technology.

Table 3.7: Literacy rate and Diffusion rate

Adoption rate\ Literacy rate	Above 10%	5-10%	4-5%	3-4%	2-3%	1-2%	<1	Total
50 - 55				1		1	1	3
55 - 60	3		1		2	1		7
60 - 65		1		2	2	1		6
65 - 70		2			2	2	2	8
70 - 75		1		2	4	6		13
75 - 80		1		4	2	3	1	11
80 - 85				1	3	4	5	13
Total	3	5	1	10	15	18	9	61

The above table reveals no relationship between literacy rate and the rate of adoption of chulahs. The regression coefficient between these shows a statistically not significant negative value

x coefficient = -0.20979; R^2 = 0.127587

But linking the literacy rate at the macro level will not say much especially when the overall spread is rather low. Only a field study may be able to reveal the true relationship.

The Time Factor and Rate of Diffusion

The programme was initially introduced in 20 taluks in 1984-85 and it had spread to all the taluks by 1987-88. Naturally one may expect a better rate of diffusion in those areas where it had been started earlier due to the neighbourhood effect.

Table 3.8: Time of Introduction and Diffusion Rate

Diffusion rate Year of Introduction	Above 10%	5-10%	4-5%	3-4%	2-3%	1-2%	<1	Total
1984-85		3		6	6	4	1	20
1985-86	2			4	6	9	4	25
1986-87	1	1				4	3	9
1987-88		1	1		3	1	1	7
Total	3	5	1	10	15	18	9	61

The above table suggests the fact that the year of inception is not relevant to the rate of adoption. Out of the 20 Taluks in which the programme started in 1984-85 only 3 taluks have a rate of adoption of 5-10 per cent. In one taluk the rate is less than

1 per cent, though the programme had started there in 1984-85. But two taluks out of nine taluks, where the programme started in 1986-87, have over 5 per cent rate of diffusion. The year of inception of the programme does not seem to influence the pattern.

Table 3.9: Year of Inception and Spatial Pattern

Natural division Year	Hilly	Midland	Coastal	Total
84-85	11	6	3	20
85-86	11	6	8	25
86-87	4	2	3	9
87-88	5	2	0	7
Total	31	16	14	61

No sharp variation is found among the, three divisions as regards the time of introduction (See table 3.9). Compared to the coastal regions the chulah programme had been initiated earlier in hilly taluks in 1984-85.

The Price factor and the Rate of Diffusion

Table 3.10: Price of chulahs in Kerala

Type	Cost Rs.	Subsidy Rs.	User Contribution (Rs) SC,ST	Hilly	Others
Parishad 11 (Fixed)	150	55	95	95	95
Parishad 21 (Fixed)	160	65	95	95	95
Gamini* (Portable)	135	75% & 50% of cost	33.75	33.75	67.5
<u>Special Scheme</u>:					
IREP					
Parishad 11	150	140	10	10	10
Parishad 21	160	140	20	20	20
Estate) Scheme) Coir Village)					
Parishad 11	150	150	0	0	0
Parishad 21	160	160	0	0	0

* Local taxes extra.

An important point that has to be borne in mind while examining inter regional differences in adoption rate is the inter regional variations in the price of chulah or the cost that has to be incurred by the user in installing it. As can be seen from table 3.10, there is substantial subsidy paid on each chulah by government. Subsidy works out to be about 35 per cent for Parishad Model 11 and 40 per cent for Parishad Model 21, so that the actual beneficiary pays only Rs.95/- for installing a fixed chulah. The subsidy for portable chulah is 75 per cent for users belonging to SC/ST and hilly region, while other users receive 50 per cent cost as subsidy. Thus there is a difference in the subsidy rates of portables. But for the fixed models it is same for all the users.

Besides the above normal subsidy schemes, there are special schemes in which the stoves are virtually supplied freely. Thus in the blocks selected under IREP, the user has to pay only Rs.10 for parishad 11 and Rs.20 for Parishad 21 model. Even this nominal contribution is done away with in the case of special programmes like those run by Tata Tea Estate for their workers in Devicolam taluk. A close examination shows that almost all the taluks with high incidence of chulah diffusion are taluks where some special programme or other are being implemented. All the eight taluks with diffusion rate of more than 5 per cent have some special scheme,the only exception being Thalipparamba . The high incidence in Thalipparamba is due to the concerted efforts made by the local units of KSSP. The Devicolam taluk that achieved a diffusion rate of 34 per cent is entirely due to the implementation of programmes in the Tata Tea Estate. If the taluks with special programmes are not considered the inter taluk variation sharply comes down.

The above discussion points to the need for a closer scrutiny of extension schemes and agencies. But the very low over all adoption rate raises questions regarding the actual performance of the chulahs and the role of extension agencies which we shall discuss in the next chapter.

NOTES

1. The ratio of 3.6 is obtained by dividing total number of chulahs on 31st March 1991 by the total number of households.The approximate number of households estimated on 31st March 1991 was 5900000.

2. ANERT sends the monthly and yearly progress report of the programme to the DNES, and from that, it is learnt that 150036 fixed (family type) chulahs had been installed up to March 31st 1991. Here we could trace out only 137108 stoves.

CHAPTER 4

The Performance of the Chulah

When a new technology embodied in a product is being introduced, the perception of actual users is very important in understanding the pace and pattern of diffusion. Certain problems with the stoves may be the major constraint on their adoption. The performance of the chulahs has to be proved in the kitchen. In many cases, the actual fuel saving in the kitchen may be much less than that obtained in laboratory conditions. The inconvenience in using a new chulah, although it provides many advantages, may limit diffusion. Frequent breakdowns which necessitates repair may keep the potential users away from adoption. Thus, it is very essential to understand the user reactions to the new chulahs. The success of the chulah programme depends to a great extent on the ability to adapt the technology to the feed back received from users.

We did not conduct any primary survey of users. However, we shall be utilising the primary information collected by two agencies. The first one is the KSSP survey, which was conducted in 1988. The survey was done by the KSSP activists at the unit level. It covers almost all the chulahs installed by KSSP till then. It was not a well structured questionnaire, and was intended to collect a few items of information. But in the column for remarks, the problems, if any felt, were noted. The information is extracted here by going through each of the entry in the schedules. The survey schedules for two districts - Thiruvananthapuram and Alappuzha - only were available.

Second is the data collected by ANERT, for 1990-91, which contain the information noted in the completion certificates submitted by various implementing agencies. The data contain details of 48.6 percentage of fixed chulah and 10.7 percentage of portables installed during this period. But it covers 86.5 percentage of the fixed chulah installed by KSSP, 83.3 percentage by Pazhakulam Social Service Society (PASSS) 68.5 percentage by Welfare Services and 57.3 percentage by other agencies. Only 0.5 percentage of the fixed chulah, installed under IREP, is covered in the sample. Detailed discussions with the implementing agencies and users and other studies are used to supplement the information from the above two sources of data.

Section 1

Fuel Efficiency

We shall first examine the record of the chulahs with regard to the fuel efficiency, which is considered as the major advantage of improved chulah. The efficiency claimed for parishad chulah is over 25 per cent (Report, KSSP, 1985). This has been more or less verified by tests conducted at Engineering college in Thiruvananthapuram[1]. However it is a well known fact that the laboratory results may not be obtained in the kitchen and the actual fuel efficiency may be lower than what is officially claimed.

Jas Gill (1987) observed that many stove programmes failed because the advantages of these over the traditional chulahs were not very much. In many cases they were not smokeless. Another reason he cited was that the improved chulahs emphasised fuel economy, while rural people were more interested in stoves that allowed speedy cooking. Thus the importance attached to the characteristics of the stove by the user and the promoters may be different. Shaller (1979) has given the instance of the Lorena stove in Guatemala which was made of sand and clay. It claimed 50 per cent of fuel saving and less smoke. The stove had many advantages but in practice it was a failure in conserving fuel .

There has been however, no accurate field testing of the chulahs with respect to fuel efficiency. Only experiment in this direction that we know of is that by ASTRA. ASTRA chulah is a three pot mud stove, has a percentage heat utilisation of 40 in laboratory conditions (ASTRA 1987). But this stove in the field showed that average fuel saving was only 19 percentage and in certain regions it showed negative saving[2]. There have been a number of studies that have attempted to ascertain the user perception regarding the fuel efficiency of the stoves. The limitation of this method is obvious. Madhu Sarin has surveyed the results of such studies on chulah programme in various parts of India. We have tabulated the relevant data regarding user perception of fuel efficiency of Nada chulah (See table 4.1).

Table 4.1: Estimation of Fuel Consumption by Users

Users Estimate of Fuel consumption	Madanpur village (Haryana)		Haripur and Tabar (Haryana)		Madanheri (Punjab)		Total	
	No	%	No	%	No	%	No	%
More	3	12	9	36	7	33	19	27
Same	2	8	11	46	5	24	18	25
Less	21	81	4	17	9	43	34	48
Total	26	101	24	99	21	100	71	100

Source: Adapted from Madhu Sarin (1986) PP 1713, 1714, 1715.

There are significant inter village differences in the estimate. But it is note worthy that, on the average, 27 per cent of users felt that the improved stoves needed more fuel, compared to the traditional stoves. Only 48 per cent observed saving of fuel. The surveys conducted by Tapar Polytechnic in Patiala, which has been designated as the technical backup support agency for the Punjab government, indicated similar picture in terms of fuel consumption in Punjab (Madhu Sarin 1986)[3].

The above studies reveal that in actual practice, the fuel efficiency of a significant proportion of improved chulah's is far below the official claims. Shaller (1979) observed that the main reason for the lower fuel efficiency obtained for the Lorena stove in Guatemala was due to the user adaption of the stove. The removal of the fire box door and the dampers and use of firebox as an oven were some of the adaptation made by the users, which reduced the fuel efficiency. This instance demonstrates the need to incorporate the requirements and views of the users without which rapid diffusion is impossible.

The poor performance in fuel efficiency in actual kitchen practice does not seem to be an important problem of the Parishad chulah propagated in Kerala, Ramabhadran (1991) observes, "feed back on fuel wood saving shows 20-30 per cent in domestic type and 30-40 per cent in community chulahs". In the KSSP survey, although it was not a question directly asked to the users, only 10 (0.23 per cent) reported more fuel consumption which were noted in the remarks column. Again, all the chulah owners interviewed accepted that there was discernible fuel saving.

Removal of Smoke

An important advantage of Parishad chulah is its removal of smoke from the kitchen. The stove has to be properly constructed and maintained to achieve it. In the KSSP survey, only 32 (1.44 per cent) households reported the problem of smoke in the kitchen. Discussion with the stove owners revealed their satisfaction with the performance of the chulah as regards the removal of smoke. This characteristic had been emphasised as the major reason by many users for their adoption of the chulah. Madhu Sarin (1986) reported that many stoves promoted during the NPDIC had the problem of smoke mainly due to the faulty construction. In the evaluation of ASTRA stove also, leakage of smoke was seen among 25 percentage of the chulahs. The results obtained for the Parishad chulah in this regard were better than observed elsewhere in India.

Thus the performance of Parishad chulah, as regards fuel saving and removal of smoke has been quite up to the mark. In short it would not be incorrect, therefore, if we conclude that the divergence of field experience from laboratory results, that are often described in many other parts of India, doesnot appear to be significant in Kerala.

The Use Status of Chulahs

An objective indicator of the users' effective adoption of the improved chulahs is the proportion of chulahs that are actually used. The experience in many parts of India showed that the stoves are often demolished or only rarely used. The status of utilisation of Nada chulah installed in different states, during the NPDIC, was found to be far from satisfactory (See Table 4.2).

Table 4.2: Use Status of Stoves in different villages

Villages Use Status	Haryana State Madanpur		Haripur and Tabar		Daon		Punjab Madanheri		Himachal Pradesh different villages			
	No	%	No	%	No	%	No	%	No	%	Total	%
Broken	10	29	1	4	7	27	4	17	198	53	225	46.6
Not used atall	1	3	4	15	-	-	-	-				
Used for 6 months	9	26	13	50	12	45	12	52	27	7	88	18.2
Used most of the time	5	15	2	8	3	12	5	22				
Used all the time	9	26	6	23	4	15	2	9	149	40	170	35.2
Total	34	99	26	100	26	99	23	100	374	100	483	100

Source: Adapted from Madhu Sarin (1986) PP. 1711, 1713, 1714, 1715.

The stoves used `for all the time' were only 35.2 percentage on the average for the three states, whereas 46.6 percentage of the stoves was not used.

In Gujarat, Self Employed Womens' Association (SEWA), a NGO, was asked by the Forest department to install improved chulahs. They installed 8000 chulahs with the sanctioned money. A survey of 180 chulahs after a few months showed that 60 (33 per cent) had either been broken or converted into traditional chulahs. The chimneys of 65 (36 per cent) chulahs had been removed. Only 55 (31 per cent) chulahs still had their chimneys and were in use. Not even one of the chulah owners reported fuel saving (Madhu Sarin 1986).

The evaluation of ASTRA stove showed a better utilisation rate compared to other parts of India. (See Table 4.3). The rejection rate (proportion of stoves not used plus demolished) was only 20 per cent.

Table 4.3: Use Status of ASTRA Stove

Catagory of households	No.of stoves built	Stoves in use No	%	Number of stoves not in use	Number of stoves demolished	Percentage of stoves rejected
	1	2		3	4	3+4/1 x 100
SC/ST	1332	987	74.1	229	116	25.9
Other Castes	869	765	88.04	65	39	11.95
Total	2201	1752	79.6	294	155	20.4

Source: Evaluation of ASTRA stove programme (1988) PP.7

Nearly 80 percentage of the ASTRA stoves was utilised, but there existed difference in the rate of utilisation between SC/ST and others. This variation indicates the fact that the socio-economic factors are relevant in the use of the stoves. The KSSP user survey helps us to assess the use status of stoves installed in Kerala. One point that may be kept in mind in this context is that the entire sample is drawn from chulahs that were installed by KSSP. The conclusions may not be fully valid for other agencies.

In Table 4.4, we have presented data on use status of chulah installed in 9 taluks in Thiruvananthapuram and Alappuzha districts (See Table 4.4).

Table 4.4: Use Status of Chulahs in Taluks

Taluks	Total surveyed	Full use without complaint	Percentage	Full use with complaint	Percentage	Part use	Percentage	Not used	Percentage	Demolished	Percentage
Thiruvananthapuram	355	304	85.63	20	5.63	7	1.97	9	2.53	15	4.2
Neyyattinkara	401	273	68.08	22	5.49	20	4.99	36	8.98	50	12.5
Chirayinkil	492	371	75.41	54	10.97	12	2.44	23	4.67	32	6.5
Nedumangad	998	701	70.24	120	12.02	42	4.21	65	6.51	70	7.0
Karthikappally	500	325	65.0	2	0.4	37	7.4	65	13	71	14.2
Cherthala	960	796	82.91	53	5.52	30	3.12	39	4.06	42	4.4
Ambalapuzha	332	255	76.81	20	6.02	15	4.5	28	8.4	14	4.2
Kuttanad	182	144	79.12	2	1.09	12	6.59	13	7.14	11	6.0
Chengannur	90	71	78.88	8	8.88	4	4.44	2	2.22	5	5.5
Total	4310	3240	75.17	301	6.98	179	4.15	280	6.5	310	7.2

The percentage of chulah reported no complaint was 75 per cent and was in full use. Another 7 per cent of the stoves was in full use but registered complaints. Thus as many as 82 percentage of the stoves was in full use. The percentage of the chulahs demolished had been 7.2, and 6.5 percentage was not being used. Thus the percentage of stoves rejected constituted 13.7 per cent. But it has to be noted that nearly 1 per cent of the stoves was not used or demolished due to the change of house or kitchen ie., not due to any problem with the chulah. Thus the actual percentage of chulahs not used and demolished ie., rejected constituted 12.7 per cent of chulah installed. Percentage of the chulahs partly used was only 4.1 per cent. Karthikappally in Alappuzha district and

Neyyattinkara in Thiruvanathapuram district recorded the lowest percentages of stoves in full use without complaint, namely 65 per cent and 68 per cent respectively. Only 66.6 per cent of the stoves in these two taluks functioned without complaints. Thiruvananthapuram and Cherthala were the two Taluks which had a highest proportion of chulahs without complaints. The percentage of stoves without complaint in these two taluks was 86.8. The rate of demolition was higher in Karthikappally, (14.2 per cent) followed by Neyyattinkara (12.5 per cent). The percentage of stoves not used was also high in Karthikappally (13 per cent). Neyyattinkara ranked the second place in this respect also. These, taluks accounted for the higher rejection rates of the stoves.

Nature of complaints

In Table 4.4, we noted that 24.8 percentage of the stoves had various complaints. Table 4.5 shows the nature of complaints.

Table 4.5:The Nature of Complaints

Taluks	No.of Chulah surveyed	No.of Chulah with complaint	No.of Chulah specified complaint	Nature of Reported Complaints					
				Technical	Use of other fuels	Change of house or kitchen	Difficult to clean	Psychological	Others
1	2	3	4	5	6	7	8	9	10
Tvm	355	51 (14.3)	34 (66.6)	30 (88.2)	1 (3.0)	1 (3.0)	-	-	2 (5.9)
Ntka	401	128 (31.9)	58 (45.3)	39 (67.2)	4 (6.9)	4 (6.9)	-	2 (3.4)	9 (15.5)
Ckl	492	121 (24.6)	74 (61.2)	65 (87.8)	3 (4.1)	2 (2.7)	-	-	4 (5.4)
Ndd	998	297 (29.7)	201 (67.7)	176 (87.6)	-	17 (8.4)	-	1 (0.5)	7 (3.5)
Kply	500	175 (35)	76 (43.4)	51 (67.1)	6 (7.9)	9 (11.8)	3 (3.5)	-	7 (9.2)
Ctla	960	164 (12.7)	106 (64.6)	97 (91.5)	-	2 (1.9)			7 (6.6)
Amza	332	77 (23.2)	65 (84.4)	47 (72.3)	-	6 (9.2)	2 (3.1)	-	10 (15.4)
Ktd	182	38 (20.9)	28 (73.7)	24 (85.7)	1 (3.5)	1 (3.5)	-	-	2 (7.1)
Chgr	90	19 (21.1)	13 (68.4)	10 (76.9)	1 (7.7)	-	1 (7.7)	-	1 (7.7)
Total	4310	1070 (24.8)	655 (61.2)	539 (82.3)	16 (2.4)	42 (6.4)	6 (0.9)	3 (0.5)	49 (7.5)

*Values in brackets in column 3 are the percentages of the corresponding row in column 2.
** Values in brackets in column 4 are the percentages of the corresponding rows in column 3.
*** values in brackets in columns 5,6,7,8,9 and 10, are the percentages of the corresponding rows in column 4.

It has to be borne in mind that only in the case of 61.2 percentage of the chulahs, the nature of complaints had been specified in the survey registers (See column 4). The proportion also varied considerably between Taluks. In Karthikappally and Neyyattinkara, the percentages of chulahs where the nature of complaints had been specified constituted only 43.4 percent and

45.3 percent respectively. Relatively higher proportion of the installed chulahs ie., 14.2 per cent and 12.5 per cent respectively in these taluks were reportedly demolished and this may perhaps be one reason for the low response to register the complaints. In the case of Ambalapuzha, the nature of complaints was specified in 84.4 per cent of the cases.

Technical problems constituted 82.3 percentage of the complaints specified. Surprisingly the percentage of technical faults recorded were low in the case of two taluks, Karthikappally and Neyyattinkara. However it may be remembered that in these two taluks the percentage of the nature of complaints specified was also very low. The lower percentage of specification of the nature complaints might have influenced this result. Highest proportion of technical faults had been reported from Cherthala (91.5 per cent) followed by Thiruvananthapuram (88.2 per cent), which had been the taluks with lower percentage of complaints. Change of house or kitchen was the major cause of demolition or non use of the chulahs. Some of the people were not using the stove since they had been using LPG or kerosene. This catagory constituted 2.4 per cent of the reasons reported. A very small fraction of the users (0.5 per cent) had pschological aversion to this new cooking device.

Miscellaneous complaints consisted of 7.5 percentage of the complaints and the reasons reported were such as(a) water in to the kitchen through the chimney (b) difficulty to drain rice[4] (c) difficulty in using large splints of firewood (d) lesser space in the kitchen due to the installation of stove (e) difficulty in using larger or smaller pots[5] (f) worn out grating/reducer etc.

Nature of the technical complaints

In 93 per cent of the cases the information on the nature of the technical complaints is also available. Table 4.6, shows the major types of technical complaints recorded.

The most frequent technical complaints was regarding the mould. In 70 per cent of the cases the mould was broken. Smoke in the kitchen was the other major complaint accounting to 12 per cent of the technical complaints. Some found it difficult to start the fire. Increased fuel usage had been reported by 2 percentage of users. There were other miscellaneous technical problems such as use of smaller pipes, no cowl for the chimney or broken baffles etc.

In Ambalappuzha, Cherthala, and Neyyattinkara the problems of broken mould recorded were relatively low. In the latter two taluks the problem of smoke was relatively higher.

Table 4.6: Technical Problems of the Chulah

Technical Complaints Taluks	No.of chulah with Tech.facts	No.of chulah specified complaint	Broken mould	Broken pipe	Smoke	Diffi- cult to start to file	More fuel	Others
Tvm			(5.6)	-	(1.4)	(0.3)	(0.3)	(0.3)
	30	28	20	-	5	1	1	1
		(93.3)	(71.4)		(17.8)	(3.6)	(3.6)	(3.6)
Ctla			(3.7)	(0.4)	(1.5)	(0.8)	(0.3)	(1.8)
	97	81	35	4	14	8	3	17
		(83.5)	(43.2)	(4.9)	(17.3)	(9.9)	(3.7)	(21.0)
			(6.9)	(1.2)	(0.9)			(3.3)
Amza	47	41	23	4	3	-	-	11
		(87.2)	(51.2)	(9.8)	(7.3)			(26.8)
			(10)					
Cgnr	10	9	9	-	-	-	-	-
		(90)	(100)					
			(9.7)		(2.8)	(0.4)		(0.2)
Chrl	65	65	48	-	14	2	-	1
		(100)	(74.0)		(21.5)	(3.1)		(1.5)
			(14.6)	(0.3)	(0.6)	(0.7)	(0.1)	(0.7)
Ndgd	176	172	148	3	6	7	1	7
		(97.8)	(86.0)	(1.7)	(3.5)	(4.1)	(0.6)	(4.1)
			(7.1)		(1.1)	(0.5)	(2.7)	
Kttd	24	21	13	-	2	1	5	-
		(87.5)	(62.0)		(9.5)	(4.8)	(23.8)	
			(6.8)		(1.4)	(0.6)		(0.8)
Kply	51	48	34	-	7	3	-	4
		(94.1)	(70.8)		(14.6)	(6.3)		(8.3)
			(4.7)	(.3)	(2.7)	(1.0)		(0.3)
Ntkra	39	36	19	1	11	4	-	1
		(92.3)	(52.8)	(2.7)	(30.5)	(11.1)		(2.7)
			(8.1)	(0.3)	(1.4)	(0.6)	(0.3)	(10)
Total	539	501	349	12	62	26	10	42
		(93.0)	(70)	(2.4)	(12.4)	(5.2)	(2.0)	(8.4)

* Values in brackets in column 3 (shown bottom) are the percentages of the corresponding rows in column 2.

** Values in brackets in column 4,5,6,7,8 and 9 (shown bottom in each column) are the percentages of the corresponding rows in column 3.

*** Values in brackets shown at the top of each cell are the percentages of the total chulah surveyed in each taluk

Table 4.7: Technical Problems and Use Status.

Technical faults User Status	Broken Mould	Broken Pipe	Smoke	Difficult to start fire	More	Others fuel	Not tioned	Total men-
Full use	179	8	49	13	3	32	5	289
Partuse	78	2	-	1	1	1	8	91
No use	81	3	4	5	2	3	23	121
Demolished	11	1	7	7	4	6	3	39
Total	349	14	60	26	10	42	39	540

Use status and technical problems depicted in table 4.7 did not establish clearly any particular problem specific to the use status. Major reasons for demolition of stove, apart from broken mould, seem to be smoke and difficulty to start fire. An important reason for part use and no use is broken mould. In the full use catagory also the major problem is that of broken mould.

The major technical problems of the Parishad chulah observed were, the broken mould, leakage of smoke and difficulty (or delay) in starting fire. Mould may break due to the low quality of the mould or the problems with the installation or careless use of the stove. Once KSSP brought clay linings from Tamilnadu. The chulahs proved to be susceptible to breakage due to poor quality of linings and the remaining linings had to be destroyed[6].

If the various parts of the stove are not well connected or packed properly the stove may break. Careless use of the stove may be another cause of the breakage. Putting large splints into the stove, use of large pots on the stove etc. may break the mould.

The problem of smoke can arise either due to faulty installation or due to failure to follow proper cooking practices. Block in the connecting pipe, height for the baffle, deposits of soot in the chimney, failure to close the auxiliary pot hole while cooking and putting excessive amount of firewood etc can cause smoke in the kitchen.

For the new chulahs some delay or difficulty to start fire initially may be felt. It normally takes one week for the stove to function smoothly. If this problem persists it may be due to the problem with the construction itself. The above said problem may also arise if the angle of the connecting parts is not exact.

The quality of the lining, the proper construction, and use of the stove etc. are important to derive the maximum efficiency. Therefore care has to be taken both by the stove promoters as well as the users. The implementing agencies should be quick in attending to any of the problems experienced by the users. The users have to be properly educated since this is a new process of cooking.

The Chinese experience with the biogas plant will be interesting and useful in this context. In China during 1958-70, a massive programme of construction of biogas plant was launched. The quality of the plant was not important for them and only quantity was considered. A later survey showed that majority of plants was not used because they were not in conformity with the standards. But from 1980 onwards they started making plants strictly based on specific standards and it showed an impressive result. But many households who had the plant earlier were reluctant to adopt the new one because of their earlier bitter experience with it (Daxiong, et.al 1990). This means that, for a rural technology to diffuse, specification standards have to be strictly adhered in the improved technology.

Having examined the use status of the stove we shall now examine the socio-economic status of the users. This will also indirectly give important insights into the status of non users and probable reason for the slow rate of diffusion.

Section 2

The Socio-Economic Status of Users

A study done by Ramabhadran (1991) showed that, the level of adoption of the chulah by the poor people was rather low. The distribution of the users of stove by economic status is given in table 4.8. Our sample consists of 22671 users whose chulahs were installed in 1990-91.

Table 4.8: Spread of Chulah by Income Class

Annual Income/ in Rs Chulah type	Less than 1000	1000-2000	2000-3000	3000-5000	5000-10000	10000-25000	Above 25000	Total
Parishad 21	936(4.9)	3513(18.3)	2881(15)	3893(20.3)	6415(33.5)	1283(6.6)	231(1.2)	19152(100)
Parishad 11	53(16.45)	125(38.8)	50(15.5)	22(6.8)	34(10.3)	27(8.4)	11(3.4)	322(100)
Gamini (Portable)	275(9.2)	944(31.7)	662(22.2)	455(15.3)	426(14.3)	196(6.6)	23(0.8)	298(100)
Priyagni (Portable)	1			1		2		4
Missing	22	34	35	34	54	20	16	212
Total	1287(5.7)	4616(20.4)	3628(16)	4405(19.4)	6926(30.5)	1528(6.7)	281(1.2)	22671(100)

* Values in the brackets are row percentages.

Annual income has been classified into seven groups. The following points may be noted: (a) the share of the lowest income group of families with annual income less than Rs.1000 and higher income groups with annual income above Rs.10,000 in the total number of chulahs installed is low at 5.7 percent and 7.5 per cent respectively (b) The income group with annual income of Rs. 5000 - 10000 accounts for the highest share of around 30 per cent of chulahs installed. (c) The spread of parishad 11 model is not very popular and the majority of it was installed in poorer households. The parishad 21 model had shown a greater acceptance amongst the high income groups. (d) The spread of the portable models was also low among the high income group.

Roof type and Family Income

A serious draw back of the above remarks are the unreliability of information regarding the income status of the users. We do not know what care was taken to ascertain the actual income of users while filling up the subsidy form. In most case the income stated in the ration cards, which is ill famous for their under statement, has been used. An added problem is that the under statement of income may not have been uniform across regions as, at least, in the case of income status of users in the Tata Tea Estate that constitutes 35 per cent of the users in the sample. The information on income has been provided by the employers and therefore there is little likelihood of any severe under estimates.

Table 4.9: Type of Roof and Income Class

Roof/ Annual Income in Rs.	Asbestos AC	Concrete	Grass	GI	Palmyrah	Tiles	Missing	Total
<1000	174	80	8	6	192	802	25	1287
1000-2000	131	251	50	45	468	3606	65	4616
2000-3000	412	289	34	45	198	2585	65	3628
3000-5000	1631	306	16	119	124	2164	45	4405
5000-10000	4741	427	3	184	64	1472	35	6926
10000-25000	243	496	1	29	29	726	4	1528
Above 25000	45	116	1	13	4	101	1	281
Total	7377	1965	113	441	1079	11456	240	22671
Percentage	32.5	8.7	0.5	1.9	4	50.55	1	100

The possibility of such inconsistency is very well brought out by the table 4.9 that presents distribution of user households by annual income and type of roofing of their house.

Majority of the households with palmyrah and grass roofing belonged to the lower income classes of less than Rs.2000/- per annum. The proportion of palmyrah and grass roofing is also seen to decline with the rise in the income bracket. The share of the concrete houses owned by the lower income classes is relatively lower.

But what is significant to note is that 17 per cent of the concrete houses are in the households with income less than Rs.2000 per year! The proportion of houses with concrete roofing do not reveal any trend with respect to the income of the family. Again it is seen that nearly 70 per cent of the households with annual income of between 5000 - 10000 has asbestoes roofing. Most of the estate coolie households thus seem to constitute middle income group.

In the light of the above finding it may be more accurate to take the type of roofing as a proxy for income. Grass and palmyrah to constitute the lowest income group, followed by asbestoes roofed houses, tiled houses and concrete houses in the ascenting order. A higher percentage of the GI roofing among the high income two classes, was also mainly due to the roofing in the Tata Tea Estate.

Roof Type Chulah Spread

Table 4.10: Chulah Type by Roof

Roofing Chulah type	Gross	Palmyrah	Tiles	Asbestos	GI	Concrete	Missing	Total
Parishad 21	101	808	8711	7294	402	1695	141	19152
Parishad 11	5	58	167	9	16	55	12	322
Gamini	5	203	2459	33	2	200	79	2981
Priyagni			2		1	1		4
Missing	2	10	117	41	20	14	8	212
Total	113	1079	11456	7377	441	1965	240	22671
Percentage	.5	4.8	50.5	32.5	1.9	8.7	1.1	100

We find that half of the improved chulahs was installed in the houses with tiled roof (see table 4.10). The percentage of improved chulah installed in the houses with grass, was 0.5 percentage. The share of chulahs installed in palmyrah houses, was 4.8. Percentage of the stoves installed in concrete houses constituted 8.7 per cent. About 1/3 of the chulahs was in the houses with asbestos and/or GI roofing. According to the 1981 census the roofing of the 46.5 per cent of the houses was with ie., grass, palmyrah, bamboo etc. The rest of the households used tiles, asbestoes, concrete etc. for roofing. But share of the chulah installed in houses with grass and plamyrah roofing constituted only 5.1 per cent. The very low diffusion among the households with grass and palmyrah roofing, shows that, the spread of this technology is low among the poor. The spread among the households with concrete roofing was also low, but higher than households with palmyrah and grass roof.

Income of the households seems to be an important determinant in the adoption of the chulah. The adopter has to pay the price of the chulah and for the poor people it is difficult to pay Rs.100 for the purpose. The space in the kitchen may also be another important limiting factor. Installing a fixed chulah will take away much space from the already small kitchen of the poor. For the installation of the stove, a platform is required and the kitchen of the poor does not have it. Construction of a new platform may not be feasible.

Parishad 21 model is popular among the users. Only 0.4 percentage of the households with asbestos roofing adopted the portable model, in contrast to the 21.5 percentage of the house with tiled roofing. The reason is that, most of the asbestos roofed houses are in the hilly region of Tata Tea Estate, where the fixed chulahs were freely installed. The diffusion of portables among the houses with grass roof was low, only 4.4 per cent. This result is rather surprising as portable model does not require extra space or platform in the kitchen as in the case of the fixed chulah. 93.8 percentage of chulahs was fixed model, and out of this 4.4 percentage was parishad 11 model. Around 75 per cent of the chulahs installed in the houses with palmyrah as well as tiled roofing was fixed models. In the concrete houses, 89 percentage of the chulah installed was the fixed model and 95 per cent for houses with GI roofing. Thus, the portable models have relatively higher acceptance rate among the houses with tile and palmyrah roofing.

Chulah type and User Category

Table 4.11: Chulah type and User Catagory

User Catagory/ Chulah type	Scheduled Caste	Scheduled Tribe	Hilly	Others	Total
Parishad 21	2568(13.4)	1030(5.4)	6345(33.12)	9209(48.1)	19152(100)
Parishad 11	17(5.2)	20(6.2)	9(28.3)	194(60.2)	322(100)
Gamini	20(0.67)	14(0.46)	2787(93.5)	160(5.3)	2981(100)
Priyagni			3	1	4
Missing	11	2	122	77	212
Total Percentage	2616(11.5)	1066(4.7)	9348(41.2)	9641(42.5)	22671(100)

* Values in the bracket are row percentage

Table 4.11 shows the spread of the chulahs among different user catagory. In this table, the distinction between the users is not clear because some of the SC/ST beneficiaries may be living in the hilly region.

The adoption of chulah among the SC was 11.15 percentage of the total. 4.7 percentage of the users of the chulah was ST households. The share of the hilly region in the total chulah was 41.2 percentage and the other catagory had 42.5 percentage.

The percentage of fixed chulah installed by the households in the hilly region was 69 percent of the total. 97.5 percentage of the chulahs adopted by the other user catagory was fixed models. The relatively higher rate of adoption of portable models in the hilly region was due to the higher subsidy given in that region. Although SC and ST households were also eligible for a higher subsidy for the portables, their adoption rate was low. The reason might be their inability to pay even the low price. A relatively higher proportion of fixed chulah adopted by the SC/ST category of users might be mainly through the free installation of chulahs by special programmes.

To sum up our discussion in the present chapter while the performance of the chulahs has been on the whole satisfactory, it was not devoid of certain problems, both technical and non technical which called for adaptive changes in the technology. Viewed in this perspective the absence of any substantial efforts towards correcting these problems stood in the way of diffusion process. Our analysis of the socio economic characteristics of users have pointed towards some interesting aspects: The technology has hardly diffused among the upper and lower income groups; while the access to substitutes would have prevented the diffusion among the upper income group, the cost to be incurred for installing the chulah would have made it difficult for lower income group to adopt.

NOTES

1. Fuel efficiency test for various models (in laboratory conditions) conducted by Engineering College, Thiruvananthapuram in 1986 showed the following results for the smokeless models.
   KSSP 11 - 22 per cent
   KSSP 21 - 24 per cent
   KSSP 12 - 26 per cent
   Magan (Portable) 14.5 per cent
   Settlement 7.5 per cent
   (A private firm) (Source ANERT)

2. Evaluation of ASTRA stove (1988) showed a fuel saving of 19 per cent over the traditional stove, on the average, in the field test. The saving of fuel in different regions showed sharp variation. The saving was maximum in the Ragi zone (34 per cent). The fuel saving was less significant in the Jowar zone (18 per cent). Rice zone, in contrast showed a completely different result and the ASTRA stove was seen consuming more fuel (23 per cent) more than the traditional.

3. According to one survey conducted in 1985, of 805 chulahs, 35.4 percentage of users reported increased fuel consumption. In another survey of the 2882 chulahs 57.6 percentage of the users reported increased fuel consumption.

4. The traditional stoves are used as a support for the pot for draining rice

5. Smaller pots can be used in the improved chulah with the use of a reducer, which is made of cast iron

6. In Sri Lanka, the early effort of the Sri Lankan Sarvodaya Shramadan Movement, a non political organisation, to diffuse chulahs failed due to the problems with the stove. The chulahs were not durable - most stoves were broken within a short time because it was made with mud. Later they developed a chulah with fired clay inner lining which was durable and it was well accepted by the people (Navaratna H.1985).

CHAPTER 5

The Diffusion Mechanism

Thus far, we have examined interregional differences in the rate and pattern of diffusion of the improved chulahs in Kerala and some of the explanatory factors like the characteristics of the technology, characteristics of the users and the macro environment. In terms of the analytical framework that has been specified in chapter 2, what remains to be examined is the institutional context of technology. Here, our focus of analysis is on the role of various agencies which is expected to play the rôle of a catalyst in the diffusion process.

In India, prior to NPDIC, the improved chulahs were popularised by the voluntary organisations, in different parts of the country. The intervention of the government was a great stimulus to this programme, and large number of chulahs were installed all over the country, thereafter. In Kerala, the programme was started in 1984, and the State Committee on Science and Technology (STEC) was the nodal agency. Initially, KSSP, Rural Development department and the Forest department were the implementing agencies for fixed chulahs and the Kerala State Civil Supplies Corporation for the portable chulahs.

Section 1

Structure of the Diffusion Mechanism

ANERT, a separate agency, was made the nodal agency in 1986, which is also engaged in the development and diffusion of other non conventional energy sources. The R&D backup unit is the Centre for Applied and Fundamental Research (CAFR) of the Engineering College, Thiruvananthapuram.

The target for the state is fixed by the DNES. The State Government/Union territory/nodal agencies are at liberty to involve voluntary agencies. Implementing agencies are required to split the overall targets assigned to them region wise and month wise, giving preferences to fuel scarce areas and special target groups such as SC and ST population.

The functions of ANERT

The chulah programme is only one of the activities of ANERT, and we shall discuss only those related to the chulah programme viz.

1. co-ordinating and supervising the activities of the implementing agencies.
2. training the self employed workers (SEWs) and potters.
3. channelling the subsidy.
4. publicity and
5. direct installation of chulahs.

Each implementing agency has to register it's name with the ANERT. It co-ordinates the activities of the various agencies and undertakes sample physical verification of the chulahs installed. It sends monthly and yearly progress report to the DNES.

ANERT gives training to the potters who make the inner linings. Training is also given to the SEWs to install the chulah. Successful SEWs will be given a certificate and a code number which has to be noted in the completion certificate submitted to claim subsidy. Only trained workers are allowed to install chulahs. The implementing agencies can sponsor the trainees according to their requirements. Training camps are held in different parts of the state.

ANERT channels the subsidy to the users through implementation agencies. The subsidy is released only when the implementing agencies or SEWs produce the completion certificate.

Creation of awareness is the crucial element in the diffusion of rural technology like the improved chulah and thus publicity and user education are an integral part of the programme. The usual modes of publicity are advertisement in news papers, pamphlets, exhibition, wall calender etc. Local meetings are held for user education. Wall calenders specifying the appropriate chulah practices and maintenance are distributed. 4 per cent of the chulah cost is used for publicity and user education.

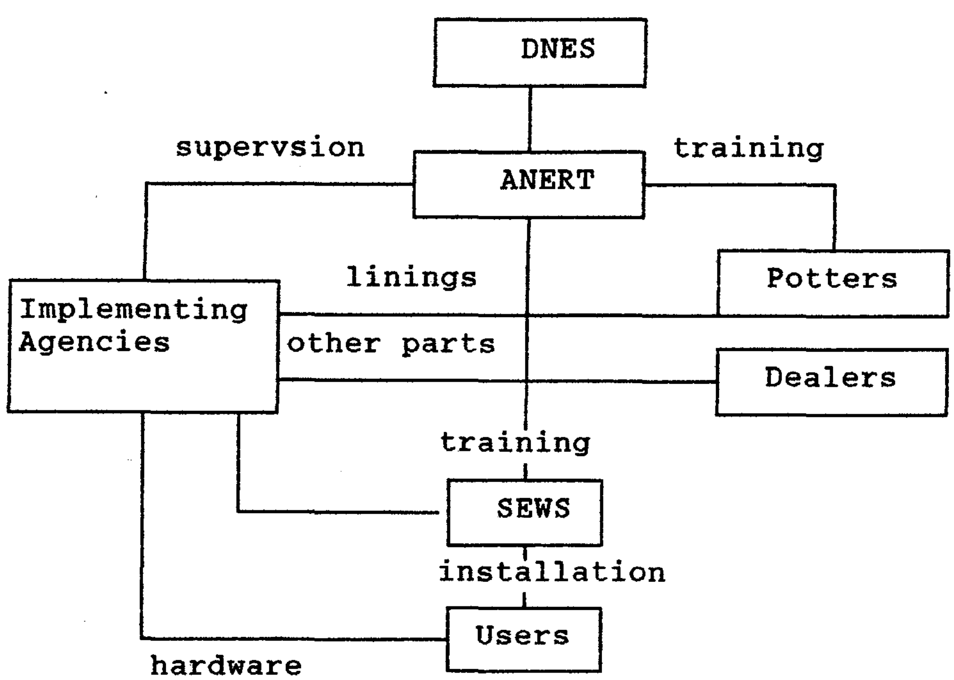
Direct installation of chulah is also done by ANERT. However, the total number installed has been very small.

Implementation Agencies

The structure of chulah implementation is decentralised with coordination and supervision by ANERT. Any agency is free to cooperate with the programme. The SEWs of these agencies are trained by ANERT. Thus, every agency has their own SEWs. Earlier the training camps of SEWs were also conducted by the agencies which were financed and supervised by ANERT. At present ANERT directly organises the camps. The different parts of the stoves are procured by the agencies themselves. The inner linings are procured mainly from the potters in Kerala. But some of the agencies procure them from Tamil Nadu. The asbestoes pipe, bricks grating etc., are bought from the dealers by the agencies. The beneficiary has to transport these parts, at his own cost, from the centres at which the agencies stock the parts to the kitchen. The chulahs are installed by the SEW of the agencies. Some agencies collect the price of the chulah excluding the subsidy from the user at the time of installaltion of the chulah or registeration of their names. While others collect the full cost and reimburse the subsidy later when they realise it from ANERT. The subsidy will be released by ANERT to the agencies only after the presentation of the completion certificate duly signed by the beneficiary.

The above discussion of the structure of the diffusion mechanism is summarised in the chart below.

Figure 5.1. Chart Showing the Diffusion Mechanism



Section 2

An Analysis of the Implementation Agencies

The NGOs have been playing an important role in popularising the improved chulahs. As the number of agencies involved in the programme increases, the spread of the chulah may improve. However, the number of agencies that are involved in the programme has tended to decline. Even among the surviving agencies only a few are actively involved. There has been also a decline in the number of chulahs installed by some of the leading voluntary organisations.

The implementation agencies may be broadly categorised into five types:

a) Kerala Sastra Sahitya Parishad, the leading implementation agency, is a unique people's science movement with a network all over Kerala and may be considered as a type in itself.

b) The other science or non formal education movements or organisations such as Kerala Association for Non Formal Education and Development (KANFED) and Desiya Sastra Vedi that have regional contacts and influence may be considered as a second type.

c) Welfare or charitable societies or voluntary organisations mostly confined to operations within a region and do not have wider ideological perspectives as of the former two. Pashakulam Social Service Society (PASSS) and Welfare Services (WS) are examples of this type of agencies.

d) Some of the educational or technical institutions like polytechnics etc. also undertake extension work in their surroundings.

e) There are also a number of locality based voluntary associations such as mahila samajam, clubs etc.

f) Finally, of late, governmental agencies such as block development/IREP offices are also playing an important role in diffusion.

Table 5.1 shows the share of important agencies in the programme.

Table 5.1: Agency Wise Achievements

Agencies\Year	1984-85	1985-86	1986-87	1987=88	1988-89	1989=90	1990-91
KSSP	1500	3201	1923	18099	17737	14100	10255
PASSS			665	1066	5005	10601	8642
Welfare services				224	2198	1980	1555
Desiya Sastravedi			60	431	560	1757	591
Peermed Development Society				230	503	793	1204
Others	248	544	1817	1274	2901	1368	2153
IREP							
Wadakkancheri					167	2487	2089
Athiyannoor						2427	3584
Mananthavady						3835	3761
Nileshwar						1506	3830
Pattanakkad							106
Devicolam							500
Palakkad							788
Areekode							1130
ANERT - Direct						59	178
Total	1748	3735	4425	21324	29071	40913	40366

Source: Agency wise achievement report - ANERT - Various years
* a slight discrepancy is seen between the agency wise achievement total and progress report total.
** only family fixed chulah considered.

Kerala Sastra Sahitya Parishad

Kerala Sastra Sahitya Parishad (KSSP) is the largest people's science movement in India with a membership of 57323 and network of 1764 units spread all over Kerala (28th Annual Report- KSSP). The movement has a history of nearly three decades and is engaged in a wide spectrum of activities such as formal and informal education, health, technology adaptation and diffusion, land and water management, housing, environment and so on. The movement seeks to popularise science and create a scientific temper among the people. It is also engaged in developing a theoretical and practical critique of the present practice of science. In the process it also has begun to display a keen interest in evolving and propagating appropriate technologies and developmental alternatives. The high efficiency chulah has been an important area of practical intervention to propagate appropriate technology.

Apart from the social benefits that accrue in terms of conservation of wood, betterment of women's health and economy in domestic expenditure, an important motive of KSSP in undertaking chulah programme has been to utilise the high efficiency chulah as an entry point into rural households for its wider concientisation efforts. Thus awareness creation plays a very important role in KSSP chulah programme. The pre installation meetings of users are a common practice. Chulah lectures that branches off into issues of nutrition, elementary physics and women rights are organised. In certain centres padayatras, house to house campaigns street theatre plays have also been undertaken for awareness creation. KSSP regularly participates in various exhibitions to explain the benefits of the chulah.

Moreover, greater attention is paid to monitor the standard of work of the SEW. Most of the SEWs are parishad activitists themselves and therefore highly motivated cadres. Periodic districtwise meetings of SEWs and state level meetings of key SEWs are held. Further, field inspections including a use status survey the data which we used in our earlier chapter were conducted. The post installaltion visits and services are also often given by local parishad units.

The organisational structure of KSSP has four tiers - state - district - Regional - Local (Unit). The implementation of the chulah programme is mainly the responsibility of the district committees. The chulah sub committee at state level co-ordinates the district units. The purchases are made and stocks are kept at district level and distributed to localities where chulahs are to be installed. The beneficiary has to take at his own expense the hardware of the chulahs from these centres. The beneficiary has to pay the price of chulah less the subsidy, at the time of collection of the parts. The SEWs of KSSP will install the stoves. The user has to supplement the additional labour required and also to provide burnt rice husk, sawdust, clay etc.

KSSP collects the inner linings from the trained potters in different parts of Kerala at wholesale rates. Bulk purchase of iron grates and asbestos pipes is made. In the process there is considerable economies of scale which facilitates a saving which accrues to the local unit of the parishad and the district committee.

The unit level installation is supervised from the district level but the awareness creation and follow up work is undertaken by the local units.

Of late, KSSPs involvement in the chulah programme has declined. The share and also the absolute number of chulah installed by KSSP had declined recently. The share of KSSP declined from 84.87 per cent in 1987-88, 61.01 per cent in 1988-89, to 34.46 per cent in 1989-90, and to 25.06 per cent in 1990-91. It appears to be mainly due to the diversion of Parishad activists to literacy programme in the last two years. It resulted in the general slackness of all other traditional activities of the organisation.

Other Non Formal Education or Science Movements and Groups

Two other science organisations that are involved in the chulah programme are the Desiya Sastra Vedi and Sastra. Desiya Sastra Vedi has mostly been concentrating in Malappuram district while Sastra is active in Cannanore district. Desiya Sastra Vedi has skeleton network in most of the districts but very few active local units. Sastra Vedi has been involved in chulah programme from 1986-87 onwards. Activities of Sastra confined to certain parts of Kannur district.

KANFED is an organisation with fairly good network of full time paid officers at the district level and a relatively large number of activists mostly engaged in non formal education and literacy activities. KANFED has not been very active in chulah programme but has been installing about 500 chulahs every year, mainly in Kozhikode and Kasargod districts.

Charitable and Welfare Societies

The prominent charitable societies with at least regional activities are PASSS and WS. A brief discussion on these are given.

PASSS is a registered charitable society started in 1984 with a membership of 25. It has an executive committee of seven members. President and Secretary are elected from the executive. Its objective is the intervention in the socio-economic development of the rural people. The chulah programme is only one of the activities of PASSS. It's area of operation is whole of the state but, chulah implementation is mainly confined to certain regions.

In 1986-87, the share of PASSS in the total chulah implemented was 15.02 per cent. The share in the following years, were 5 per cent in 1987-88, 17.22 per cent in 1988-89, 25.91 per cent in 1989-90 and 21.43 per cent in 1990-91. A distinguishing feature of activities of PASSS is that it undertakes various chulah schemes sponsored by different agencies such as Tata Tea Estate in Devicolam, Coir villages in Alappuzha. These programmes are large in scale and the hardware is brought in bulk. The pottery linings are bought from co-operatives in Tamil Nadu. These massive programmes have an advantage, because the beneficiaries are already identified by the sponsoring agencies concerned. PASSS does not have prior and post installation contacts with the users. The beneficiary contribution is nil. The beneficiary houses are close to each other and therefore the transportion of the materials and construction are easy.

The Welfare Services (WS) is a church organisation controlled by Ernakulam diocese. Chulah programme is one of its activities. The chulah installation is done by the SEWs of WS in different parts of Kerala, but mainly confined to districts of Ernakulam, Thrissur, and Alappuzha. The programme is implemented with the help of other voluntary organisations mainly related to the church in different localities. The materials are supplied by WS at different locations and the user has to collect it from there. The installation of chulahs sponsored by other agencies are also undertaken.

WS undertakes a limited awareness campaign. Pamphlets are distributed. Small meetings and slide shows etc. are also conducted for publicity and user education.

It installed around 6.81 per cent of the total chulah in 1989-90. However, in 1990-91 the performance of WS was also poor.

Other Institutions and Voluntary Association

The Polytechnics also participate in the chulah implementation programme as a part of their interaction with the community. Carmel polytechnic in Alappuzha and Thyagaraja polytechnic in Thrissur are two of them. But the total number of chulahs installed by them is rather very low. Similarly, the share of the locally based agencies like Mahila Samajam, clubs etc. is also very low. Most of the agencies may dropout from the programme soon.

Government Agencies

Integrated Rural Energy Planning (IREP), a central government sponsored programme, was started in the sixth plan to improve the energy availability in the rural areas. This programme aims at the development of different sources of energy, both conventional and non-conventional, to suit the rural requirement. The implementation of NPIC is one of the important activities of IREP.

The IREP activities are concentrated in selected blocks in India. The first one in Kerala was in Wadakkanchery block in Thrissur district which was started in 1986. In Kerala now there are 8 such blocks spread in 8 districts. The programme may be extended to all districts soon.

In the IREP programme, the user contribution is very low, only Rs.10/- for Parishad 11 model and Rs. 20/- for Parishad 21 model. The scheme is implemented with the help of panchayath committees or voluntary organisations within the block. Publicity for the programme is done through pamphlets, or through panchayath committees. Those intending to adopt the chulah have to register their names with the panchayath/IREP office. The parts of the stoves are distributed at selected centres. The user has to take home things at his own expense. The SEWs of IREP install the stoves.

An interesting feature visible in the chulah programme is that the share of IREP in the total number of chulahs installed in the state is increasing. In 1988-89, the share of IREP was only 0.57 per cent. But there was a dramatic increase in the subsequent years and rose to 39.11 per cent in 1990-91.

Agencies and Diffusion Among Income Groups

Table 5.2, shows the spread of the technology among different income groups, according to the chulah installed by each agencies.

Table 5.2: Agency wise Spread Among Income Groups

Agency\ Income in	Less than 1000	1000 - 2000	2000 - 3000	3000 - 5000	5000 - 10000	10000 - 25000	Above 25000	Total
KSSP	650	2529	1644	1563	1339	1046	205	8976
	(7.2)	(28.2)	(18.3)	(17.4)	(14.9)	(11.6)	(2.3)	(100)
PASSS	384	777	758	1768	5087	324	49	9147
	(4.2)	(8.5)	(8.2)	(19.3)	(55.6)	(3.5)	(0.5)	(100)
W.S	18	283	350	271	112	39	5	1078
	(1.7)	(26.2)	(32.5)	(25.1)	(10.3)	(3.6)	(0.5)	(100)
Others	219	871	706	666	253	75	16	2806
	(7.8)	(31.00)	(25.0)	(23.7)	(9.0)	(2.7)	(5.7)	(100)
IREP	15	155	169	136	135	44	6	660
	(2.2)	(23.5)	(25.1)	(21)	(20.1)	(6.6)	(0.9)	(100)
Missing	1	1	1	1				4
Total	1287	4616	3628	4405	6926	1528	281	22671
Percentage	(5.7)	(20.4)	(16)	(19.4)	(30.5)	(6.7)	(1.2)	(100)

Source: ANERT
(*) Values in bracket are row percentages.

Nearly 50 per cent of the chulahs installed by KSSP, Welfare Services and IREP had been to those having income less than Rs.3000, while more than half of the chulahs installed by PASSS was in the income category of 5000 - 10000.

But as we noted earlier, the income data is not fully reliable, therefore we look into the nature of roofing and the chulah installed by agencies.

Agency wise Spread and Nature of Roofing

Table 5.3: Agency wise Spread and Roofing of Households

Agency\Roof	Asbestos	Concrete	Grass	GI	Palmyrah	Tiles	Missing	Total
KSSP	326	1522	14	107	606	6351	50	8976
	(3.6)	(17.0)	(0.1)	(1.2)	(6.7)	(70.8)	(0.6)	(100)
PASSS	6758	157	2	265	195	1733	37	9147
	(73.9)	(1.7)	(.02)	(2.9)	(2.1)	(18.9)	(0.4)	(100)
W.S	6	143	0	3	42	879	5	1078
	(0.6)	(13.3)	(0)	(0.3)	(3.9)	(81.5)	(0.5)	(100)
Others	271	129	95	66	217	1909	119	2806
	(9.6)	(4.6)	(3.4)	(2.3)	(17.7)	(68.0)	(4.2)	(100)
IREP	16	14	2	0	19	581	28	660
	(2.4)	(2.1)	(0.3)	(0)	(2.8)	(88)	(4.2)	(100)
Missing	0	0	0	0	0	3	1	
Total	7377	1965	113	441	1079	11456	240	22671
Percentage	(32.5)	(8.7)	(6.5)	(1.9)	(4.0)	(50.55)	(1.0)	(100)

Source: ANERT
* Values in bracket are row percentages.

Relatively larger share of the chulah installed by various `other agencies' was among the households with Palmyrah and grass roofing (11.1 percent). 17 per cent of the chulahs installed by KSSP was in concrete houses. The major share of the chulahs installed by PASSS was in houses with Asbestos cement roofing, which was mainly due to the nature of roofing in the Tata Tea Estate. The spread of chulah through IREP among the households with palmyrah and grass roofing was also very low. There does not appear to be any systematic difference between the agencies with respect to the socio-economic status of the users but for PASSS who has large number of plantation workers among their beneficiaries.

Difficulties Faced by Voluntary Agencies

The greater involvement of voluntary agencies has no doubt facilitated the diffusion of the technology to almost all villages in Kerala. However, as we have noted, their activities instead of gaining momentum has tended to decelerate.

An important reason seems to be the financial problem faced by the voluntary organisations. Many of the district level activists of the KSSP also complained of the adequate working capital as a reason for the slackness. In the present mechanism, the subsidy to the voluntary agencies is released by ANERT only after the presentation of completion certificates, signed by the beneficiary which ensures that the chulah has been installed. But the materials needed for the chulahs have to be bought in advance by the agencies and the delay in realising the subsidy creates financial difficulties to the agencies. An alternative has been to collect the full price from the users and reimburse them when the agency receives the subsidy from ANERT. But the additional financial burden is a incentive to the users. In the case of small organisations getting the parts of the store at a competitive price is also a major problem.

Ensuring the quality of the parts of the stoves and craftmanship in stove construction is also difficult. Various agencies get the pottery linings, which is the crucial component of the stoves from different places/states. Therefore the quality of the linings varies. If the quality is not up to the mark, the stove may break soon. Physical verification of all the stoves by ANERT is not possible.

Scarcity of linings is also felt. Only 100 potters have been trained till now. Training of more potters is essential. Production of linings can be reorganised on the co-operative basis in different areas, so that the supply can be ensured. ANERT could procure these and supply these to the agencies involved.

The dropout of SEW is yet another problem. Till now 804 SEWs are trained. It is estimated that 25 per cent of SEWs are not working now. The major reason for dropout is that the programme is unable to give full time employment to most. Therefore, they look out for some other job. KSSP in its 23rd annual report (1985-86) pointed out that although it had trained 340 SEWs only 40 were fully involved in the programme. A SEW is paid Rs.25/- per chulah installed. One can make two to three chulahs a day, if the beneficiary houses are close. If the beneficiary houses are not near to each other a SEW can make only one stove a day. The low remuneration received by the SEW is observed as one of the reasons for the high drop out rate of the SEWs. Dropout of experienced trained worker may adversely affect the quality of chulah installed.

Chulah programme is only one of the many activities of the implementing agencies. Change in priorities of these organisations can also adversely affect the chulah programme. There is no competition between different agencies, as we expect in the case of suppliers of other products. The reason is that there is not much financial profit in the implementation of the stove programme.The price of fixed chulah is sufficient only for the cost of running the programme. If profit is not the motivating force then the commitment of these agencies become more important for the success of the programme.

The operation of different agencies is mostly limited to a particular region the only exception being KSSP. Thus,the spread of the technology is confined to certain regions where the agencies' involvement is active. The greater involvement of more agencies in different parts of the state, is needed for greater even to spread of the technology. As mentioned by Ramabhadran (1991) opening of sales depots for chulah parts by ANERT can attract new agencies also. Such a measure has an additional advantage that the quality of the parts can be ensured.

CHAPTER 6

CONCLUSIONS

Woodfuel, the earliest source of domestic energy, continues to be the major source of energy for cooking for most of the households in the third world countries including India. It is unlikely that there would be any significant change in the use pattern in the near future. The over exploitation of the forest resources and other biomass has made the present pattern of woodfuel use unsustainable. Consequently most of the developing countries are now facing acute woodfuel crisis. This crisis is aggravated by the inefficient use of woodfuel. In Chapter 1 we discussed the nature of domestic fuel crisis and its adverse implications for the welfare of the poor in the third world. Improved chulahs are one of the measures to lessen the impact of the crisis and many countries are now popularising the use of such stoves. The improved chulahs have higher fuel efficiency and thus reduces the pressure on woodfuel sources, economises domestic expenditure or time spent on fuel collection and improves the working conditions in the kitchen with salutary effect on the health of the women.

In India, during the sixth plan the diffusion of improved stoves was made a priority area with the initiation of the Integrated Energy Planning Programme. An ambitious programme of extending the new technology to 100 million households by the turn of this century has been initiated. However, the review reports on the actual implementation of the programme are not very encouraging. It is in this background that our case study of the chulah programme in Kerala assumes importance.

The programme was initiated in the state in 1984-85. It is generally held in the literature that the pattern of technology diffusion takes the form of a logistic curve wherein the number of users increases at an increasing rate initially and later at a decreasing rate. In Kerala, the latter stage has already started without the technology having reached the majority. The number of improved chulahs diffused is low compared to its potential. Hardly 3.6 per cent of the households have adopted improve chulahs. This study has been an attempt to understand the reasons for low diffusion. Given the high dependence of Kerala on woodfuel, the higher incidence of commercialisation of fuel and the relatively higher level of education in the state, we argued that the lessons from Kerala would have special relevance.

In the second chapter we had reviewed the current theoretical approaches to the diffusion of technology. It was felt that the specific features of domestic technologies such as improved chulah significantly departs from the usual industrial technologies whose diffusion has largely been the subject matter of current diffusion literature. We tried to spell out the various elements that are relevant for our study from the existing theoretical approaches. The influence of these factors on the chulah diffusion in Kerala have been examined with the help of primary and secondary data made available by various agencies and our own detailed field enquiries in chapter 3 to 5. We shall now attempt to summarise this discussion. It may noted that our data sources and consequently the analysis pertains to fixed type of models that accounts for 80 per cent of the chulahs installed in the state.

A. Characteristics of Technology

It has often been the experience of many a chulah programme that the claimed fuel efficiency for the stove is not realised in the kitchen. Failure of Lorena stove in Guatemala and experience of chulah programme in north India, reviewed in the literature, were largely due to the above reason (Chapter 4 Section 1). This deficiency may be either due to the technical faults inherent in the chulah or faulty installation and adaptations or inappropriate practices by the user. Parishad chulahs propagated in Kerala was seen to give satisfactory fuel efficiency record in the field as evidenced by our own field enquiries, low percentage of complaints recorded in a major user survey conducted by KSSP and the 80 per cent full utilisation status of the stoves installed. Similarly complaints of smoke omission was also relatively low (Chapter 4 Section 1).

25 per cent of the stoves had complaints of which 7 per cent were in fact demolished. Broken mould was seen to be the most important technical problem with the improved chulah (Chapter 4 Section 1).

The chulah requires a professional fitter but cleaning the pipes and stoves can be done by the users. Once moulds are broken they can be replaced properly only with the help of a trained person. The repair of the stove thus requires outside service and follow up which were seen to be inadequate.

The durability of the stove has not yet been authentically tested, but it was observed that the chulahs upto 4 to 5 years of duration were working properly. But as we noted, the incidence of breakage of moulds is high. It is either due to poor quality of the linings or wrong stove practices by the user (chapter 4 Section 1). The production of mould is undertaken in a decentralised fashion by potters trained by ANERT. The implementing agencies purchase it from the potters. There is no mechanism for ensuring the quality and it results in uneven quality of moulds. We have identified it as an important problem to be tackled if the chulah programme is to succeed (Chapter 4 Section 1).

The chulah is not a very costly instrument but gives the benefits that are largely nonvisible or indirect. Many users are reluctant to pay out an initial sum of Rs.100 or so to install the chulah. Our analysis clearly showed that the regional variation in the incidence of chulah is largely explained by the existence of special programmes in which the chulahs are virtually given free. The price of chulah was seen to be an important factor in the diffusion process (Chapter 3 Section 2). The demand for chulah is higher when the price is reduced. However, we have no knowledge of the use status of stoves that are freely distributed to the users. Our data on use status analysis did not cover special programme schemes.

B. Characteristics of Users

Available evidence points to low diffusion rate of the stove among the poor. Its acceptance is also low among the affluent who have access to alternative fuels (Chapter 4 Section 2). Given the limitation of the income data in self attested consumer statements, we did not go into any detailed analysis of the financial status of the users. But an analysis of the users by roof type yielded interesting results.

Only 5 per cent of the chulahs were installed in houses with grass/palmyrah roofs which is around 45 per cent of the total house in Kerala. But the share of chulah installed in concrete houses constituted 9 per cent (Chapter 4 Section 2). The relative incidence of stoves by roof type reflects the validity of our comments on income status on stove adoption. It is also to a lesser extent a reflection of technical problems in installation of the stove in concrete houses without chimneys or lack of adequate space to build platform necessary for the fixed stoves in the small kitchens of the huts.

No analysis could be undertaken as to the relationship between the education or access to the information of the users and the diffusion rate due to the limitation of data. But given the positive correlation of educational level and income, it is likely that most of the users are relatively better educated. Our discussion with the SEWs revealed that utilisation and maintenance are properly done by those with access to information, which incidentally is not equivalent to higher educational status. Interview with many non adopters of the chulah revealed that they are not well aware of the advantages of the stove. Even the educated did not realise fully the advantages of the stoves.

The relatively higher rate of adoption in the hilly tracts, it was speculated, could also have been due to the relatively higher proportion of wood splints in the fuel basket in these tracts when compared to non hilly regions. Only small splints can be used in these stoves models propagated in Kerala, since the opening to the fire chamber and the platform width is small. Making firewood into small pieces increased use of laboursome process. Further, there is difficulty in using agro wastes like bush, twigs, saw dust, rice husk etc (Chapter 4 Section 1).

C. Macro Environment

Our discussion of the talukwise variation in the incidence of chulah adoption clearly proved that there existed little relationship between regional fuel scarcity and the adoption rate. (Chapter 3 Section 2). In fact the rate of adoption was highest in the hilly taluks compared to the coastal. The hilly taluks are better endowed with fuelwood sources than coastal regions. The price of firewood is not related to the diffusion rate (Chapter 3 Section 2).

D. Institutional Context

The most important point that emerges from our discussion is the vital role of the institutional context in the diffusion programme. Taluks with significantly higher diffusion ratios are all those with special institutional mechanism for diffusion as part of the special programme or with better voluntary organisation intervention (Chapter 3 Section 2). Our survey of the voluntary organisations showed that a wide spectrum of organisations are engaged in the programme from Kerala Sastra Sahitya Parishad with all Kerala network and clearly defined social perspective to locality based welfare organisation like Mahilasamajam (Chapter 5 Section 1). An important finding was the decline of momementum in the interventions by voluntary organisations of late. There is not much monetary incentive for the agencies in the programme. Their motivation would vary with pressures from other committments. It is particularly true of multifaceted organisations like KSSP.

But without a substantial increase in the number of organisations and the existing organisations involving themselves or in more determined manner it will not be able to reach all the potential users. We had discussed the financial constraints that inhibit the voluntary agencies in involving in a large way in the chulah diffusion programme (Chapter 5 Section 2). Substantial working capital is required for economically viable scale of operation.

Our analysis points to the primacy of supplyside factors in limiting the diffusion of stove. The regional variations are not correlated to factors such as relative fuel scarcity or price of fuel. The diffusion rate is basically a function of the efficiency of the extension agency and the extension work. Various technical features of the stove and its price do limit the demand from the poorer sections or from users with specific requirements such as space heating in high ranges. There is urgent need to evaluate the programme and absorb user responses to the stove.

To sum up, our study shows,

a) need for ensuring uniform and better quality for the moulds and R & D efforts to improve the durability of moulds and diversify models;

b) better training and supervision of the SEWs whose financial incentives may have to be raised;

c) an institutional mechanism by which the working capital requirements of voluntary agencies can be reduced either through opening ANERT's own stock yards in various parts of the state or arranging for the stove parts at wholesale rates to established agencies on credit and also an increase in the handling charges now allowed for the agencies;

d) reduction in the price of chulah;

e) better maintenance and repair services and feed back system, and

f) wider and deeper user awareness programme.

APPENDIX 3.1

Taluks, Chulah, Firewood Price, Literacy.

Taluks		Household	Total Chulahs	Diffusion Ratio	Price of Firewood	Literacy
NEYYATTINKARA	*	130909	1195	0.9128	650	66.9
THIRUVANANTHAPURAM		168613	8959	5.3134	650	74.84
CHIRAYANKIL	@	94178	1392	1.4781	600	68.74
NEDUMANGAD	*	97381	2399	2.4635	650	69.24
KOLLAM		139032	2545	1.8305	550	72.98
KOTTARAKKARA	*	90595	1796	1.9824	550	74.24
KARUNAGAPPLY		66120	2076	3.1397	550	72.19
PATHANAPURAM	*	71293	2040	2.8614	550	72.33
KUNNATHOOR	*	35432	374	1.0555	550	74.65
CHENGANNUR	@	26788	647	2.4153	600	80.11
MAVELIKKARA	@	46281	606	1.3094	600	77.66
KARTHIKAPPALLY		65517	3795	5.7924	650	75.24
KUTTANAD		35690	381	1.0675	700	83.15
AMBALAPPUZA		65647	1940	2.9552	650	76.93
CHERTHALA		79401	2663	3.3539	600	76.17
ADOOR	*	58846	1814	3.0826	550	78.85
KOZHENCHERY	*	71264	639	0.8967	550	83.4
RANNI	*	37218	269	0.7228	550	83.4
THIRUVALLA	@	37100	235	0.6334	500	83.4
MALLAPPILY	@	26951	71	0.2634	465	83.4
KOTTAYAM	@	96156	1767	1.8376	450	83.55
CHANGANACHERY	@	51705	218	0.4216	450	82.07
KANJIRAPPALLY	*	36857	422	1.1450	400	80.01
VAIKOM	@	48061	1815	3.7765	450	79.45
MEENACHIL	*	62497	1476	2.3617	400	81.19
THODUPUZHA	*	48425	1487	3.0707	450	75.13
UDUMBANCHOLA	*	67216	1940	2.8862		68.76
PEERMEDE	*	34671	802	2.3132		63.42
DEVICOLAM	*	36363	12366	34.0071		57.42
KOCHI		74907	1672	2.2321	575	80.18
KANAYANNUR	@	106708	2119	1.9858	500	77.91

* denotes hilly and @ denotes midland and others are costal

APPENDIX 3.1 (Continued)

Taluks, Chulah, Firewood Price, Literacy.

Taluks		Household	Total Chulahs	Diffusion Ratio	Price of Firewood	Literacy
ALUVA	@	63270	1290	2.0389	500	74.32
PARUR	@	55415	2195	3.9610	500	77.36
MUVATTUPUZHA	*	49572	473	0.9542	400	77.28
KOTHAMANGALAM	*	28975	726	2.5056	450	72.31
KUNNATHUNAD	*	62426	926	1.4834	475	74.46
THRISSUR	@	113700	1520	1.3369	550	78.29
MUKUNDAPURAM	*	117452	3083	2.6249	600	75.66
KODUNGALLUR		42284	675	1.5963	540	72.17
THALAPPILLY	@	82751	6255	7.5588	550	67.65
CHAVAKKAD		60745	811	1.3351	600	69.84
OTTAPPALAM	@	106535	3815	3.5810	600	63.21
MANNARGHAT	*	45090	1436	3.1847	600	53.23
PALAKKAD	*	82857	4230	5.1052	600	61.14
CHITTUR	*	71266	1381	1.9378	550	50.88
ALATHUR	@	64819	2665	4.1114	650	55.58
PONNANI		40159	938	2.3357	580	58.42
TIRUR		121499	2177	1.7918	560	57.81
ERANAD	*	152700	5302	3.4722	550	62.75
PERINTHALMANNA	@	55215	977	1.7694	600	62.45
KOZHIKKODE	*	187388	3741	1.9964	350	72.56
QUILANDY	*	95611	1162	1.2153	450	69.07
VADAKARA	*	79391	395	0.4975	500	65.61
VYTHIRI	*	34158	938	2.7461	500	56.08
S.BATTERY	*	38842	1082	2.7856		61.64
MANANTHAVADY	*	30358	8017	26.4082	500	56.75
KANNUR		88305	2088	2.3645	600	72.63
THALIPPARAMBA	*	94954	5346	5.6301	600	67.09
THALASSERY	*	114704	3744	3.2641	650	71.49
KASRAGOD	*	70108	313	0.4465	850	52.33
HOSDURG		73707	7487	10.1578	750	57.88
Total		4432078	137108	3.0935		

* denotes hilly and @ denotes midland and others are costal

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