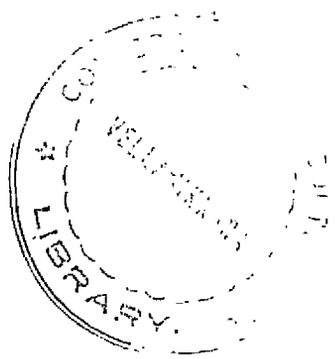
UTILIZATION OF BIOGAS TECHNOLOGY BY THE FARMERS OF PALAKKAD



By

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THESIS

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requirement for the degree

Master of Science in Agriculture

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Department of Agricultural Extension
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DECLARATION

I hereby declare that this thesis entitled, "Utilization of Biogas Technology by the Farmers of Palakkad", is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, asscciateship, fellowship, or other similar title, of any other University or Society.

LATHA, A.

Vellanikkara,
3rd October, 1990

CERTIFICATE

Certified that this thesis entitled, "Utilization of Biogas Technology by the Farmers of Palakkad", is a record of work done independently by **Ms. Latha, A.**, under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to her.

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CHAPTER I

INTRODUCTION

> "It seems clear that the first major penalty man will have to pay for the rapid consumption of the earth's non-renewable sources will be that of having to live in a world where his thoughts and actions are ever strongly limited, where social organisation has become all persuasive, complex and inflexible and where the state completely dominates the actions of the individual"
>
> -Harrison Brown, 1954

The remarkable growth of human population and the development of civilizations have led to the alarming increase in the utilization of various energy sources on our planet. Energy, in its various forms and manifestations is considered to be the most important input for any developmental activity in this modern technological world, be it agriculture, industry, transportation or communication. The rate of energy consumption is so high that it has registered a five fold increase in the last twenty five years.

The main energy sources may be classified as commercial and non-commercial. The Sixth Plan had estimated that about 40-45 per cent of the total energy used in India is from non-commercial sources like firewood, agricultural wastes and animal dung. The commercial sources like coal, oil, hydropower

and nuclear power account only for the rest (Pathak, 1984). Due to over exploitation, most of the fossil fuel, are expected to become scarce and costlier by the turn of the century. Of the non-commercial sources, firewood consumption stands highest at 65 per cent followed by cowdung (25 per cent) and agricultural wastes (15 per cent) as reported by Meena (1982).

The commercial sources of energy cater mostly to the urban needs. Since the villages are scattered and majority of people in villages cannot afford to pay for energy, it is difficult to depend on commercial sources, which are expensive (Thomas, 1987). This disparity exists in the distribution of electrical energy also with 70 per cent of it going to the industries (Moulik, 1982). Thus wood and cowdung remain the main sources of fuel in rural India.

Increasing consumption of wood for fuel has in turn led to large scale deforestation of our tropical forests. Today land under forests in India is barely 22 per cent against the world average of 33 per cent, while in Kerala it is still low with only 7 per cent (Brown, 1985). The burning of cattle dung for fuel in turn deprives the soil of a very valuable organic fertilizer reducing its fertility and productivity.

Added to that, the oil crisis of 1973 has raised the price of crude oil affecting the economy of the developing countries. It is estimated that at the 1983 oil production

level of 18 billion barrels, proven oil resources would last just for 37 years (Brown, 1985).

Thus it becomes very clear that the energy problem in India like any other developing country is mostly rural energy problem. However, its gravity is still unfelt among the rural masses. Anyhow, it has become clear to the policy makers and researchers all over the country that, for the long term sustenance of humanity, development of viable, renewable sources of energy is essential. Realizing the importance, various renewable sources of energy such as solar, wind, tidal, geothermal, biomass and the like are currently being popularised among the masses by the different agencies. Among these, biogas technology based on anaerobic decomposition of organic wastes has tremendous potential as far as rural India is concerned. Along with large quantities of organic wastes available, India has the largest cattle population in the world numbering around 250 million. This decentralized technology based on recycling of organic resources facilitates the production of biogas as fuel and slurry as a valuable fertilizer and also helps to reduce the dependability on foreign energy sources.

Biogas technology is not new to our farmers. Attempts to popularize this technology were initiated by the Khadi and Village Industries Commission (KVIC) way back in the 1960s on a small scale. It could gain popularity only after the oil

crisis in 1973. The Ministry of Agriculture took up the programme of construction of biogas plants during 1974-75 period and was included under the 20-point programme of the Government. The State Governments entered the scene only after the creation of the Department of Non-Conventional Energy Sources (DNES) under the Ministry of Energy. The programme was transferred to this Ministry after the launching of the National Project for Biogas Development (NPBD) in 1982. By the end of 6th plan, around 1.4 lakh biogas plants were constructed under the KVIC and 3.24 lakhs by the different agencies (Thomas, 1987).

Among the various models available, three models viz., floating drum, Janatha and Deenabandhu model are popular in Kerala. The floating drum model is popularised mainly by KVIC, while the Department of Agriculture is concerned with the other two models.

Need for the study

Kerala is a state which has high potential for the large scale utilization of biogas technology with its vast biomass reserves and cattle population. At present this technology is mainly based on cattle dung and hence the name gober-gas is being used. The Central Government provides complete assistance to this programme through loans and subsidies. The details of biogas plants installed in Kerala during 1983-1988 period are furnished in Table 1.

Table 1· Details of biogas plants installed in Kerala by the KVIC and the Department of Agriculture

District	1983-84		1984-85		1985-86		1986-87		1987-88	
	KVIC	Agri dept.	KVIC	Agri dept.	KVIC	Agri dept.	KVIC	Agri dept.	KVIC	Agri dept.
Thiruvananthapuram	45	50	74	281	75	369	67	335	50	272
Kollam	35	15	31	62	50	245	46	227	63	143
Pathanamthitta	0	0	94	93	125	45	197	63	105	46
Alappuzha	20	13	70	41	75	75	74	56	59	51
Kottayam	68	99	97	401	150	235	62	288	34	349
Idukky	17	51	29	293	25	68	4	84	10	103
Ernakulam	201	66	188	340	200	207	80	252	89	240
Thrissur	39	32	82	203	75	228	49	84	41	54
Palakkad	229	90	337	556	300	261	189	177	180	248
Malappuram	40	7	117	105	150	114	30	85	17	107
Kozhikode	7	35	43	81	75	115	31	89	10	41
Wynad	12	33	102	143	150	81	81	70	46	57
Kannur & Kasargod	28	22	36	151	50	134	36	163	59	105

Source: Office of the Additional Director of Agriculture, Thiruvananthapuram and The Khadi and Village Industries Commission, Thiruvananthapuram.

In spite of the huge governmental investment and attempts at popularisation of this technology, biogas is yet to make its required impact among our farmers. Realizing the importance of biogas plants, some of the farmers had already adopted the technology but many are yet to adopt who have to be persuaded to do so. However, no systematic study seems to have been conducted to evaluate the extent of utilization of this technology in Kerala. Considering the above aspects, it was decided to study the response of the farmers towards biogas technology in terms of their attitude towards biogas technology, their perception about the various attributes of biogas plants and the motives governing adoption of biogas plants. These in turn could be influenced by various socio-economic and socio-psychological characteristics of the farmers. The effect of situational factors also cannot be ruled out. Keeping all these in view, the present study was formulated. It was felt that a study in this direction could help the various agencies involved to evolve a suitable strategy to speed-up the popularisation of this technology. The findings of this study could help the extension workers to formulate means of improving the attitude and perception of the farmers to hasten adoption. A survey of the various constraints in its effective utilization and problems in non-adoption could help the researchers to bring about necessary modifications in the technology. This in turn could pave way for improved fuel and fertilizer production through research and development efforts in utilization of other inputs for this technology other than cattle dung.

The study has been thus designed with the following specific objectives

1. To compare the attitude of users and non-users towards biogas technology
2. To study the perception of users about the efficiency of biogas technology
3. To find out the motivational pattern of users in the adoption of biogas technology
4. To find out the influence of selected socio-economic, socio-psychological and situational characteristics of the farmers on attitude and perception
5. To find out the constraints in utilization of biogas technology and reasons for non-adoption

Limitations of the study

Since the present study was conducted as a part of the postgraduate research programme, the study had the inherent limitations in terms of time and coverage. Being a post-graduate research work, the study had to be completed within the period of two years along with course work. Therefore, the study was confined to only one district of the state. However, care has been taken to make the study as objective and systematic as possible. Although the district was selected as

a true representation, the study may have some limitations in making generalisations to other areas. Nevertheless it is expected that the findings of this study would definitely throw light on the shortcomings of this technology and pave way for remedial actions.

Presentation of the study

The thesis is divided into five chapters. The first chapter has already covered the need, objectives and the limitations of the study. The second chapter deals with the theoretical orientation covering the review of literature pertaining to this study while the third one comprises the methodology dealing with the description of the study area, selection of respondents, empirical measurement of the selected variables, tools for data collection and statistical techniques used. The fourth chapter deals with the results of the study and also discussions on the results. The final chapter gives the summary and conclusion of the study. The references and appendix are given at the end.

Theoretical Orientation

CHAPTER II

THEORETICAL ORIENTATION

A review of previous works, either theoretical or empirical, may assist in the delineation of new problem areas and may provide a basis for developing a theoretical framework for the study. This in turn may also help in operationalising the variables enabling data collection on the problem under investigation. Based on the objectives of the study, the review of literature is furnished under the following heads.

1. Biogas as a renewable source of energy
2. Attitude of farmers towards biogas technology
3. Perception of farmers about the efficiency of biogas technology
4. Motivational pattern of farmers in the adoption of biogas technology
5. Relationship between attitude towards biogas technology and selected socio-economic and socio-psychological characteristics of farmers
6. Relationship between perception about the efficiency of biogas technology and selected socio-economic and socio-psychological characteristics of farmers
7. Effect of selected situational variables on attitude and perception of farmers about biogas technology

8. Constraints in utilization of biogas technology

9. Reasons for non-adoption of biogas technology

10 Conceptual framework for the study

1. Biogas as a renewable source of energy

In the race for rapid industrialisation, energy or rather energy crisis has come to stay as the most important problem faced by a developing country like India. Commercial sources of energy like coal, oil and the like which are also non-renewable are getting scarce day by day due to over exploitation. They also incur heavy drain of money for the country to meet the increasing domestic demand. On the other side, majority of our population being rural, depend on non-commercial sources of energy like firewood, agricultural wastes and animal dung. This in turn is depriving the country of its valuable natural resources. With about 70 per cent of the population depending directly on agriculture and allied sectors, it is highly necessary that we should pay equal attention to rural development along with industrialisation. In this context, it is necessary that our vast untapped sources of renewable energy could be harnessed to meet the increasing energy requirements for both industrial and rural development.

As rightly pointed out by Aswathi (1975), Meena (1982) and Racherla and Gandikota (1989), new and renewable sources

of energy such as solar, wind, biomass, hydro, geothermal and tidal power have acquired importance in the near future in view of their renewability. So also, their conversion and utilization cause no environmental problems which could be substituted for fossil fuel.

Among the various sources of energy, biogas technology has tremendous potential as far as India is concerned. India has the largest cattle population in the world numbering around 250 million. About 30 to 40 crores of animal dung is available annually as a base for biogas production besides large quantities of plant residues and other organic wastes which could be mixed with animal excreta or used alone. If all these available materials are utilized, about 70,000 million m^3 of methane can be obtained which could save upto 16 crore tonnes of firewood (Malyadri, 1987).

Biogas technology is mainly based on the anaerobic decomposition of organic materials resulting in the production of methane (55-70%), carbon dioxide (30-45%) as well as small quantities of other gases. It has a high thermal efficiency of 60 per cent (Singh et al., 1987). Apart from this, the slurry coming out after digestion of the organic matter can be used as a valuable organic fertilizer. It is a good source of nitrogen, phosphorus and potassium and a number of micro-nutrients like zinc, sulphur and iron as reported by Khandelwal and Mahdi (1986).

The decentralized technology of biogas proves its usefulness to the rural household, to the farmer and to the society as a whole in many ways as reported by Ganguly (1982), Mahdi (1982), Chawla (1986) and Patel (1986) as:

- provides a cheaper and better fuel which could be used for cooking, lighting and running diesel engines for irrigation pumpsets
- provides a good quality manure that can supplement and optimize the use of chemical fertilizers
- the heat energy available from biogas is about 20 per cent more than that of biomass
- provides an efficient smokeless fuel that will reduce the drudgery of the rural woman
- improves rural sanitation and hygiene reducing the incidence of eye diseases and other disease causing pathogens spread through cattle dung
- reduces the indiscriminate felling of trees for fuel and consequent deforestation
- helps to kill the weed seeds in the slurry
- improves soil fertility and increases yield by 10-20 per cent

- offers employment to a large number of educated unemployed masons in rural areas and

- facilitates the installation of plants even in remote areas where electricity is not available.

Chaturvedi (1984) has estimated that on an average, 100 kg of N, 50 kg of P_2O_5 and 50 kg of K_2O is produced from a plant of 4 m^3 size per year in the form of slurry. This can be mixed with upto three times its weight with the agricultural wastes and composted, which will still retain the plant nutrients to the same percentage.

Bahadur (1982) found that after installation of biogas plants, the fuel consumption pattern had changed substantially with utilization of dung cakes having gone down considerably. At the same time, he has reported that as long as biogas technology depended on cattle dung alone, only two to three per cent of the families will be in a position to take its advantage. With the technical, economic and social constraints faced by this technology, it may take more than a decade even for the modest coverage of two or three per cent of the families to be completed. Therefore he suggested using of other biomass materials to reduce the dependence on cattle dung alone and to spread the technology among non-cattle owning families also.

Based on his study, Patel (1986) suggested the installation of community biogas plants to benefit the villagers or families who do not possess even a single cattle head. He further suggested that the energy obtained from such plants can also be used to run co-operative flour mills or drinking water supply plants and the fertilizer produced may be used for crop production.

Malyadri (1987) observed a change in the fuel consumption pattern of most adopters of biogas plants. Most of the farmers also had a very positive feeling towards biogas plants and felt that installation of the plants was a concrete step towards economic development and solution to the problem of fuel and fertilizers.

However, in general, it can be inferred that, in spite of the high governmental investment and popularisation of this technology, biogas is yet to make its required impact on the masses.

2. Attitude of farmers towards biogas technology:

The researcher could not trace any study related to attitude of farmers towards biogas technology. However an attempt is made to review studies related to attitude of farmers towards improved agricultural technology.

a) Concept of attitude:

A general concept on attitude could be obtained through the following definitions and explanations. Allport (1935) defined attitude as a mental and neural state of readiness, organised through experience exerting a directive or dynamic influence upon the individual's response to all objects and situations with which it is related. According to Thurstone (1946), attitude is the degree of positive or negative affect associated with a psychological object. This concept of attitude has three parts; it is always directed towards an object, it is positive or negative tendency in relation to an object and it is a tendency to react in a certain way.

Kretch and Crutchfield (1948) defined attitude as an enduring organisation of motivational, perceptual and cognitive processes with respect to some aspect of the individual's world.

Schneider (1977) pointed out that most modern definitions of attitude emphasised cognitive, affective and behavioural components of attitude. While the cognitive part refers to what a person believes about something, the affective part refers to how much one likes or dislikes the attitude object and the behaviour component refers to how the person is inclined towards the attitude object.

Bhatia (1978) opined that as a result of social learning and interaction, each one of us acquire certain attitudes towards persons, things, situations and issues. Thus Our attitudes largely determine our behaviour, thoughts and effort with regard to any situation or issues and therefore study of attitude is most important in any programme of controlling and changing other people's behaviour.

b) Studies on attitude towards improved technologies/programmes :

Singh and Singh (1971) reported that sample farmers had quite favourable attitude towards all the three improved farm practices viz., chemical fertilizers, improved farm implements, green manuring.

Sharma (1974) found that 18.33 per cent of the villagers had relatively more favourable attitude towards the Applied Nutrition Programme (ANP). While 20 per cent of them were found to have only a little favourable attitude or even unfavourable attitude, majority (61.67%) were found to have moderately favourable attitude towards ANP.

Singh and Singh (1974) found that only eight per cent of the respondents in the control village and 24 per cent in the treated (National Demonstration) village had positive attitude towards high yielding varieties of wheat.

In a study on the impact of agricultural development programmesamong tribals, Prakash (1980) found that majority of the tribal farmers (63 per cent) were having a favourable attitude towards agricultural development programmes in the more developed area against a less favourable attitude among the majority of respondents of the low developed area.

Vijayakumar (1983) reported that farmers who were beneficiaries of Special Agricultural Development Units (SADU) had comparatively more favourable attitude towards modern technology in coconut cultivation compared to non-beneficiaries. Cherian (1984) observed that majority of the contact farmers (71.43%) and other farmers had medium level of attitude towards T&V system. She also found significant difference in the attitude of the two categories of farmers towards the programme.

Samad and Nair (1984) observed that 82 per cent of the farmers of Intensive Paddy Development (IPD) areas, 83 per cent from Coconut Package (CP) areas and 76 per cent from Pepper Package (PP) areas had favourable attitude towards the respective package programmes.

Sanjeev (1987) found significant difference between trained and untrained farmers in their attitude towards improved paddy cultivation practices.

Nanchu (1989) observed that 62.66 per cent of the farmers were having medium level of attitude towards developmental schemes while almost equal number of farmers belonged to high and low category of attitude towards the same.

3. Perception of farmers about the efficiency of biogas technology :

A few theoretical concepts related to perception are reviewed followed by empirical studies.

Barnett(1953) stated that the novelties would appeal only if they would be superior to existing devices in saving time and labour. Also the cost of acquiring or using a novelty might be prohibitive as far as some potential acceptors were concerned. Nichols (1953) reaffirmed that a practice would be accepted if its utility could be easily shown and it was compatible with other elements of rural culture.

According to Blalock (1963) perception has the following characteristics.

a. It is an individual matter. Thus there may be as many perceptions as there are individuals.

b. It must be dealt with in terms of what an individual actually experiences.

c. It involves not only perceiving the stimuli but also interpreting and describing these stimuli in terms of that are meaningful to the individual.

d. Various internal and external factors may influence both the interpretation of the stimulus and the response it is likely to provoke.

e. It is a dynamic phenomenon that may be continually changing within an individual.

According to Bhatia (1978), the simplest definition for perception is sensation plus meaning, sensation meaning quality and perception meaning an object suggested by that quality.

Jaiswal and Roy (1968) found that the perception of farmers of all the six characteristics i.e., profitability, cost, physical compatibility, cultural compatibility, complexity and communicability significantly influenced the adoption of agricultural innovations. Mulay and Roy (1968) also had reported the same conclusion. Tully (1968) suggested that a farmer may not become interested in any information, if he does not perceive it as relevant to his own farming situation, resources and goals. Further the farmer's perception will depend on his values, beliefs and attitudes.

Chandrakandan (1973) found that if the farmers perceived a practice to be more efficient in saving time, labour and money in producing more, it increased their adoption.

In a study on perception of farm practice attributes, Chandrakandan and Subramanyan (1975) found that farmers are likely to adopt farm practices when they perceive the practices to be more communicable, simple to adopt, less costly, highly divisible and more profitable. The same results were obtained by Arul Raj and Knight (1978).

In his study on the utilization of farm processing equipments, Thiruvathuvadas (1981) reported that majority of the users of multicrop thresher felt that while the cost of the equipment was very high, it had high efficiency in saving time, labour and efficiency in coverage, and was profitable and easy to understand and use.

Muthukrishnan (1982) in a study conducted on the utilization of biogas technology, found that while majority of the users perceived the cost of gas plants as low, one-third perceived the cost as high and the rest as medium. Most of the respondents expressed that their plants had high efficiency in saving labour, fuel, electricity and in producing gas and were profitable when compared to fuelwood and electricity.

Sundaram (1986) reported that while majority (75 per cent) of the farmers had medium level of perception, 14 per cent and 11 per cent of the respondents respectively had low and high level of perception about the effectiveness of soil conservation practices. Regarding the perception of utility of soil test recommendations also, majority belonged to the medium perception category (Balan, 1987).

In a study conducted by Sudha (1987) on the perception about Lab-to-Land programme, it was found that about 55 per cent of the non tribals and 75 per cent of the tribals belonged to the high perception group.

4. Motivational pattern of farmers in the adoption of biogas technology

a) Concept of motivation :

Maslow (1954), one of the pioneers in the field of motivation research argued that individuals are primarily 'wanting' creatures motivated by a desire to satisfy certain specific types of needs. Most individuals, according to him pursue a hierarchy of needs namely physiological needs, safety, belongingness, esteem needs and self actualization needs, such that once a certain need or set of needs are satisfied, it loses its potency as a motivating factor until activated again.

Atkinson (1964) referred to motivation as the arousal of tendency to act to produce one or more effects. Coleman (1971) used the term motivation to include any inner condition of the organism that initiates or directs its behaviour towards a goal. Motivation also helps one to understand the directionality of behaviour and activation or energizing of behaviour. Guilford (1971) defined motive as any particular internal factor or condition that tends to initiate and sustain activity.

Ghorpade (1980) suggested that most of our motives have a cyclical nature. They originate in a need, and this need creates a drive in the organism. It pushes the organism to behave in a certain fashion to satisfy its need and once the instrumental behaviour achieves its goal, the need is satisfied.

Chauhan (1985) opined that a number of factors influence motivation namely physiological system of the individual, his emotional state, habits which instigate and regulate actions in a dynamic sense, the mental set, values and attitudes of the individual.

b) Motivational pattern :

Das and Sarkar (1970) reported that farmers show favourable attitude when the main objective of adoption of practices is only monetary gain and higher the economic

motivation, more favourable will be the attitude towards improved farm practices. Rao et al. (1971) in their study on the motivational pattern of farmers towards the adoption of high yielding varieties of wheat reported a hierarchy of motives with economic motive obtaining the first rank followed by national welfare, innovativeness, self-actualization, prestige, security, affiliation and dominance in the descending order.

In his study on the motives of farmers influencing the cultivation of high yielding varieties of rice, Raghudharan (1972) observed that the farmers gave family need motive the first place followed by affiliation, prestige, innovativeness, patriotism and freedom from debt as the last.

Srirangamurthy (1975) found that farmers and farm women had participated in the training programme with the following orientations in the order of rank namely, learning orientation, orientation of solution seeking, sociability orientation, [illegible] persuasion by others, personal goal orientation, orientation of liesure time utilization and incentive orientation.

Venkiduswamy's (1976) study revealed that economic motives like freedom from debt, family need and security were more important for motivating small farmers in the adoption of cotton other than motives like prestige and self-actualization.

Haque and Ray (1983) also found economic motive as an important variable in determining the adoption of composite fish culture.

Mishra and Sinha (1983) at the same time observed that only personal achievement motivation of farmers was important for their adoption of wheat technology and that too in isolation rather than in combination with other motivational variables. They also found a low motivational status among small and medium farmers.

Sanjeev (1987) obtained the motivational pattern of farmers trained in Krishi Vigyan Kendras as chiefly economic motive followed by innovativeness, prestige motive, affiliation motive, self-actualization and finally achievement motivation. Anilkumar (1988) reported economic motive as the most important motive influencing farmers in the participation in Agro-Forestry Programme. Affiliation motive, self esteem, recognition, safety and self-actualization were the other motives in the descending order of importance.

5. Relationship between attitude towards biogas technology and selected socio-economic and socio-psychological characteristics of farmers

A. Socio-economic variables :

Socio-economic variables selected for the study included educational status, annual income, farm size, family

educational status, family size, livestock possession and indebtedness. In many studies, these variables have been found included under socio-economic status.

Reddy and Reddy (1977) found that attitude of farmers towards crop loan system was an important factor for implementation of schemes connected with it and attitude was significantly associated with socio-economic status. Prakash (1980) could not find any significant relationship between the attitude and socio-economic status of tribal farmers towards settled agriculture in his study on agricultural development programme.

Mani and Knight (1981) observed a positive and significant relationship between socio-economic status and attitude of participants whereas the same had non-significant relationship in the case of non-participants towards regulated market. Pathak (1981) at the same time observed a negative and significant correlation between the two variables with respect to farming.

Cherian (1984) reported a positive and significant relationship between socio-economic status and attitude of contact farmers towards T&V system while in the case of other farmers they were not related. Singh and Kungroo (1985) also observed the same trend in the case of attitude towards goat and sheep farming.

In the case of farmer demonstrators and neighbouring farmers, Syamala (1988) found a positive and significant association between their attitude towards demonstrated cultivation practices and socio-economic status.

The various studies on socio-economic variables taken separately are reviewed.

Educational status:

Singh and Singh (1971) reported a positive association between education and attitude of sample farmers towards improved agricultural practices. Makkar and Sohal (1974) also reported the same trend regarding soil testing. However, Reddy and Reddy (1977) and Kher and Jha (1978) could not find any correlation between the two variables.

Pillai (1978) found a positive correlation between education and attitude of farmers towards soil conservation practices. While Kamaruddeen (1981) reported the same trend in the case of both neighbour and control farmers towards demonstrated practices, Mani and Knight (1981) observed just the opposite trend in the case of participants and non-participants of regulated market.

In an impact study of Special Agricultural Development Units (SADU) on agricultural development in rural areas, Vijayakumar (1983) indicated that education of both

beneficiaries and non-beneficiaries had a significant relationship with their attitude towards improved practices of coconut cultivation. Cherian (1984) also noted a similar relationship in the case of contact farmers of T&V system.

Singh and Kunzroo (1985) observed a positive correlation between education and attitude of farmers towards goat and sheep farming. However, Sanjeev (1987) could not find any significant relationship between the two variables with regard to improved paddy cultivation practices.

Anil Kumar (1988) found that farmers having higher educational status had high positive attitude towards Agro Forestry Programme.

Kunchu (1989) concluded that farmers with primary to secondary education had medium level of attitude towards developmental schemes and those with collegiate education had a high level of attitude.

Based on the above reviews, it was hypothesised that there would be a positive and significant relation between educational status and attitude of farmers towards biogas technology.

Annual income :

Sushama (1979) observed a significant relationship between income of the tribes and their attitude towards modern

living practiqes in morc developed areas and a non-significant relationship was noticed in the case of less developed areas.

Kamarudeen (1981) reported a significant association between attitude towards demonstrated practices and income level of control farmers and a non-significant association in the case of neighbouring farmers.

Vijayakumar (1983) observed a significant positive relationship between income and attitude of both beneficiaries and non-beneficiaries of SADU. Viju (1985) also reported the same result among tribals.

Kunchu (1989) found that farmers with low to medium income had only medium attitude towards developmental schemes.

Based on the above trends and relationships, a positive and significant relationship between annual income and attitude towards biogas technology of farmers was hypothesised for the present study.

Farm size :

Singh and Singh (1971) found that size of holding was positively associated with the attitude of sample farmers towards improved agricultural practices. Makkar and Sohal (1974) observed that respondents operating medium size of holding showed more favourable attitude towards soil testing than others.

In a study on the attitude of rural women towards Applied Nutrition Programme, Menon and Prema (1976) observed that farm size had a positive influence in creating a favourable attitude towards the programme. Pillai (1978) also arrived at the same conclusion with respect to adoption of soil conservation practices.

Sushama (1979) and Prakash (1980) in their studies on tribes, could not find any significant relationship between attitude and farm size of tribal farmers with regard to modern living practices and settled agriculture respectively.

Mani and Knight (1981) in their study on regulated market revealed a positive and highly significant relationship between farm size and attitude. Vijayakumar (1983) also reached the same conclusion in the case of both beneficiaries and non-beneficiaries of SADU. At the same time, Cherian (1984) could observe only a non-significant relationship between the two variables.

Kunchu (1989) reported that farmers with higher farm size were found to possess a medium to high attitude towards developmental schemes. Based on the reviews, it was postulated that there would be positive and significant relationship between attitude and farm size of farmer respondents.

Family educational status :

A study relating adoption of biogas technology with educational status conducted by Aggarwal and Arora (1989) revealed that the highest educational level of a family member of adopter family was significantly associated with the adoption of biogas plants.

Based on this study it was hypothesised that there would be positive and significant relationship between attitude of farmers and their family educational status with respect to biogas technology.

Family size :

In the case of family size also, only a single study relating this variable with adoption of biogas plants could be located.

In a study conducted by Reddy and Reddy (1977) family size of the farmers was found to have no association with their attitude towards crop loan system. Kher and Jha (1978) also reached the same conclusion regarding Primary Agricultural Credit Society.

Aggarwal and Arora (1989) in a study on adoption of gober gas plants also found that family size was not related with the adoption of gas plant.

It was hypothesised in the present study that there would be negative and significant relationship between family size and attitude of the respondents towards biogas technology.

Livestock possession :

No direct or indirect studies relating attitude of farmers towards farm technology with livestock possession were available. However, in the study on adoption of biogas plants, Aggarwal and Arora (1989) had suggested that size of the livestock is a crucial variable which influenced the adoption of gober gas plant. Their study revealed that size of the herd had positive influence on the adoption of gober gas plant.

Hence, it was hypothesised that attitude towards biogas technology of farmers would be positively and significantly associated with their livestock possession.

Indebtedness :

Only two indirect studies were available relating attitude with indebtedness.

In his study on the impact of agricultural development programmes, Prakash (1980) had reported a negative relationship between indebtedness and attitude in both the more developed and less developed areas. Viju (1985) also arrived at the same conclusion in his study on tribal farmers.

It was hypothesised in the present study that attitude towards biogas technology of farmers would be negatively and significantly related to their indebtedness.

B. Socio-psychological variables

Three socio-psychological variables namely social participation, utilization of interpersonal sources of information and innovation proneness were included for the present study.

Social participation:

Reddy and Reddy (1977) found that attitude of farmers towards crop loan system was significantly related with their social participation. Pillai (1978) and Kamarudeen (1981) also arrived at the same conclusion.

In a study conducted by Mani and Knight (1981), social participation was found to maintain positive and significant relationship with attitude of participants towards regulated market, whereas the same had non-significant relationship with attitude of non-participants. The same observations were made by Cherian (1984) in the case of contact and non-contact farmers of T&V system respectively.

Viju's (1985) study revealed a significant relationship between attitude and social participation among tribal

farmers. On the other hand, Sanjeev (1987) could not find any significant relationship between the two variables in his study on training programme.

It was hypothesised that there would be a positive and significant relation between attitude towards biogas technology and social participation of the respondents.

Utilization of interpersonal sources of information:

Rogers (1958) in his studies on the importance of personal influence on adoption found that personal source such as individual contact with the neighbours proved effective in the adoption process.

Reddy and Reddy (1977) could not find any relationship between urban contact or extension contact and attitude of farmers towards crop loan system. Sushama (1979) and Prakash (1980) also did not observe any significant relationship between the two variables in their studies on tribes.

In his study, Kamarudeen (1981) reported a positive and significant relationship between information sources utilization and attitude of neighbour and contact farmers. Cherian's (1984) study also revealed the same trend among contact and other farmers of T&V system.

Sanjeev (1987) observed a significant relationship between extension contact and attitude towards improved paddy cultivation practices. Anilkumar (1988) also confirmed the influence of this variable on the involvement of farmers in Agro-Forestry Programme.

Farmers depend on many sources to obtain information on new farming practices. In the case of biogas technology also farmers obtain technical and other related information from a number of sources. As this is a door to door popularised technology it was decided to find out the influence of interpersonal sources, both localite and cosmopolite, on the attitude formation of farmers. Therefore, it was hypothesised that there would be positive and significant association between attitude towards biogas technology and utilization of interpersonal sources of information.

Innovation proneness :

Syamala (1988) found that innovation proneness exhibited positive but non-significant relationship with the attitude of farmer demonstrators towards National Demonstration Programme (NDP).

It was hypothesised there would be a positive and significant relation between innovation proneness of farmers and their attitude towards biogas technology.

6. Relationship between perception about the efficiency of biogas technology and selected socio-economic and socio-psychological characteristics of farmers

The same variables believed to influence the attitude of farmers were supposed to influence their perception of efficiency of biogas technology also.

I Socio-economic variables

Education:

Bhilegaonker and Dakh (1978) in a study on mobile farm advisory service observed that farmers with high utility perception were having education above middle school level indicating a positive relation.

Pillai (1978) could not find any significant correlation between the perception of simplicity and educational status of farmers with respect to soil conservation measures. However, in a similar study, Sundaram (1986) found a positive relationship between perception of effectiveness of soil sonservation practices and education. With respect to utilization of soil test recommendations also, the same trend was noticed by Balan (1987).

In his study on utilization of biogas technology by farmers, Muthukrishnan (1982) found a positive and significant correlation between education and perception of attributes of biogas plants.

In the present study, it was hypothesised that there would be a positive and significant relation between perception about the efficiency of biogas technology and educational status of the users.

Annual income :

Bhilegaonker and Dakh (1978) found that farmers with medium income level had high perception of the utility of mobile farm advisory service indicating a positive correlation.

Muthukrishnan (1982) reported that income and perception had positive relationship with each other. He further added that since biogas plants required high initial investment, persons with more annual income find it easy to install gas plant as compared to those with low income.

Balan (1987) obtained a positive correlation between the annual income and perception of effectiveness of soil test recommendations among farmers.

In the case of tribal participants, Sudha (1987) observed a positive and significant association between income and perception about Lab-to-Land programme.

It was hypothesised that there would be a positive and significant relation between annual income of users and their perception about the efficiency of biogas technology.

Farm size :

While Pillai (1978) noticed no significant correlation between perception of simplicity and size of holding with respect to soil conservation practices, Balan (1987) reported a positive correlation between the size of holding and perception about soil test recommendations.

Muthukrishnan (1982) found that farmers with bigger farm size had more number of cattle and also perceived the gas plants to be profitable compared to others.

In the present study, it was hypothesised that there would be positive and significant relationship between farm size and perception of efficiency of biogas technology among user respondents.

Family educational status :

Not a single study directly or indirectly relating family educational status with perception could be located. An individual's behaviour could also be influenced by the family background to which he belongs. The family educational status could be an important aspect which could influence one's outlook and perception about the world around him. Therefore, it was thought desirable to find out whether family educational status of users would exert any significant influence on their perception of efficiency of biogas technology.

It was hypothesised that there would be a positive and significant relationship between family educational status of the users and their perception of efficiency of biogas technology.

Family size :

The researcher could not come across any study relating perception with family size, either direct or indirect. The family size was believed to be an important determinant in the utilization of biogas from a given plant size. The fuel requirement of a family was believed to depend on family size. Hence it was decided to find out its influence on perception of efficiency of the technology.

It was postulated that there would be a negative and significant correlation between family size of the users and their perception of efficiency of biogas technology.

Livestock possession :

Muthukrishnan (1982) found that farmers who had more cattle perceived the biogas plants as more profitable when compared to those who had low cattle population.

Livestock possession is considered as an important determinant of plant size due to the dependence of biogas technology on cattle dung. Hence it was believed to influence perception about the efficiency of this technology.

It was hypothesised that there would be a positive and significant relationship between livestock possession of the users and their perception of efficiency of biogas technology.

Indebtedness :

No study relating indebtedness with perception could be located by the researcher. Biogas technology is popularised by the government mainly by providing loans and subsidies. It was assumed that indebtedness could play an important role in influencing the perception of efficiency of this technology of those farmers who had availed loans. So it was decided to include this variable for the study and a significant negative relation between indebtedness of users and perception of efficiency of biogas technology was hypothesised.

II Socio-psychological variables

Social participation :

In their study, Bhilegaonkar and Dakh (1978) found that farmers with high utility perception of mobile farm advisory service also had high social participation. While Pillai (1978) observed no significant correlation between the two variables, Sundaram (1986) reported that social participation had a positive and significant relationship with the perception of effectiveness of soil conservation practices

among farmers. Muthukrishnan (1982) observed no relationship between perception and social participation of users of biogas technology.

It was hypothesised that there would be a positive and significant relation between social participation of users and their perception of efficiency of biogas technology.

Utilization of interpersonal sources of information:

Sundaram (1986) observed that a positive relationship existed between perception and contact with extension agency of farmers taking part in soil conservation practices.

Balan (1987) found a positive and significant correlation between utilization of information sources and perception of effectiveness of soil test recommendations among farmers.

Based on the positive trends observed in the two studies reviewed, it was hypothesised that there would be a positive and significant relationship between utilization of interpersonal sources of information of the users and their perception about the efficiency of biogas technology.

Innovation proneness :

A positive and significant correlation between innovation proneness and perception of farmers about the

effectiveness of soil conservation practices was reported by Sundaram (1986). Balan (1987) also arrived at the same conclusion regarding the relation between perception about soil testing and innovativeness.

Ramegowda and Siddaramaiah (1987) found that perception about innovation attributes namely profitability, trialability and observability were positively and significantly correlated with innovativeness.

It was postulated that there would be a positive and significant relation between innovation proneness of users and their perception about efficiency of biogas technology.

7. Effect of selected situational variables on attitude and perception of farmers about biogas technology

Biogas technology is mainly based on the recycling of bio-resources or wastes. Since it has been popularised in Kerala mainly as a technology based on cattle dung, a rural farm oriented nature of the technology could play an important role in its utilization. Also, Kerala being a state that is facing increasing water scarcity year after year, further adoption of this technology would depend on the availability of perennial source of water. Bhavani (1976) and Pathak (1984) have rightly pointed out that water is required for anaerobic digestion in equal proportion to the amount of dung. Scarcity

of water in some rural areas may be a limiting factor in the popularisation of this technology.

Another aspect is the availability of other fuel sources like firewood, kerosene and butane gas. Again, as reported by Bhavani (1976) farmers use firewood and agricultural wastes at almost negligible cost. Thus there is a lack of felt need due to the availability of alternative sources of fuel for cooking. As for Kerala, kerosene and butane gas are also equally popular.

In the light of the above, it was thought desirable to find out whether the following situational variables would exert any influence on the attitude or perception of respondents towards biogas technology.

1. Rural background
2. Extent of availability of perennial source of water
3. Extent of availability of other sources of fuel
4. Extent of utilization of other sources of fuel

It was postulated that there would be positive and significant relationship between attitude of farmers and their rural background and extent of availability of perennial source of water. At the same time it was postulated that the extent of availability as well as utilization of other sources of fuel would have a negative and significant relationship with attitude of farmers towards biogas technology. A similar hypothesis was made in the case of perception also.

8. Constraints in utilization of biogas technology

In spite of the efficient principles behind biogas technology and the massive governmental and non-governmental efforts to promote it, the technology has not been able to make the required impact as a viable alternative to the fuel crisis facing our country. A number of studies have been conducted to find out the constraints and problems in utilization of biogas technology, which are reviewed here.

Aswathi (1975) pointed out that the fall in temperature during winter hampers the generation of the gas, which brings down the output of the plant considerably.

Mahdi (1982) opined that biogas does not provide direct cash flow of income except in case of manure as byproduct. So to a villager, the immediate benefits of biogas seem to be long term in sense of convenience, health, hygiene or environmental goals. Chawla (1986) also had reported the same opinion.

In his study on utilization of biogas technology, Muthukrishnan (1982) could observe a number of constraints. While seasonal variation in gas production was observed by 55 per cent of the respondents, the problem of storing excess gas was found by 46 per cent of the users. Inaccurate estimation of economics of gas plants and lack of technical guidance after installation were some of the other important constraints.

Pathak (1984) grouped the problems into three categories as (a) technical including corrosion of gas holders and pipelines, low generation of gas in winter, accumulation of water in pipeline, choking of inlet or outlet, cracking of the digester wall, daily preparation of the slurry, (b) socio-economic including high initial cost, lack of sufficient space, scarcity of water and (c) organisational problems, including lack of availability of proper technical knowledge and need for maintenance and repair.

Malyadri (1987) found that shortage of building materials like cement, bricks and other fabrication materials at the time of installation, lack of direct cash flow of income from the plant, lack of proper technical guidance, inadequate number of trained masons forcing the adopters to pay higher wages, wrong site of the plant, irregular organisational support, lack of proper co-ordination between the implementing agencies were some of the constraints felt by users of biogas technology.

9. Reasons for non-adoption of biogas technology :

There could be a number of reasons why many farmers in-spite of owning the requisite number of cattle do not come forward to install biogas plants.

Sundaraswamy (1971) reported that lack of knowledge and sufficient money were the main reasons for non-adoption of

recommended farm practices. Sripal (1981) also emphasised the same reasons in the case of cotton cultivation.

Aswathi (1975) observed that ninety five per cent of the Indian farmers have only three animals or less. Therefore, only the comparatively rich farmers who have got a large number of cattle have had gober gas plants installed. Mahdi (1982) also stressed that biogas technology can only cater to the cattle-owning upper income strata of the rural population which hardly comes to 8-10 per cent.

Bhavani (1976) pointed out a number of reasons why biogas technology was yet to gain popularity in India. Due to the availability of alternative sources for cooking like firewood and agricultural wastes, there is a lack of felt need among the people for biogas. Also institutional problems imposed by the distribution of income among rural population with low access to capital, lack of long term financing by banks, acute scarcity of water were also some of the important reasons. Chawla (1986) also expressed the same opinion. He further added that high water table, rocky subsoil and non-availability of regular feed material created difficulties in adoption due to its site specific nature.

10. Conceptual framework for the study

In any study involving the human being the unit of analysis should be the molar behaviour or the whole behaviour

of the individual. As proposed by Kretch and Crutchfield (1948), what must be considered as giving rise to the dynamics of molar behaviour are the properties of the immediate psychological field or a cross section of the psychological existence of the individual. By psychological field is meant a state of neuropsychic processes that are reflected in the form of the experienced world of the individual and in the form of patterns of neural processes in the brain of the individual. This psychological field is produced through influence rising from three sources: (1) the external physical environment of the person, (2) his internal physiological state and (3) neural traces of past experiences. They further proposed that the patterns of the psychological field is not rigid; it is constantly subject to changes due to dynamic interaction of its parts.

Attitude and perception are two important components governing human behaviour at any time. Kretch and Crutchfield (1948) have pointed out that the particular culture in which a man finds himself will shape the specific beliefs and attitudes. The specific tensions, needs, demands, emotional experiences and perceptions of man are definitely conditioned by the nature of his real world, by the stimulus patterns to which he is subjected. These cultural situations create and limit the situations for the individual out of which arise his needs, emotions and perceptions which are organised into beliefs and attitudes.

It has been already pointed out by Allport (1935), that attitudes are formed under one of several conditions, namely (1) the accumulation and integration of a number of related experiences, (2) the individuation, differentiation and segregation of experiences, (3) trauma or dramatic experiences, (4) the adoption of ready made attitudes, when the individual develops attitude through contact with other holding the same attitudes rather than as a result of first hand experience. Further Murphy et al. (1937) posited that attitudes are rarely individual affairs but are largely borrowed from groups to which we owe our strongest allegience. Individual variations such as age, sex and various personality characteristics have much to do with the nature of groups with which one becomes affiliated. The influence of such variables as encouragement by friends, knowledge, previous reading and organisational membership on behaviour was investigated by Sample and Warland (1953). According to them the effect of these variables on behavioural intentions and behaviour was mediated by the structure of the attitude, "attitudinal certainty".

Triandis and Triandis (1971) stated that people have attitude towards social objects because they help them to organise, simplify and understand the world around them, protects their self esteem by avoiding unpleasant truths about themselves and allow them to express their fundamental values.

Bower (1966) pointed out that according to many psychologists, the ability of perceive the world is as much a part of man's greatest endowment as the ability to breathe, while others have contended that perception is an acquired capacity wholly dependent on experience and learning. According to Segall et al. (1966) perception is subject to many of the same influences that shape other aspects of behaviour. In particular, each individual's experiences combine in a complex fashion to determine his reaction to a given stimulus situation. Thus to the extent that certain kinds of experiences are more likely to occur in some cultures than others, there will be wide differences in perception across the cultures.

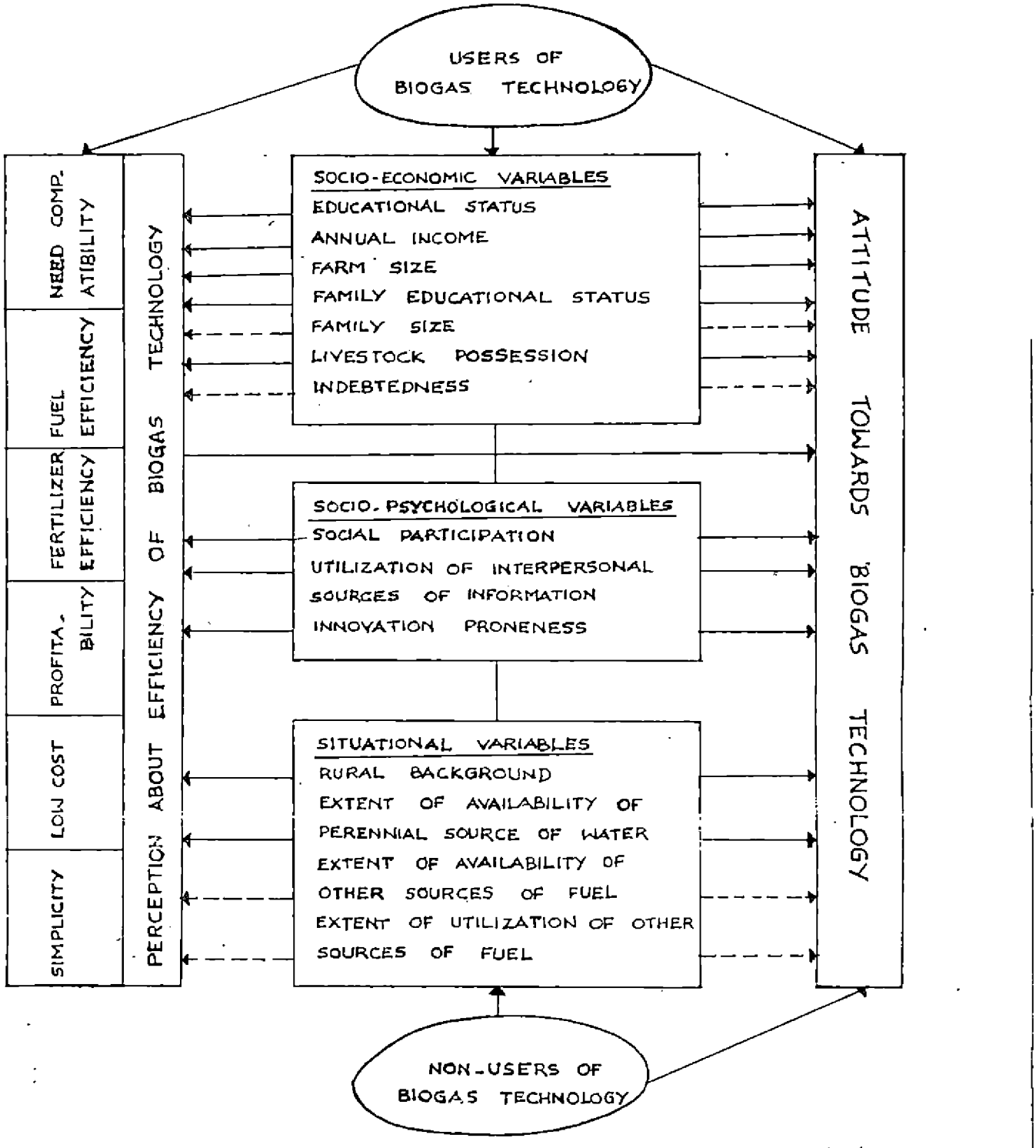
Man does not perceive all that is presented to him. Bhatia (1978) opined that perception is selective and is influenced by, (a) attention-at a time, out of a large number of stimuli that are pressing upon our sense organs, we perceive only a few of them these to which we attend, (b) set-we always perceive what we expect to perceive viz., we all have built expectancies in life and our mind is set to receive certain stimuli, (c) interests and values - when a specific stimulus is of special importance to the individual, he perceives it more easily and readily, (d) social norms-social and cultural factors influence perception and lastly social perception where things, situations and people are perceived according to interest, attitudes and values of the groups to which we belong.

The conceptual framework developed for the study thus assumes that attitude towards biogas technology and perception about its efficiency play an important role in the utilization of this technology. Kelman (1974) has emphasised the use of attitude as a dependent variable labelling it as a variable par excellence for the major categories of social-psychological research. Therefore attitude and perception were taken as dependent variables for the purpose of the study. As suggested by Hochberg (1958), the criteria for restricting perception is that there must be a stimulus physically present. While the attitude of both users and non-users of biogas technology was studied, the perception was studied in the case of users only.

It was conceptualised that there would be significant relationship of the two variables viz., attitude and perception with certain socio-economic and socio-psychological characteristics of the respondents. Due to the location specific nature of this technology, relationship of attitude and perception with selected situational factors was also envisaged.

The conceptual framework developed for the study is depicted in Fig.1.

FIG.1 CONCEPTUAL DIAGRAM SHOWING THE HYPOTHESISED RELATIONSHIP BETWEEN THE DEPENDENT AND INDEPENDENT VARIABLES OF USERS AND NON-USERS OF BIOGAS TECHNOLOGY



Methodology

CHAPTER III

METHODOLOGY

In this chapter the methods employed in the study are presented under the following heads.

1. Location of the study and sampling procedure adopted
2. Selection of variables for the study
3. Operationalisation and measurement of variables included in the study
4. Techniques employed in data collection
5. Statistical tools used in the study

1. Location of the study and sampling procedures adopted

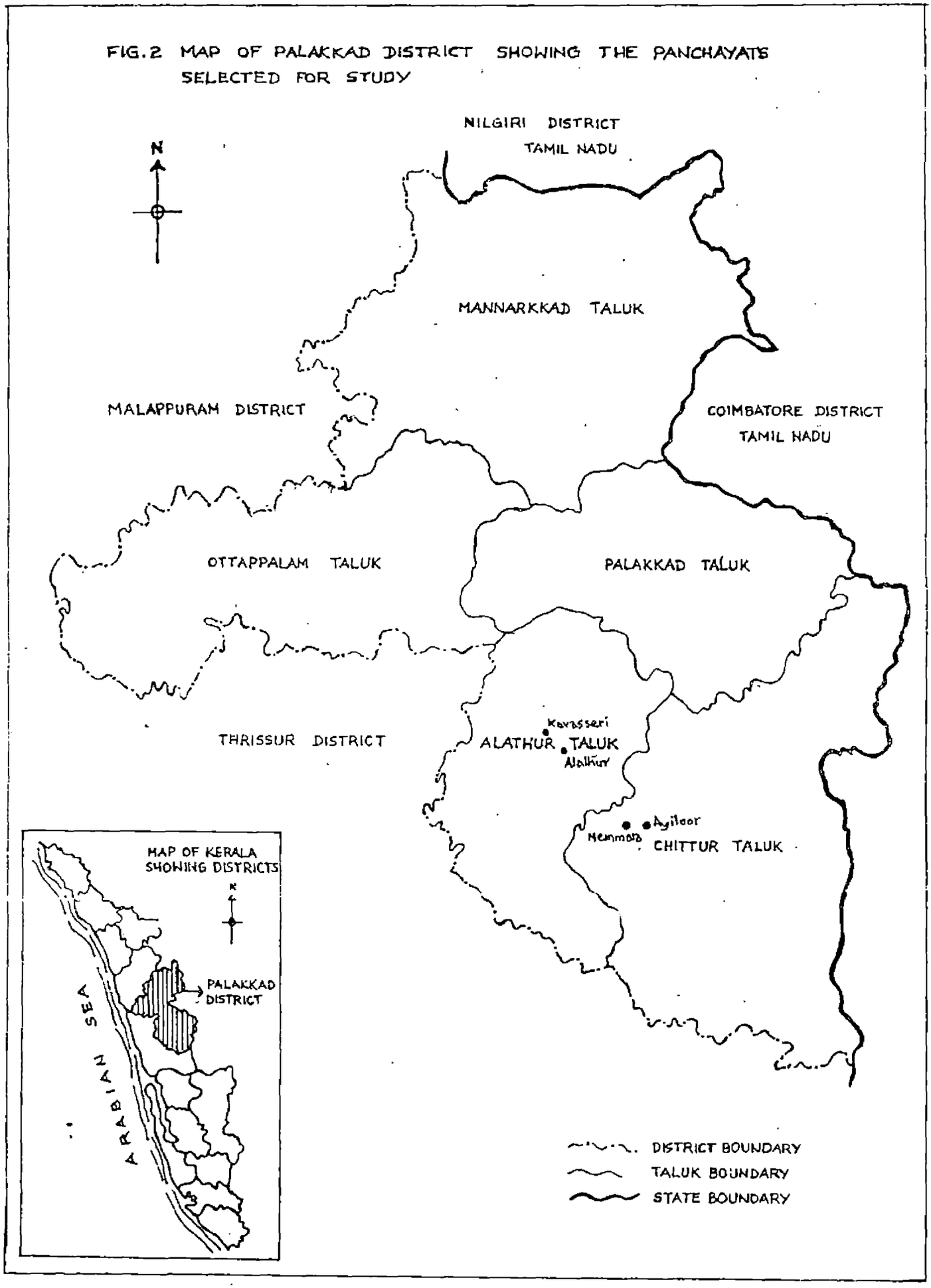
In Kerala, biogas technology is being popularised as a cattle dung oriented technology. Hence the requirement of a minimum number of cattle is important for setting up biogas plants of different size. Palakkad district has the maximum cattle population among the 14 districts of Kerala and the maximum number of biogas plants have been installed in this district (Table 1). Palakkad district was therefore purposively selected for the study. Also it is one of the four intensive districts in Kerala selected under the National Project for Biogas Development (NPBD) for intensifying the spread of this technology.

Multistage random sampling technique was employed for the selection of the respondents. Palakkad district has four sub-divisions namely Alathur, Shoranur, Mannarkkad and Chittoor. Out of these, Alathur sub-division was selected randomly which formed the first stage of sampling (Fig.2).

Out of the 22 panchayats under Alathur sub-division where Krishi Bhavans are functioning, four Krishi Bhavans namely, Ayiloor, Alathur, Nemmara and Kavassery Krishi Bhavans were randomly selected at the second stage. Even though the Khadi and Village Industries Commission (KVIC) has been popularising this technology since the 1970s, the Department of Agriculture entered the scene only after 1983. So only the biogas plants installed since 1984 were taken for the study to maintain uniformity in selection of respondents.

At the third stage, a list of farmers who had installed biogas plants after 1984 were collected from the selected Krishi Bhavans. From this list, 20 farmers were selected at random from each Krishi Bhavan to make up a total of 80 user respondents. A sample of 20 farmers were selected from each Krishi Bhavan from the neighbourhood of the selected user respondents who were categorised as non-users. As for the non-user respondents, the users were asked to give the names of three or four farmers living nearby who possess cattle and had not installed biogas plants and from their names, one was selected at random. A total of 80 non-user respondents were thus selected for the study. A user of

FIG.2 MAP OF PALAKKAD DISTRICT SHOWING THE PANCHAYATS SELECTED FOR STUDY



biogas technology for the study purpose was considered as any individual who had installed a biogas plant between 1984-1989 and utilizes it for fuel and fertilizer purpose. A non-user was any individual in the neighbourhood of the user who owned two or more [illegible] cattle but had not installed a biogas plant.

2. Selection of variables for the study

Based on the objectives of the study, review of relevant literature and discussions with officials in the Department of Agriculture and the KVIC, the following variables were selected for the study.

A. Dependent variables

1. Attitude towards biogas technology of users and non-users of biogas technology

2. Perception of users about the efficiency or biogas technology

B. Motivational pattern of users in the adoption of biogas technology

C. Independent variables

(i) Socio-economic variables

x_1 Educational status

x_2 Annual income

x_3 Farm size

x_4 Family educational status

x_5 Family size

x_6 Livestock possession

x_7 Indebtedness

(ii) Socio-psychological variables

x_8 Social participation

x_9 Utilization of interpersonal sources of information

x_{10} Innovation proneness

(iii) Situational variables

x_{11} Rural background

x_{12} Extent of availability of perennial source of water

x_{13} Extent of availability of other sources of fuel

x_{14} Extent of utilization of other sources of fuel

D. Constraints in utilization of biogas technology by users

E. Reasons for non-adoption by non-users

3. Operationalisation and measurement of variables

A. Dependent variables

1. Attitude towards biogas technology

For this study, attitude has been operationalised as the degree of positive or negative disposition associated with biogas technology of users and non-users.

A number of attitude scales have been developed in the past for measuring the attitude of respondents towards a technology or practice or programme. An attitude scale is one that assesses the degree of affect that individuals may associate with some psychological object. Tripathy et al. (1970) used Likert's (1932) technique of five point rating scale for measuring the attitude of gram sevaks towards Community Development Programme. Cherian (1984) had developed an attitude scale following the method of summated ratings to measure the attitude of farmer respondents towards T&V system. In the present study also, attitude of users and non-users was measured using an attitude scale developed for the purpose utilizing Likert's summated rating technique.

As a first step, the statements regarding different aspects of biogas technology were collected on the basis of review of literature and discussion with the officials of Department of Agriculture and the KVIC and some farmers who had installed biogas plants. Care was taken to develop a universe of content including all possible statements that would reflect the attitude of the respondents towards the stimulus under study. The collected statements were then edited by comparing against the criteria described by Edwards (1957). Out of a total of 80 statements, 33 statements were selected after editing. Care was taken to include both positive and negative statements on biogas technology.

The edited statements were administered to 60 biogas plant owners in Thrissur district. They were asked to respond to each statement in terms of their own agreement or disagreement with the statements on a five point continuum as follows.

SA - Strongly agree

A - Agree

UD - Undecided

DA - Disagree

SDA - Strongly disagree

After collecting the responses from the farmers, these statements were subjected to item analysis. The purpose of item analysis is to examine how well each statement discriminates between respondents with different attitudes.

The procedure involved in item analysis as suggested by Edwards (1957) was followed. First of all, the total score was found out for each respondent by summing up the scores obtained for all the statements in the list. The various responses were assigned numerical weights such that strongly agree response was given score of 5, agree-4, undecided-3, disagree-2 and strongly disagree-1 for positive statements. The order was reversed for negative statements. Thus the total score of an individual was the summation of numerical weights assigned to the responses. The respondents were then arranged in descending order of the total scores. From these, 25 per cent of the subjects with the highest total score and

25 per cent of the subjects with lowest total score were taken up for item analysis. It was assumed that these two groups would provide the criterion groups in terms of which one can evaluate an individual statement. The following formula was used for evaluating the responses of the high and low group to each statement.

$$t = \frac{\bar{X}_H - \bar{X}_L}{\sqrt{\frac{s_H^2}{n_H} + \frac{s_L^2}{n_L}}}$$, where

$\bar{X}_H$ - the mean score on a given statement for the high group

$\bar{X}_L$ - the mean score on a given statement for the low group

s_H^2 - the variance of the distribution of responses of the high group to the statement

S_L^2 - the variance of the distribution of responses of the low group to the statement

n_H - the number of subjects in the high group

n_L - the number of subjects in the low group

The value of 't' is a measure of the extent to which a given statement differentiates between the high and low groups. As an appropriate rule of thumb, any value of 't' equal to or greater than 1.75 only was considered. Statements with 't' values were arranged in ascending order of magnitude and ten statements having the maximum 't' values were selected

for the final scale which consisted of six positive and four negative statements. The statements with their 't' values are furnished in Appendix-I.

Reliability of the scale:

Guilford (1954) has defined reliability as the proportion of variance in the obtained test score. Hence a scale can be considered reliable only when it consistently produces the same or similar results when applied to the same sample. Three methods of measuring reliability are generally in use namely pre-test method, multiple form method and split-half method. Out of these, split-half method was used in the present study.

Split-half method

The developed scale containing the ten statements was administered to 30 biogas plant owners of Thrissur district. The statements were split into two equal halves such that there were three positive and two negative statements in each half and their scores were added up. Thus two sets of scores were obtained. Correlation coefficient (r) worked out between the two sets of scores (0.721) which was significant indicating that the scale was reliable.

Validity of the scale:

Seltiz et al. (1977) have defined validity of a measuring instrument as the extent to which differences in scores on it reflect true differences among individuals on the characteristic that we seek to measure rather than random or constant errors. There are usually three types of validity - content, criterion-related and construct validity. Among these, content and criterion-related validity of the scale were tested in this case.

a. Content validity :

The main criterion for content validity is how well the contents of the scale represent the subject matter under study. This was well considered during the preparation of the scale itself taking utmost care to include all the items to represent the universe of content.

b. Criterion-related validity:

The developed attitude scale was administered to 30 biogas plant owners of Thrissur district along with an already standardized innovation proneness scale developed by Moulik (1965). It was expected that innovation proneness and attitude towards improved practices would be correlated. The individual scores of the two scales for each respondent was correlated to find out how far the innovation proneness score

for each individual was capable of predicting the attitude of respondents towards biogas technology. The significant correlation coefficient (r) value of 0.665 indicated that the measuring instrument developed was valid.

Administration of the scale

The attitude scale which was found to be reliable and valid was administered to the respondents for measuring their attitude towards biogas technology at the time of data collection.

2. Perception about the efficiency of biogas technology

Theodorson and Theodorson (1970) defined perception as the selection, organisation and interpretation by an individual of specific stimuli in situation according to prior learning, activities, interests and experience.

In this study, perception of the efficiency of biogas technology is operationalized as the meaningful sensation of the user respondents about the worth, efficiency or value of biogas technology in terms of its simplicity, profitability, low cost, fuel and fertilizer efficiency and need-compatibility based on their experience with the technology.

Thakar et al. (1970) developed a scale to measure the perception of extension personnel about the objectives of

Package Programme. They asked the respondents to rate a set of objectives on a five point scale with responses as unimportant, undecided, not very important, important and very important.

Sudha (1987) developed a scale to measure perception about Lab-to-Land Programme. A set of fourteen statements related to the perceptual field of the programme were prepared on a four point continuum with the scoring pattern being, very effective-4, effective-3, less effective-2 and least effective-1.

In the present study perception was measured using an arbitrary scale developed for the purpose. The scale is considered as arbitrary since the rigorous procedures of standardisation by estimating reliability and validity of the scale were not attempted in the present case. However, an attempt was made to make the scale as scientific as possible.

Based on relevant review of literature and discussion with experts, six attributes of biogas technology were selected for scale development. They were simplicity, profitability, low cost, fuel efficiency, fertilizer efficiency and need compatibility. Statements reflecting these attributes were prepared and the respondents were asked to rate the statements on a three point continuum with the scoring pattern as follows.

Response	Score
Fully agree	3
Agree to some extent	2
Disagree	1

The scores for each statement of each respondent were summed up to get the overall perception score for an individual respondent.

B. Motivational pattern of users in the adoption of biogas technology

Ghorpade (1980) has defined motivation as an internal state of an organism or human being that impels it to some activity which has some specific goal and which usually originates in some physical need of the body or some psychological need.

The motivational pattern of farmers in adoption of biogas technology in the present study is operationally defined as the pattern of influence of the different motives of the users in deciding the adoption of biogas technology.

Sanjeev (1987) studied the motivational pattern of farmers for participating in training programmes using paired comparison technique.

In the present study also, motivational pattern of the users was assessed using paired comparison technique developed by Thurstone (1927). Based on review of literature and discussions with officials of the Department of Agriculture and KVIC, six important motives which could influence the adoption of technology were identified. These were safety motive, security motive, economic motive, utilitarian motive, achievement motive and prestige motive. Six statements reflecting these motives were constructed and paired in all possible ways $[\frac{n(n-1)}{2}]$ to give 15 pairs of statements. These pairs were then presented to all the user respondents (n=80), who were asked to select from each pair that statement to which he agrees more compared to the other.

After obtaining the responses, a two way frequency table was prepared (F matrix) such that each cell entry corresponded to the frequency with which one statement was judged more favourable to the other for all the 80 respondents. The proportions (p) of these frequencies were worked out, added down the column and the stimuli were rearranged in rank order of the column sums in ascending order. The normal deviates (Zij) corresponding to the p values were obtained, summated down the column and means for each column were worked out. These gave the scale values of the statements. All the values were made positive by adding the absolute scale value of the stimulus with largest negative deviation to the scale deviations (Appendix IIa, b & c).

C. Independent variables

x_1 Educational status:

Educational status is operationalised as the extent of formal education attained by the respondents at the time of investigation.

Educational status was measured using the procedure followed in the socio-economic status scale of Trivedi (1963) with a slight modification to suit our conditions. The respondents were categorised with the scores assigned for each category as follows.

Category	Score
Illiterate	0
Functionally literate	1
Lower primary	2
Upper primary	3
High school	4
Vocational courses	5
Collegiate	6

x_2 Annual income :

Annual income has been operationalized as the total earnings in an year of the respondents and the members of their family from both farm and non-farm sources.

This variable was measured by asking the respondent to indicate the total annual income of his family from farm and non-farm sources. An arbitrary categorisation was followed to group the respondents into different categories based on annual income and scores were assigned based on the category to which they belonged. The categories with the corresponding scores are given below.

Category	Score
Upto Rs.6,000	1
Rs.6,001-12,000	2
Rs.12,001-18,000	3
Rs.18,001-24,000	4
Rs.24,001 and above	5

x_3 Farm size :

Farm size is defined in terms of the area of land owned and cultivated by a farmer, which includes both wet and garden land.

The total land holding including both wet and garden land was considered for measuring the farm size. The area under wet land having cultivation more than once was multiplied by the number of times cultivation was done to obtain a standardized estimate.

x_4 Family educational status

This variable is operationalized for the study purpose as the mean educational status of the family of the respondent at the time of investigation.

To measure the family educational status, the respondent was asked to give the details regarding educational status of the family members. The same scoring pattern as in the case of educational status was used to measure this variable. The scores obtained for all the members were summed up. The summated scores divided by the number of effective members (above five years) gave the family educational status score.

x_5 Family size

Family size is operationalized as the number of members in the family of the respondent who reside with him.

The respondent was asked to indicate the number of members in his family who reside with him. A score of one was given for every member which was added to give the total family size of a respondent.

x_6 Livestock possession

The livestock possession is operationalized as the number of cattle owned by the respondent at the time of

investigation which could provide input for the biogas plant. Since biogas technology is mainly based on cattle dung in Kerala, at least two cattle are essential to install a minimum sized biogas plant in the house.

The livestock possession was assessed by asking the respondent to indicate the number of cattle owned by him. A score of one was given for every cow or buffalo or any other cattle owned by the respondent.

x_7 Indebtedness :

Indebtedness in the present study is operationalized as the total debt in terms of cash a respondent owes at the time of investigation to various money lending sources such as private money lenders, co-operatives, scheduled banks or nationalized banks.

The respondent was asked whether he had availed loan from any of the above mentioned sources. He was asked to indicate the purpose for which he had availed loan and the amount that is still outstanding as due. The total debt for each respondent was obtained after summing up the debts outstanding from various sources.

The respondents were then categorised based on the extent of indebtedness and scores were assigned to each

respondent based on thc category to which he belonged. The categories with the scores are given below.

Category	Score
No debt	0
Upto Rs.2,400/-	1
Rs.2,401-4,800/-	2
Rs.4,801-7,200/-	3
Rs.7,201-9,600/-	4
Above Rs.9,600/-	5

x_8 Social participation

Sadamate (1978) defined social participation of the respondent as participation in social institutions as a member or as an office bearer.

In this study, social participation is operationalized as the extent of participation of thc respondent in the meetings or activities of various social organisations, as member or office bearer and the regularity in attending the meetings.

The social participation scale developed by Kamarudeen (1981) was used for this study. In this case, both membership and holding offices in organisations as well as the frequency of attending the meetings or taking part in activities were

taken into consideration. The scoring pattern adopted was as follows.

A. Membership in organisation

No membership in any organisation	- 0
Membership in each organisation	- 1
Office bearer in each organisation	- 2

B. Frequency of attending meetings/activities

Attended all meetings/activities	- 2
Attended some meetings/activities	- 1
Not attended any meetings/activities	- 0

The individual scores obtained by a respondent against each item were added together to give the social participation score of an individual.

x_9 Utilization of interpersonal sources of information

In this study utilization of interpersonal sources of information is operationalised as the extent of use of different personal sources by the respondent with a view to obtain information on biogas technology.

The scoring procedure developed by Nair (1969) was adopted in this study with slight modifications so as to

develop an index of interpersonal sources utilization. Each respondent was asked to indicate as to how often he obtained information regarding biogas technology from each of the listed personal sources. The frequency of use of different sources was taken into consideration and the scoring pattern followed was

Frequency	Score
Always (regularly, as and when needed)	2
Sometimes (not regularly)	1
Never	0

The scores were added across each item to give the index of interpersonal sources utilization for an individual.

x_{10} Innovation proneness

Innovation proneness is defined as the inclination of a farmer to develop interest in and desire to seek changes in the existing practices related to farm and home and to adopt such changes as and when practical and feasible.

Moulik's (1965) self-rating scale was used to measure the innovation proneness of the respondents. The scale consisted of three sets of statements, each set containing three separate statements with weights 3, 2 and 1 indicating high, medium and low degree of innovation proneness

respectively. After obtaining the most to least choice for each of the three sets of statements, the scoring was done by summing up the ratios of the weights of the most like statements to the weights of the least like statements.

iii Situational variables

x_{11} Rural background

Based on proximity to the nearest developed market centre, each respondent was classified into rural, semi-rural and semi-urban assigning a score of 3, 2 and 1 respectively to each category.

The respondents who reside within the radius of 5 km from the nearest developed market centre were considered as semi-urban, those who reside between 5 km to 10 km were considered as semi-rural and those who reside beyond this distance were classified as rural.

x_{12} Extent of availability of perennial source of water

Based on the availability of perennial source of water, categorisation was done with scores assigned as indicated

Category	Score
Available throughout the year	2
Available only during monsoon	1
Never available	0

x_{13} Extent of availability of other sources of fuel

Each respondent was asked to indicate as to the extent of availability of other sources of fuel like firewood, kerosene, butane gas or such other fuel. Based on their response, categorisation was done with the scores assigned as follows:

Category	Score
Always available	2
Sometimes available	1
Never available	0

For every source available, a score was assigned based on the extent of its availability. The total score was obtained by summing across all the individual scores for each fuel source.

x_{14} Extent of utilization of other sources of fuel

Even though other sources of fuel are available, they may not be utilized by the respondent fully. To find out the extent of utilization of other sources of fuel, each respondent was asked to indicate as to how often he used other fuel sources for the purpose of cooking or such activities. Categorisation was done with the scores assigned as follows:

Category	Score
Always utilized	2
Sometimes utilized	1
Never utilized	0

For each source of fuel utilized, a score was assigned based on the extent of its utilization. The summation of individual scores for each fuel source used gave the index of utilization of other fuel sources by a respondent.

D. Constraints in utilization of biogas technology by users

An important objective of the study was to identify the important constraints in the adoption of biogas technology as perceived by its users.

Based on discussion with experts in the field of biogas technology and review of relevant literature, twelve important constraints that are likely to be faced by the farmers were identified. The procedure used by Syamala (1988) was followed for ranking the constraints. The response to each constraint was obtained on a four point continuum viz., most felt, felt, less felt and least felt with weights 4, 3, 2 and 1 respectively. For each constraint, the frequency of response under each category was multiplied with its respective weightage and added up to get a cumulative index for that particular constraint. The ratio between the

cumulative index and the frequency of responses for each constraint was worked out. The constraints were then ranked based on this ratio.

E. Reasons for non-adoption by non-users

An attempt was also made in this study to find out the important reasons for non-adoption of biogas technology by non-users. Based on discussion with experts in the field of biogas technology and review of relevant literature, twelve such probable reasons were identified. The same procedure for ranking important constraints developed by Syamala (1988) was used in this case also.

4. Techniques employed in data collection

The data were collected from the farmers using a well structured interview schedule prepared for the purpose (Appendix-III). At first a draft schedule was prepared which was used during the pilot study. Based on the pilot study after making suitable modifications, the interview schedule was administered to the respondents for data collection during May-June 1990. A Malayalam version of the schedule was prepared and the same schedule was administered to both users and non-users except for a slight difference in a few variables. The respondents were directly interviewed by the researcher at their home.

5. Statistical tools used in the study

Student's 't' test

Student's 't' test was used to test the significance of difference between means to compare the user and non-user respondents with respect to their attitude towards biogas technology. The following formula was used for computing the 't' value.

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$$

where,

$\bar{x}_1$ = Mean of user respondents attitude

$\bar{x}_2$ = Mean of non-user respondents attitude

s_1 = Standard deviation of the user respondents

s_2 = Standard deviation of the non-user respondents

n_1 = Size of the sample of users

n_2 = Size of the sample of non-users

Simple correlation analysis

To study the relation between each independent variable and the dependent variable, simple correlation analysis was employed.

The formula used was,

$$r = \frac{\Sigma xy - \frac{\Sigma x \Sigma y}{n}}{\sqrt{\Sigma x^2 - \frac{(\Sigma x)^2}{n} \times \Sigma y^2 - \frac{(\Sigma y)^2}{n}}}$$

where,

r = correlation coefficient

x = independent variable

y = dependent variable

n = number of observations

Step-wise regression analysis

This was done to know the relative effect of the independent variables in predicting the dependent variable and for eliminating the unimportant variables. From step-wise regression analysis it becomes possible to select the best subset of independent variables which could explain the variability in the dependent variable as suggested by Draper and Smith (1966).

Results and Discussion

CHAPTER IV

RESULTS AND DISCUSSION

The findings of the present study and the discussions thereon are presented in this chapter under the following broad sub-headings.

1. Attitude of user and non-user respondents towards biogas technology.
2. Perception of users about the efficiency of biogas technology.
3. Motivational pattern of users in the adoption of biogas technology.
4. Profile analysis of the user and non-user respondents.
5. Relationship between attitude of users and non-users towards biogas technology and selected independent variables.
6. Relationship between perception of users about the efficiency of biogas technology and selected independent variables.
7. Constraints in utilization of biogas technology.
8. Reasons for non-adoption of biogas technology.

1. Attitude of user and non-user respondents towards biogas technology

The distribution of user respondents based on their attitude towards biogas technology is furnished in Table 2.

Table 2 Distribution of user respondents based on their attitude towards biogas technology

(n=80)

Category	Attitude score	Frequency	Percentage
Low (Below $\bar{X}$ - 1 S.D)	Below 31.41	14	17.50
Medium (Between $\bar{X} \pm 1$ S.D)	Between 31.41 and 42.27	57	71.25
High (Above $\bar{X} \pm 1$ S.D)	Above 42.27	9	11.25

$\bar{X}$ = 36.84 S.D = 5.43

It is evident from the table and Fig.3 that majority of the users belonged to the medium attitude category. While only 17.50 per cent of the users had a low attitude towards biogas technology, almost three-fourth of the respondents (71.25%) had medium attitude. Only 11.25 per cent had a high attitude towards biogas technology.

Similarly, the distribution of non-user respondents based on their attitude towards biogas technology is given in Table 3.

Table 3 Distribution of non-user respondents based on their attitude towards biogas technology

(n=80)

Category	Attitude score	Frequency	Percentage
Low (Below $\bar{X}$ - 1 S.D)	Below 31.37	11	13.75
Medium (Between $\bar{X} \pm 1$ S.D)	Between 31.37 and 40.21	55	68.75
High (Above $\bar{X}$ + 1 S.D)	Above 40.21	14	17.50

$\bar{X}$ = 35.79 S.D = 4.42

A glance through the table and Fig.3 reveals that majority (68.75%) of the non-user respondents belonged to the medium attitude category. Of the rest, 13.75 per cent had low attitude towards biogas technology and 17.50 per cent had a high attitude. The results indicated that irrespective of whether they possessed biogas plants or not, the respondents had a medium attitude towards biogas technology.

Table 4 presents the mean scores of the respondents on attitude towards biogas technology.

The comparison of the mean scores of users and non-users revealed that there was no significant difference between them with respect to their attitude towards biogas technology.

FIG.3 DISTRIBUTION OF USERS AND NON-USERS BASED ON ATTITUDE TOWARDS BIOGAS TECHNOLOGY

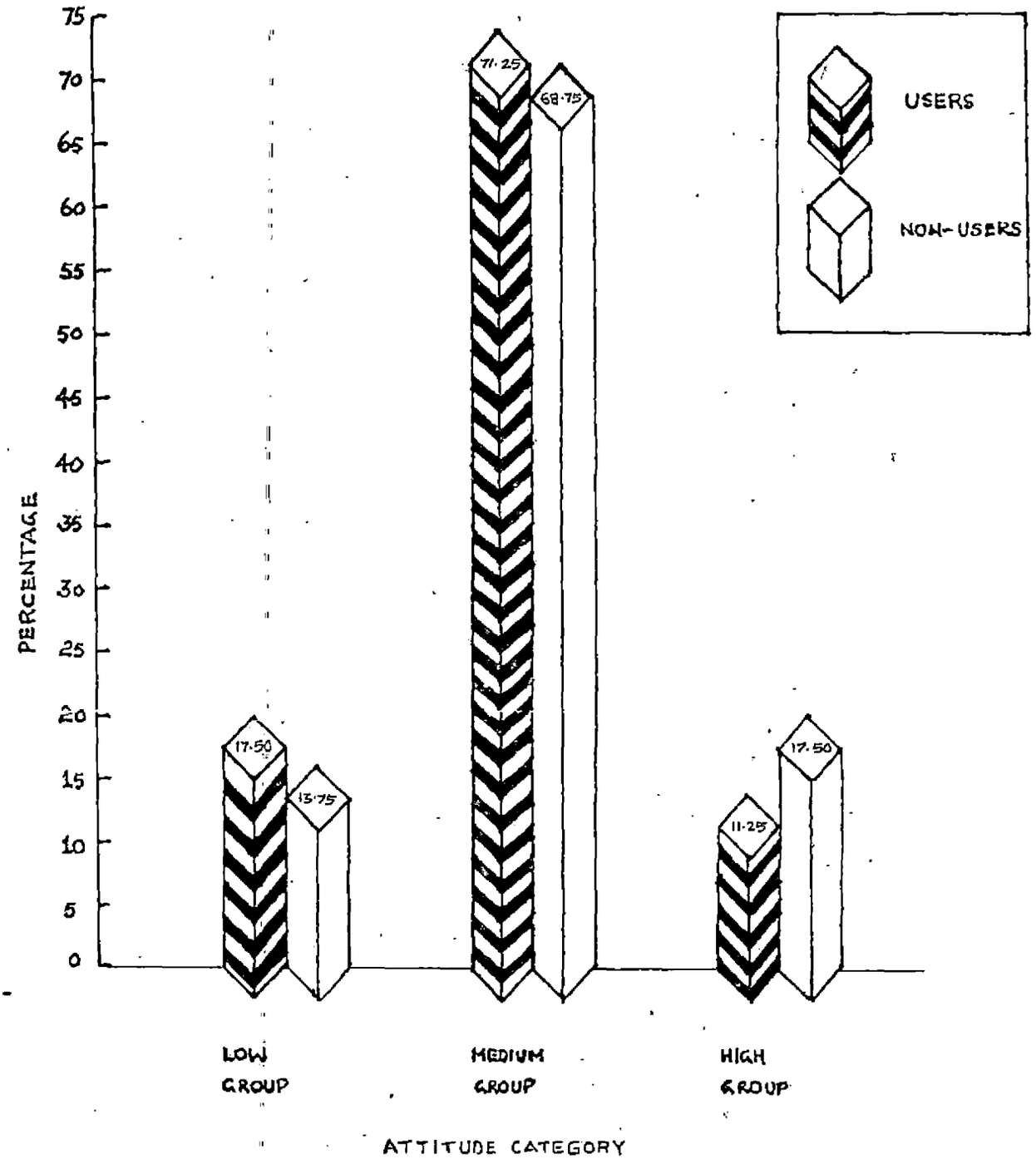


Table 4 Mean scores of the respondents on attitude towards biogas technology

Category	Mean attitude score	't' value
Users (n=80)	36.84	1.35^{NS}
Non-users (n=80)	35.79	

NS = Not significant

Attitude towards a stimulus is explained by our expectations, knowledge and first hand experience with the stimulus. According to the balance theory of attitude change, we try to maintain consistency, congruency or balance in our attitudes. If we have a positive feeling about an object and continue to receive favourable information about it, the feeling and information are congruent and hence attitude change is not likely to occur. On the contrary, if we have a positive feeling about an object and receive unfavourable information about it, we are likely to change our feeling in the unfavourable direction. The non-significant difference among users and non-users with respect to their attitude could probably be explained based on the above agreement. In the case of users, limitations of the technology based on first hand experience such as the need for constant care and maintenance might have led to the lowering of an initially higher attitude which had persuaded them to install biogas

plants. As pointed out by Sartain et al. (1973) and Ghorpade (1980), one way we learn to modify our attitudes and beliefs is through specific experience with the object of attitude.

As for non-users, formation of their attitude might be based on their knowledge about the technology obtained from various sources of information, especially through the extension functionaries of the different agencies engaged in popularisation of the technology. It is likely that they could evoke some interest in the technology among the farmers and hence the observed result. All the same, a relatively high attitude score for the users and non-users indicates that irrespective of whether they had installed biogas plants or not, the respondents in general had a favourable attitude towards biogas technology. However, the non-users might have refrained from adopting the technology due to other reasons.

The observed result was in conformity with that of Kamarudeen (1981) who reported that majority of neighbour farmers and control farmers belonged to medium level of attitude category towards National Demonstration.

2. Perception of users about the efficiency of biogas technology

Since only those who had first hand experience with biogas technology could judge the efficiency of the same,

it was decided that only the user respondents need be studied with respect to their perception.

The data pertaining to the distribution of user respondents with respect to their perception about the efficiency of biogas technology is given in Table 5.

Table 5 Distribution of user respondents based on their perception about the efficiency of biogas technology

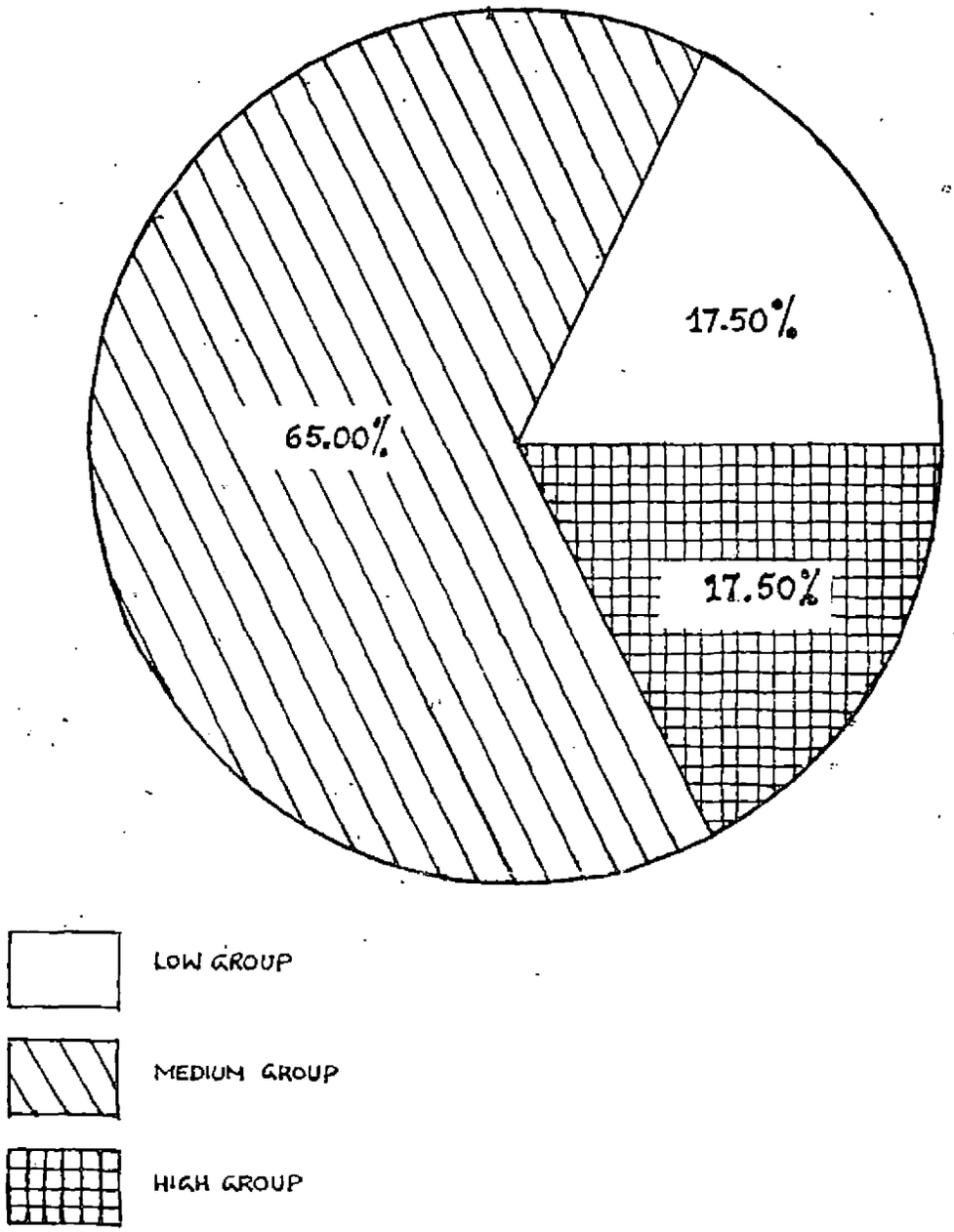
(n=80)

Category	Perception score	Frequency	Percentage
Low (Below $\bar{X}$ - 1 S.D)	Below 10.64	14	17.50
Medium (Between $\bar{X} \pm 1$ S.D)	Between 10.64 and 14.72	52	65.00
High (Above $\bar{X}$ + 1 S.D)	Above 14.72	14	17.50

$\bar{X}$ = 12.68 S.D = 2.04

While majority (65 per cent) of the users were found to possess medium perception about the efficiency of biogas technology, equal percentage of respondents (17.5%) belonged to the high and low perception category (Fig.4). As pointed out by Bower (1966) and Segall et al. (1966) perception is subject to many influences. In particular, each individual's

FIG. 4 DISTRIBUTION OF USER RESPONDENTS BASED ON PERCEPTION ABOUT EFFICIENCY OF BIOGAS TECHNOLOGY



experiences combine in a complex fashion to determine his reaction to a given stimulus situation. Here also, as in the case of attitude, direct experience with the technology might have resulted in a medium level of perception about the technology. Similar trends were also reported by Sundaram (1986) and Balan (1987) in their studies on perception about the effectiveness of soil conservation practices and soil test recommendations respectively.

Of the six attributes of biogas technology selected to study perception, comprehensibility (simplicity) obtained the highest score as revealed from Table 6. It was thus evident that majority of the users could understand the principles and working of biogas plants easily. Thiruvathuvadas (1981) had also reported that majority of the users had perceived the multi-crop thresher as easy to understand and use which promoted adoption.

Fuel efficiency was ranked as the second important attribute followed by profitability with respect to other sources of fuel. Low cost was found to have the lowest score, which indicated that most of the respondents perceived the initial cost of installation as not affordable to the common man.

The concerned agencies impart training on the principles and operations of the technology to the farmers

Table 6 Relative importance of the different perceived attributes of biogas technology

n=80

Sl. No.	Attribute	Response						Total score	Rank
		Fully agree		Agree to some extent		Disagree			
		Frequency	Score	Frequency	Score	Frequency	Score		
1.	Comprehensibility (simplicity)	52	156	28	56	--	--	212	I
2.	Low cost	19	57	30	60	31	31	148	VI
3.	Profitability	15	45	49	98	16	16	159	III
4.	Fertilizer efficiency	19	57	39	78	22	22	157	V
5.	Fuel efficiency	30	90	39	78	11	11	179	II
6.	Need compatibility	31	93	16	32	33	33	158	IV

immediately after installation of the biogas plant. The very nature of the technology also warrants them to handle it everyday for production of biogas. Hence it is likely that farmers had perceived the technology to be simple. Also, the understanding of this technology does not require much effort or thinking on the part of the farmers which must have facilitated the development of a high perception about simplicity.

Biogas has got more thermal efficiency (60 per cent) compared to kerosene or firewood (50% and 17.3% respectively) as reported by Anon. (1986). Experience with the technology must have made the users realize that biogas produces more heat and takes lesser time to cook. Muthukrishnan (1982) also had reported the perception of high fuel efficiency by majority of the users of biogas technology. Barnett (1953) opined that novelties would appeal only if they would be superior to existing devices in saving time and labour. Chandrakandan (1973) and Thiruvathuvadas (1981) also reported the same findings with respect to adoption of agricultural practices and utilization of farm processing equipments respectively.

Biogas technology incurs a high installation cost inspite of the loans and subsidies provided. It was reported that the installation cost usually exceeded the loans provided in many cases. This in turn must have caused considerable

financial burden to the farmer which could probably explain the lowest rating of 'low cost' by the farmers. Barnett (1953) had opined that cost of acquiring or using a novelty might be prohibitive as far as some potential adopters were concerned. Beal and Bohler (1957) observed that practices which cost little seem to be adopted more rapidly than those which are more expensive. Thiruvathuvadas (1981) also reported that majority of the users of multi-crop thresher felt the cost of equipment to be very high. All these related observations point out that there is a need to reduce the initial installation cost of the technology further to promote its acceptance and adoption among the potential adopters.

3. Motivational pattern of users in the adoption of biogas technology

The motivational pattern of user respondents in the adoption of biogas technology based on the scale values obtained through paired comparison test is presented in Table 7. A glance at the table reveals that, of the six motives studied namely, safety, utilitarian, security, economic, prestige and achievement motive, safety motive was found to possess the highest scale value of 2.173 which indicated that the most important motive governing the adoption of biogas technology was safety of the technology, i.e., biogas provides a clean and safe fuel which facilitates smokeless cooking. The other motives in order of importance

Table 7 'Z' matrix of paired comparison test showing motivational pattern of user respondents in adoption of biogas technology

(n=80)

	Prestige	Utilitarian	Achievement	Economic	Security	Safety
Prestige	0.000	1.787	1.282	1.538	1.645	1.960
Utilitarian	-1.787	0.000	0.454	0.598	0.800	1.353
Achievement	-1.282	-0.454	0.000	0.319	0.674	0.559
Economic	-1.538	-0.598	-0.319	0.000	0.800	0.800
Security	-1.645	-0.800	-0.674	-0.796	0.000	0.159
Safety	-1.960	-1.353	-0.559	-0.800	-0.161	0.000
Total	-8.209	-1.418	0.184	0.859	3.758	4.831
Mean	-1.368	-0.236	0.031	0.143	0.626	0.805
Mean + 1.368	0.000	1.132	1.399	1.511	1.994	2.173

were security, economic, achievement, utilitarian and prestige respectively.

Maslow (1954) postulated that the lowest level of unmet need is ordinarily the one that is prepotent - the one that commands the individual's attention and efforts. Behaviour motivated primarily by maintenance needs like safety, social approval etc. is deficiency-motivated. In other words, it is motivated by the lack of something the individual needs for stability, which was found true in the present case also.

Unlike liquid petroleum gas (LPG) which is more popular now-a-days, biogas is less toxic and never explodes. Compared to firewood, it keeps the vessels clean and soot-free and also reduces the chances of occurrence of eye or lung diseases due to constant exposure to smoke. In general, it also keeps the surrounding environment clean from flies and mosquitoes which are usually seen near cattle sheds. Keeping all these aspects in view which makes biogas more safe and clean compared to other popular fuels, farmers must have adopted the technology with this motive uppermost in their mind.

Followed by safety motive, security motive viz., biogas reduces the dependability on firewood obtained a scale value of 1.994 occupying a second position in the motivational pattern. With increasing deforestation, fuelwood happens to

be a scarce and expensive commodity. Availability of firewood as a source of fuel is again not certain and cannot be ensured always. Even though the biogas plant may incur a high initial investment, it does not incur much expense once installed, except for maintenance. Also, it provides an efficient fuel and fertilizer to the farmer. The technology itself is based on recycling of resources unlike firewood which is non-renewable. All these aspects probably explain the salience of security motive in adoption of biogas technology.

4. Profile analysis of the user and non-user respondents

A comparison of the mean values of the selected characteristics of the user and non-user respondents is presented in Table 8.

It is clear from Table 8 and Fig.5 that there was significant difference between the users and non-users with respect to farm size, utilization of interpersonal sources of information, innovation proneness, extent of availability of other sources of fuel and extent of utilization of other sources of fuel at 1 per cent level of significance. The mean values indicate that while farm size and utilization of interpersonal sources of information were higher in the case of users compared to non-users, extent of availability and utilization of other fuel sources were higher in the case of non-users.

Table 8 Comparison of user and non-user respondents with respect to selected independent variables

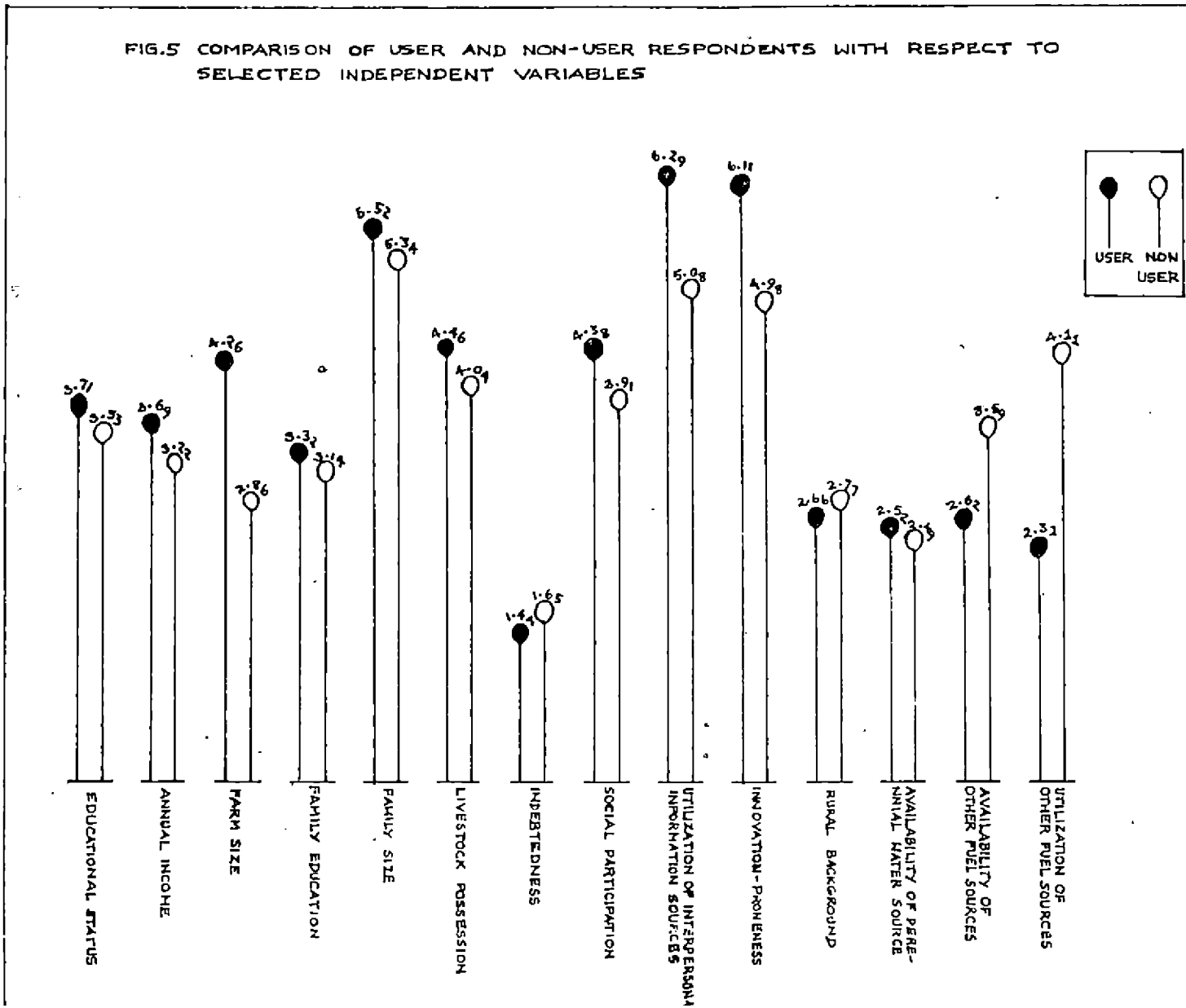
Variable Number	Name of variable	Mean value		't' value
		Users (n=80)	Non-users (n=80)	
X_1	Educational status	3.71	3.53	1.29^{NS}
X_2	Annual income	3.69	3.22	2.02*
X_3	Farm size	4.26	2.86	2.65**
X_4	Family educational status	3.32	3.14	1.31^{NS}
X_5	Family size	5.52	5.34	0.580^{NS}
X_6	Livestock possession	4.46	4.04	1.23^{NS}
X_7	Indebtedness	1.44	1.65	0.78^{NS}
X_8	Social participation	4.38	3.91	2.11*
X_9	Utilization of inter-personal sources of information	6.29	5.08	4.34**
X_{10}	Innovation proneness	6.11	4.98	3.65**
X_{11}	Rural background	2.66	2.77	1.39^{NS}
X_{12}	Extent of availability of perennial source of water	2.52	2.49	0.372^{NS}
X_{13}	Extent of availability of other sources of fuel	2.62	3.59	4.21**
X_{14}	Extent of utilization of other sources of fuel	2.31	4.11	9.21**

** Significant at 1 per cent level

* Significant at 5 per cent level

NS Non significant

FIG.5 COMPARISON OF USER AND NON-USER RESPONDENTS WITH RESPECT TO SELECTED INDEPENDENT VARIABLES



Larger farm size provides better economic security to the farmer and higher risk taking capacity. Higher utilization of interpersonal sources of information like extension agencies, relatives, friends, could build up better orientation towards the technology. Also experience with the technology would prompt the farmer to gather more information about the same from various sources. These aspects could explain the importance of these two variables in differentiating the users and non-users.

Availability and utilization of fuel sources like firewood, kerosene or even butane gas is bound to reduce the immediate need for a biogas plant by the farmer. This could explain the higher mean value for these two variables among non-users. Users were also characterized by a higher annual income and social participation compared to non-users (at 5 per cent level of significance). The mean values of other variables did not show any significant difference between users and non-users of biogas technology.

5. Relationship between attitude of users and non-users towards biogas technology and selected independent variables

5.1 Simple correlation analysis

The results of correlation analysis showing the relationship between attitude of user and non-user repondents and the selected independent variables are furnished in Table 9

Table 9 Relationship between attitude towards biogas technology of users and non-users and selected independent variables

Variable number	Name of variable	Coefficient of correlation (r)	
		Users (n=80)	Non-users (n=80)
Y_2	Perception about the efficiency of biogas technology	0.680**	--
X_1	Educational status	0.409**	0.562**
X_2	Annual income	0.633**	0.574**
X_3	Farm size	0.198^{NS}	0.293*
X_4	Family educational status	0.189^{NS}	0.463**
X_5	Family size	-0.076^{NS}	0.035^{NS}
X_6	Livestock possession	0.421**	0.145^{NS}
X_7	Indebtedness	-0.570**	-0.167^{NS}
X_8	Social participation	0.399**	0.704**
X_9	Utilization of interpersonal sources of information	0.702**	0.763**
X_{10}	Innovation proneness	0.682**	0.479**
X_{11}	Rural background	0.148^{NS}	-0.175^{NS}
X_{12}	Extent of availability of perennial source of water	0.317**	0.126^{NS}
X_{13}	Extent of availability of other sources of fuel	-0.011^{NS}	-0.254*
X_{14}	Extent of utilization of other sources of fuel	-0.391**	0.207^{NS}

** Significant at 1 per cent level

* Significant at 5 per cent level

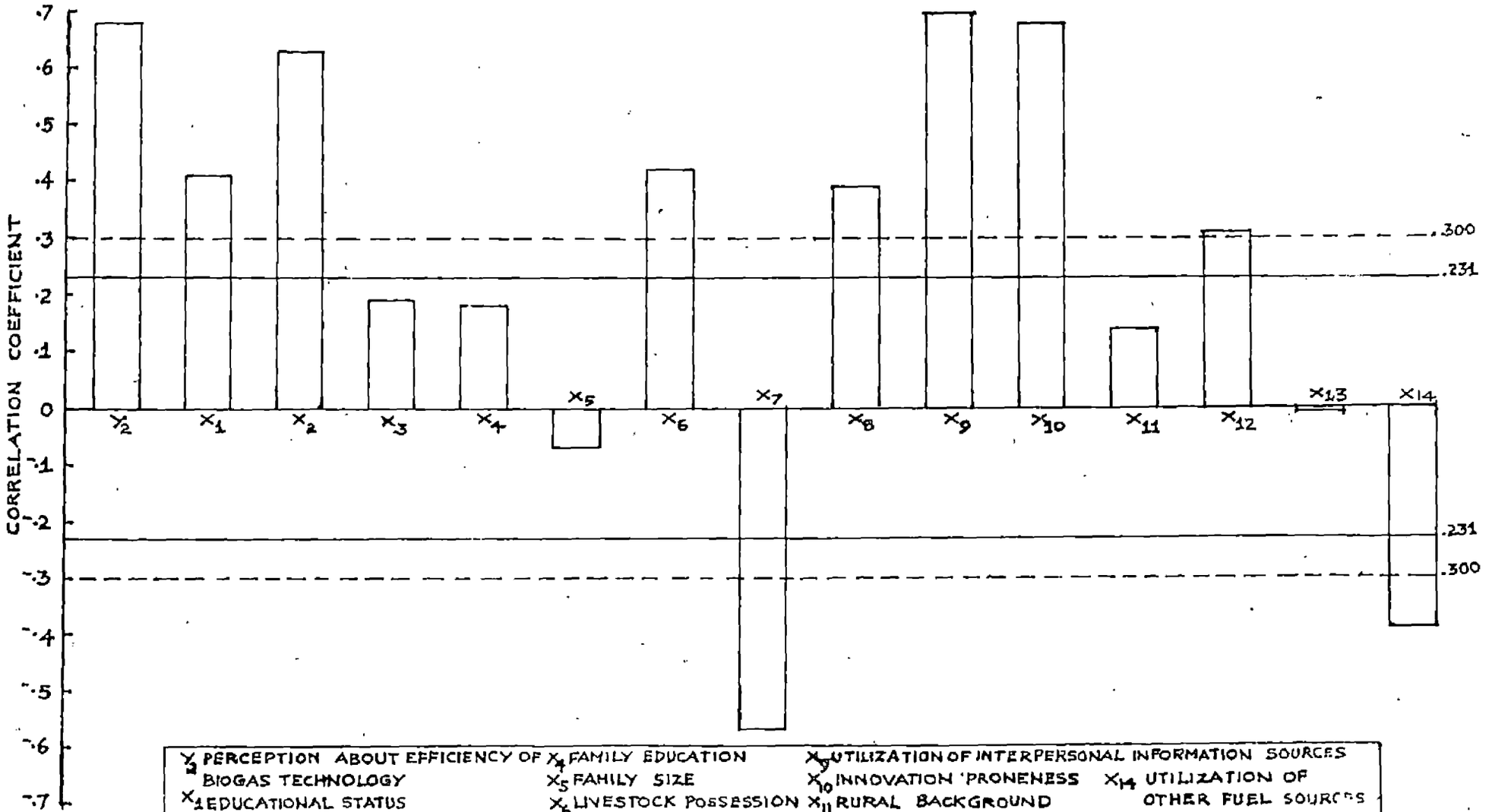
NS Non Significant

and illustrated in Fig.6 and Fig.7. As for users, perception of efficiency of the technology was also included as an independent variable for the study in relation to attitude.

Perception about efficiency of biogas technology indicated a significant positive relationship with the attitude of users, yielding a high correlation coefficient of 0.680. This clearly indicates that respondents having high attitude towards biogas technology also had high perception about the efficiency of this technology. If an individual perceives that the benefits associated with an object or situation, or that the characteristics of the object or situation will help him in his endeavour, he is likely to develop a favourable attitude towards the object or situation. This finding was consistent with the view point of Tully (1968) according to whom, perception of farmers depended on their values, beliefs and attitudes which are likely to differ from person to person.

A positive and significant relationship was observed between educational status and attitude of both user and non-user respondents (r values of 0.409 and 0.562 respectively). Education widens the vision of man, which helps him to view and evaluate objects, situations or persons in a rational perspective. In the case of biogas technology also, educated farmers have obviously been able to understand the principles behind biogas technology as a renewable source of energy

FIG. 6 RELATIONSHIP BETWEEN ATTITUDE TOWARDS BIOGAS TECHNOLOGY OF USERS AND SELECTED INDEPENDENT VARIABLES



viable under their farm and home situation. They have been able to comprehend its importance under the increasing energy crunch situation irrespective of whether they owned a biogas plant or not, compared to the less educated respondents.

Singh and Singh (1971), Makkar and Sohal (1974), Pillai (1978), Kamarudeen (1981), Vijayakumar (1983) Cherian (1984) and Anil Kumar (1988) also observed the same trend in their studies. Hence, the hypothesis that there would be a positive and significant relation between educational status and attitude towards biogas technology of users and non-users was accepted.

In the case of both user and non-user respondents, a high positive correlation (r valuesof 0.633 and 0.574 respectively) was observed between annual income and attitude towards biogas technology. This technology involves a considerable amount of initial investment for installation. Obviously user respondents with higher annual income only could afford to bear the high installation cost of the plant. At the same time, the economically backward farmers may have difficulty in incurring a high cost for construction and for repayment of loans resulting in a lower attitude. The observed result is in line with the findings of Sushama (1979), Kamarudeen (1981) Vijayakumar (1983), Viju (1985) and Kunchu (1989). Based on the results the hypothesis that there would be a positive and significant relationship between annual income and attitude towards biogas technology of users and non-users was accepted.

Farm size was found to have a positive but non-significant relationship with the attitude of users whereas it showed a positive and significant relation (at 5 per cent level) in the case of non-users. With large landholdings, the availability of fodder for cattle will be more in which case, the farmers can feed their cattle with their on farm products. This in turn helps in developing a favourable orientation towards the technology, biogas being mainly dependent on cattle dung as an input.

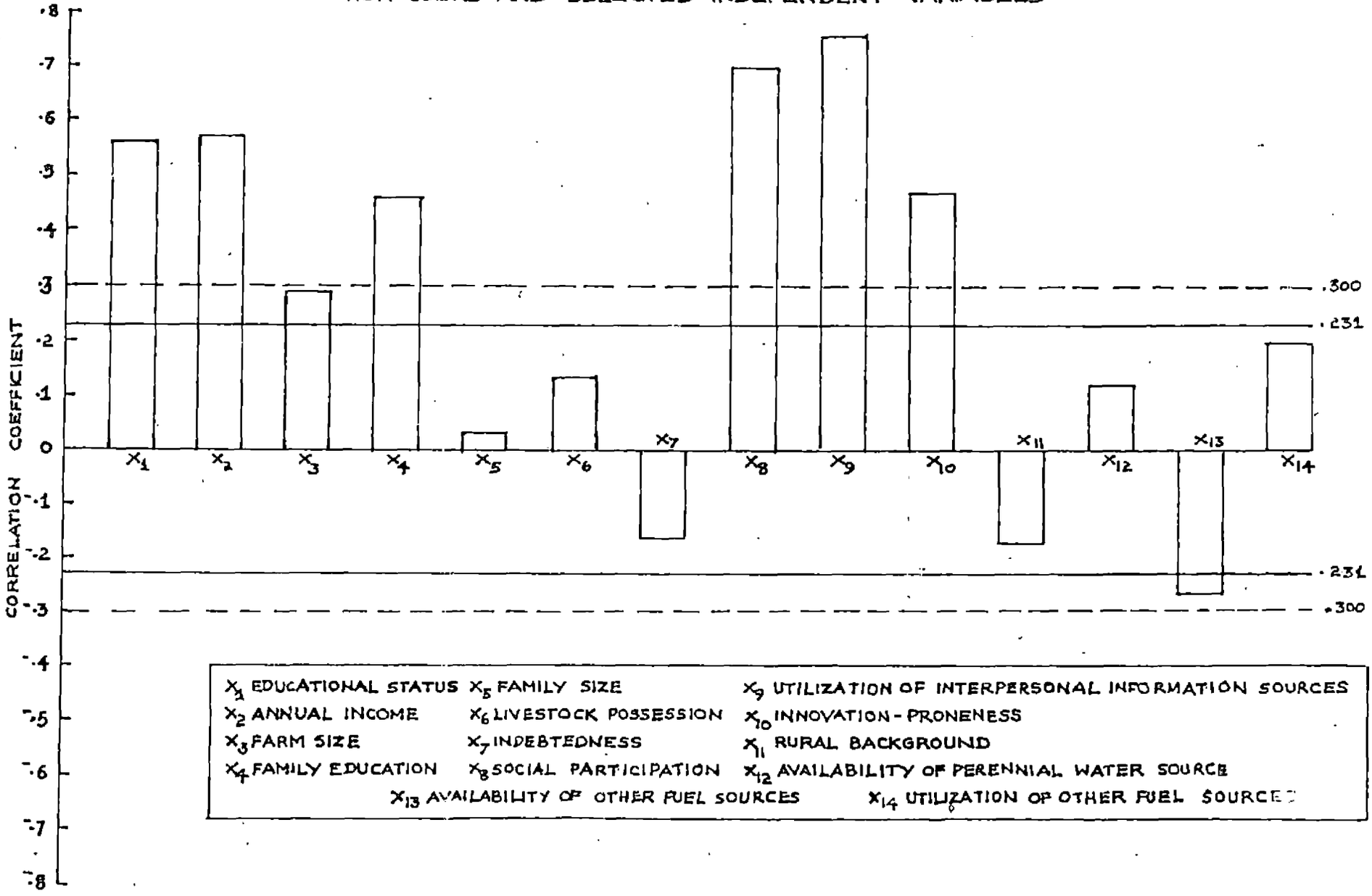
Farming is not an economically viable occupation now-a-days compared to the past. Therefore, more and more farmers are shifting to other occupations. The user respondents with higher attitude may probably have other occupations besides farming which reduce their dependability on returns from agriculture alone for any investment on their farm. This could perhaps explain the non-significant but positive relationship between the two variables among users.

Singh and Singh (1971), Makkar and Sohal (1974), Menon and Prema (1976), Mani and Knight (1981) and Vijayakumar (1983) also observed a significant positive relationship between attitude towards improved practices and farm size. Based on the above results, the hypothesis that there would be positive and significant relation between attitude and farm size was accepted in the case of non-user respondents, while the hypothesis was rejected in the case of users.

In the case of users, family educational status was found to have a positive but non-significant relation with attitude while the same had a positive and significant relationship in the case of non-users. The overall educational status of the family is likely to affect the comprehension of the members about the utility and feasibility of biogas technology under their farm and home situation and higher educational status naturally results in developing the cognitive domain of attitude towards biogas technology. This could explain the positive relationship between the two variables. Higher educational status might have helped the users in the proper evaluation of the pros and cons of the technology as a result of which the relation between the two variables probably turned non-significant. Based on the results, the hypothesis that there would be positive and significant relationship between attitude and family educational status was accepted for non-user respondents, while the same was rejected in the case of users.

A non-significant relationship was observed between family size and attitude of both user and non-user respondents. The size of a biogas plant for individual household is usually determined on the basis of the number of cattle possessed by the farmer. A large family with few cattle will not be able to meet the entire fuel requirement from a biogas plant alone. This in turn indicates that an individual household level, biogas plants are feasible only for small families which is an

FIG.7 RELATIONSHIP BETWEEN ATTITUDE TONARDS BIOGAS TECHNOLOGY OF NON-USERS AND SELECTED INDEPENDENT VARIABLES



inherent disadvantage of this technology, and hence the observed result. Reddy and Reddy (1977) and Kher and Jha (1978) also could not find any significant relationship between family size and attitude towards improved technology. Based on the result the hypothesis that there would be negative and significant relationship between family size and attitude towards biogas technology was rejected in the case of both users and non-users.

As for livestock possession, a positive and significant correlation (0.421) was observed with respect to attitude in the case of user respondents, while a positive but non-significant relationship was noticed in the case of non-user respondents. As mentioned earlier, biogas technology is being popularised in Kerala based on the recycling of cattle dung. Hence more the cattle population, more will be the input for the plant and more the fuel. This in turn could meet the fuel requirement of an entire family even one of a relatively larger size, explaining the significant positive relationship in the case of users. The fact that both fuel and manure can be obtained from the same source could also contribute towards a positive relationship between the two variables.

Based on the findings, the hypothesis that the attitude towards biogas technology of farmers would be positively and significantly associated with their livestock

possession was accepted in the case of user respondents while the same was rejected in the case of non-users.

Indebtedness indicated a negative but significant relationship with the attitude towards biogas technology in the case of user respondents and a negative but non-significant association in the case of non-users. Loans and subsidies are provided for the construction of biogas plants. Most of the users were found to have constructed their plants by availing these loan facilities. The installation cost often exceeds the loan availed by the farmers which affects the repayment of loans. Apart from this, the cost incurred for transportation of materials for the construction of the plant to remote areas had further increased the burden on the farmer. In addition, a farmer may have debt problems with other agricultural loans also. It is quite likely that with increasing debt the farmer may develop a negative orientation towards the technology and hence the observed result. A negative and significant relationship between attitude and indebtedness was also observed by Prakash (1980) and Viju (1985) in their studies on adoption of improved practices by tribal participants. In accordance with the results, the hypothesis that there would be negative and significant relationship between attitude and indebtedness was accepted in the case of users, while the same was rejected in the case of non-users.

The correlation coefficient (r) values of 0.399 and 0.704 indicated that both in the case of user and non-user respondents, a positive and significant relationship existed between the attitude towards biogas technology and their social participation. Attitude though is individual oriented, is largely borrowed from groups to which one belongs. The effect of organisational membership on behaviour has been reported by Sample and Warland (1953). Man is a social being, and his membership or involvement in different groups in the society influences his behaviour to a large extent and determines his attitude formation and change. The farmers who are members of different organisations might have obtained more information on farm and other related improved practices leading to a higher attitude. Majority opinion and group conformity are largely responsible for change in attitude which in turn could explain in positive correlation.

The finding is in agreement with those reported by Mani and Knight (1981), Cherian (1984) and Viju (1985) who had found a positive relationship between the two variables in their studies. Hence the hypothesis that the attitude of respondents towards biogas technology and their social participation would be positively and significantly related was accepted in the case of both users and non-users.

Utilization of interpersonal sources of information was found to have positive and highly significant relationship with the attitude of both users and non-users of biogas

technology. Individuals most often are strongly influenced by the opinion of friends, relatives and other who are closely and intimately associated with them. Information on different aspects of biogas technology might have been obtained through interaction with such different sources, both formal and informal, influencing attitude formation. More the frequency of interpersonal contacts, more will be the exposure and chances for attitude formation. Rogers (1958) had also pointed out the importance of personal influence in adoption. Lindzey and Aronson (1975) have brought out the role of social communication as a determinant of attitude, which includes communication or messages from other people which contain information that induces the receiver to change his attitude. Kamarudeen (1981), Cherian (1984) and Sanjeev (1987) had also reported the significant relationship between attitude and information source utilization in their studies on development programmes. Hence, the hypothesis that there would be positive and significant relationship between attitude of respondents towards biogas technology and their utilization of interpersonal sources of information was accepted in the case of both user and non-user respondents.

The 'r' values (0.682 and 0.479 respectively) given in Table 9 revealed that there was significant and positive relationship between innovation proneness and attitude towards biogas technology of both users and non-users. While theorizing the typology of innovative farmers, Rogers and Shoemaker (1971) have postulated that the inquisitiveness and

curiosity arising out of a farmer's search for efficient and latest farm technologies leads him to gather enough knowledge on improved practices. This phenomenon could well explain the positive relation between attitude and innovation proneness of farmers. Innovative farmers are likely to search for more information and adopt new ideas as a result of learning by observing and experimenting under their own farm situation. This process might have made the farmers gather more information on the principles and working of biogas technology and led to the development of a favourable attitude. Syamala (1988) found innovation proneness to be positively correlated with attitude in her study on National Demonstration Programme.

Based on the result, the hypothesis that there would be positive and significant relation between innovation proneness and attitude towards biogas technology was accepted in the case of both users and non-users.

It was found that rural background had a positive but non-significant association with attitude in the case of users, which had a negative and non-significant association in the case of non-users. Biogas is projected as a rural technology based on the principle of recycling of on farm resources. Most of the users of biogas technology are farmers possessing farm land and livestock reflecting a rural background. However, such farmers need not fully favour the

technology due to other obvious reasons which could probably explain the relationship between the two variables. Hence the hypothesis that there would be positive and significant relationship between attitude and rural background of users and non-users was rejected.

Extent of availability of perennial source of water was found to have a positive and significant relationship with attitude of users while it was not significant in the case of non-users. For generation of biogas, daily mixing of cow dung with equal quantity of water is required which forms the input for the plant. There is acute scarcity of water reported during summer in the study area. This is an important factor which could be relevant to any part of Kerala, with the extended droughts every year. This could adversely affect the efficient utilization of this technology resulting in developing a sort of unfavourable attitude towards the same. Hence the observed result is quite logical. Based on the results, the hypothesis that there would be positive and significant relationship between attitude and availability of perennial source of water was accepted for users which was rejected in the case of non-users.

A perusal of Table 9 revealed that while the relationship between extent of availability of other sources of fuel and attitude of users was negative and non-significant, the same was negative but significant, in the case of

non-users. When the sources of fuel like firewood or agricultural wastes are freely available from one's own farm, it is likely that the farmer may not perceive the advantage of biogas which incurs an initial investment for installation of the plant. The same problem has been reported by Bhavani (1976). This could naturally explain the significant negative association between the two variables in the case of non-users. Hence the hypothesis that there would be negative and significant relationship between attitude and extent of availability of other sources of fuel was accepted in the case of non-users which was rejected in the case of users.

A negative but significant relationship was noticed between attitude of users and their extent of utilization of other sources of fuel while the relationship was positive but non-significant in the case of non-users (Table 9). Due to larger family size or disposal or death of cattle or even due to some technical problems associated with the plant, there are chances that the biogas produced may not be adequate to meet the fuel requirement of the entire family. This in turn might have led to the utilization of other sources either available from one's own farm or bought for the purpose which would necessarily have resulted in an unfavourable outlook about the technology, which could explain the negative association between the two variables for users. Added to that, the mean score of family size of user respondents was higher than that of non-users (Table 8). During the course of

study the researcher had observed that most of the plants installed were not working to their full capacity compelling the farmers to utilize other sources of fuel. In accordance with the above results, the hypothesis that there would be negative and significant relationship between extent of utilization of other sources of fuel and attitude was accepted in the case of users which was rejected in the case of non-users.

5.2 Inter-correlation among the independent variables

The relative importance of the independent variables in relation to other independent variables with respect to the attitude of users and non-users is presented in Table 10.

It is evident that among users, farm size was related to the maximum number of independent variables while family educational status was related to minimum number of independent variables. As for non-users, annual income, farm size and family size were found related to maximum number of independent variables while indebtedness was related to the minimum number of independent variables.

The above results indicate that farm size was the most important factor, interrelated with maximum number of selected independent variables. A farmer's life is inextricably linked with his farm and other allied resources, and is directly and indirectly dependent for his livelihood on the returns from

Table 10 Relative importance of the independent variables in relation to other independent variables with respect to attitude of users and non-users

Sl. No.	Name of variables	Number of other independent variables with which it is significantly related					
		Users			Non-users		
		at 1 per cent level	at 5 per cent level	Total	at 1 per cent level	at 5 per cent level	Total
X_1	Educational status	6	2	8	5	2	7
X_2	Annual income	5	1	6	7	3	10
X_3	Farm size	8	1	9	7	3	10
X_4	Family educational status	1	-	1	2	4	6
X_5	Family size	1	1	2	7	4	11
X_6	Livestock possession	3	2	5	7	1	8
X_7	Indebtedness	7	-	7	1	-	1
X_8	Social participation	4	1	5	7	2	9
X_9	Utilization of interpersonal sources of information	7	1	8	7	1	8
X_{10}	Innovation proneness	7	1	8	7	2	9
X_{11}	Rural background	5	-	5	1	3	4
X_{12}	Extent of availability of perennial source of water	-	3	3	-	2	2
X_{13}	Extent of availability of other sources of fuel	3	1	4	3	3	5
X_{14}	Extent of utilization of other sources of fuel	3	-	3	1	2	3

farming. This aspect itself could explain the relationship of farm size with maximum number of other independent variables.

5.3 Step-wise regression analysis

This was employed to identify the best set of variables for predicting the dependent variable. The results of the step-wise regression analysis of attitude towards biogas technology of users and non-users with the selected independent variables are presented in Table 11 and 12.

It could be seen that of the total 77.65 per cent variation (Appendix IV) in the attitude of users explained by the selected variables found significant in correlation analysis, 75.19 per cent variation was explained by five variables. In Step No.I with only one variable included viz., utilization of interpersonal sources of information, 49.25 per cent of the variation in attitude could be explained. The predictive power increases with the inclusion of each variable in the successive steps, till a particular step when the per cent variation does not increase significantly. That step in which the highest per cent variation is explained is taken as the last step in which all variables included become significant. In this case, the fifth step gave the highest variation, which was taken as the final step.

In the final step, 75.19 per cent variation was explained by the five variables namely utilization of

Table 11 Results of step-wise regression analysis of attitude of users with selected independent variables

Step No.	Variable/s entering regression	Regression coefficient 'b'	S.E of 'b'	'F' value	Percentage of variation explained
I	Utilization of interpersonal sources of information	2.1286	0.2447	75.6801	49.25
II	Utilization of interpersonal sources of information	1.4657	0.2390	68.2043	63.92
	Perception about efficiency of biogas technology	1.1763	0.2102		
III	Utilization of interpersonal sources of information	1.2561	0.2291		
	Perception	0.9961	0.2012	57.2428	69.32
	Indebtedness	-0.9722	0.2658		
IV	Utilization of interpersonal sources of information	1.2461	0.2181		
	Perception	0.6562	0.2229	49.6121	72.57
	Indebtedness	0.2146	0.2657		
	Utilization of other sources of fuel	-0.9872	0.3311		
	Utilization of interpersonal sources of information	0.8184	0.2588		
	Perception	0.6184	0.438		
	Indebtedness	-1.06	0.2603	44.8727	75.19
	Utilization of other sources of fuel	-0.9621	0.3171		
	Innovation proneness	0.7528	0.2690		

Table 12 Results of step-wise regression analysis of attitude of non-users with selected independent variables

Sl. No.	Variable/s entering into regression	Regression coefficient 'b'	S.E. of 'b'	'F' value	Percentage of variation explained
I	Utilization of interpersonal sources of information	1.9350	0.1855	108.8519	58.26
II	Utilization of interpersonal sources of information	1.7453	0.1765	72.7754	65.40
	Family educational status	1.5350	0.3844		
III	Utilization of interpersonal sources of information	1.2844	0.2489		
	Family educational status	1.4076	0.3753	54.1168	68.11
	Social participation	0.7562	0.2914		
IV	Utilization of interpersonal sources of information	1.3467	0.2481		
	Family educational status	1.3628	0.3712	42.4545	69.37
	Social participation	0.6181	0.3039		
	Availability of other sources of fuel	0.3279	0.1874		
V	Utilization of interpersonal sources of information	1.3231	0.2465		
	Family educational status	1.1076	0.4044		
	Social participation	0.4806	0.3145	35.0226	70.29
	Availability of other sources of fuel	0.3190	0.1859		
	Educational status	0.6218	0.4086		

interpersonal sources of information, perception about the efficiency of biogas technology, indebtedness, utilization of other sources of fuel and innovation proneness. Thus these five variables were considered important in predicting the attitude towards biogas technology of users.

In the case of non-users, only eight selected independent variables found significant in simple correlation were included in step-wise regression. Among them, 70.29 per cent variation in attitude was explained by five variables viz., utilization of interpersonal sources of information, family educational status, social participation, availability of other sources of fuel and educational status. Here also, utilization of interpersonal sources of information alone could predict more than 58 per cent variation in attitude of non-users.

6. Relationship between perception of users about the efficiency of biogas technology and selected independent variables

6.1 Simple correlation analysis

The correlation coefficients showing the relationship between selected independent variables and perception is furnished in Table 13 and illustrated in Fig.8. Since only those persons who have first hand experience with the technology could form perception about its efficiency, only users were selected to study this aspect.

Table 13 Relationship between perception of users about efficiency of biogas technology and selected independent variables

Sl. No.	Name of variable	Coefficient of correlation (r)
X_1	Educational status	0.333**
X_2	Annual income	0.434**
X_3	Farm size	0.016^{NS}
X_4	Family educational status	0.145^{NS}
X_5	Family size	-0.138^{NS}
X_6	Livestock possession	0.470**
X_7	Indebtedness	-0.391**
X_8	Social participation	0.312**
X_9	Utilization of interpersonal sources of information	0.496**
X_{10}	Innovation proneness	0.437**
X_{11}	Rural background	0.089^{NS}
X_{12}	Extent of availability of perennial source of water	0.033^{NS}
X_{13}	Extent of availability of other sources of fuel	-0.198^{NS}
X_{14}	Extent of utilization of other sources of fuel	-0.479**

** Significant at 1 per cent level

* Significant at 5 per cent level

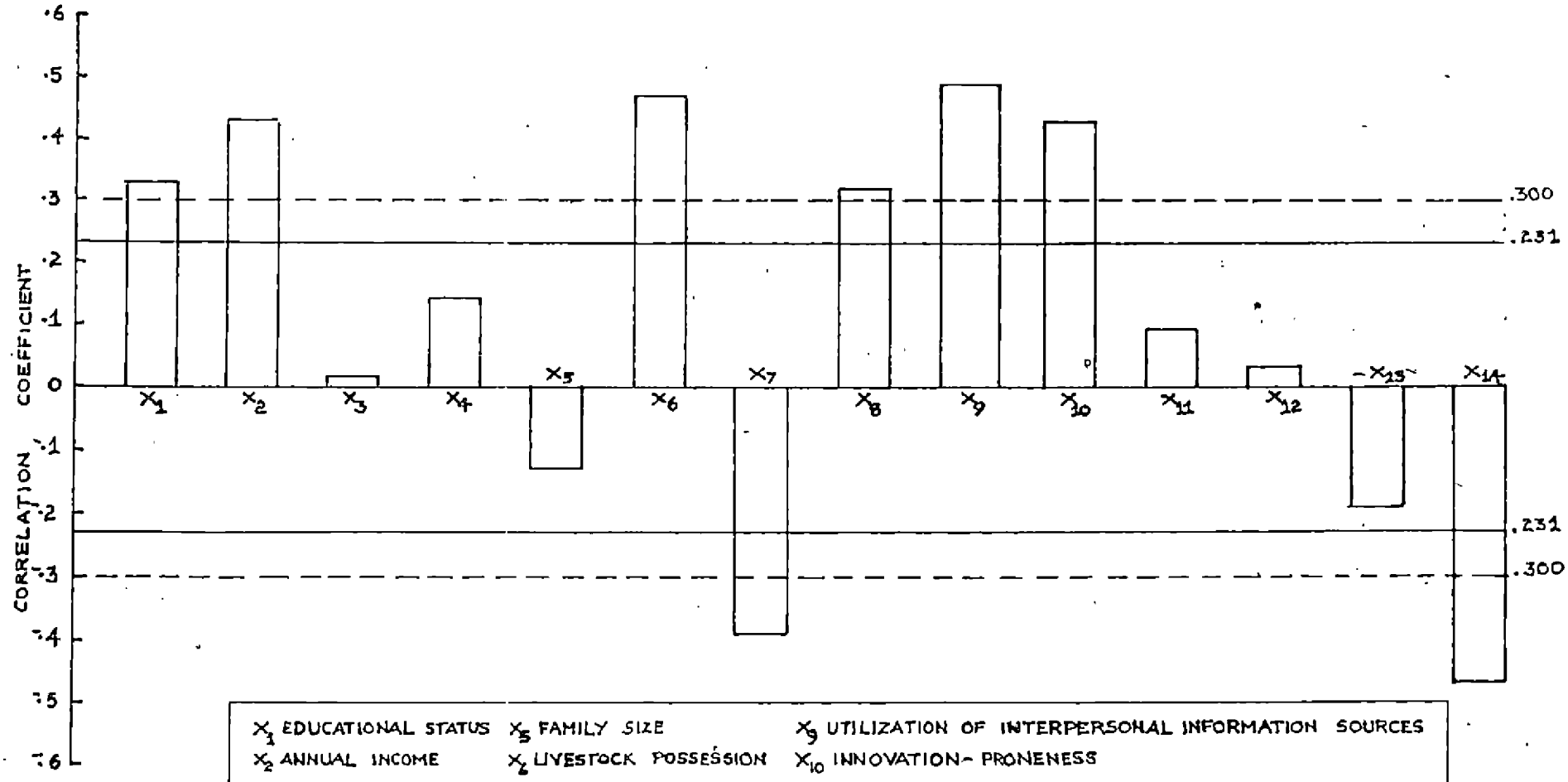
NS Non significant

Educational status was found to possess a high positive and significant relationship with the perception of users of biogas technology. Education improves the understanding and comprehension of an individual. Probably, better educated users could understand the principles and working of biogas technology and also its better fuel and fertilizer efficiency over other conventional energy sources thereby increasing their perception. The slurry coming out of the biogas plant has higher fertiliser efficiency than cattle dung which may not be fully accepted or understood by the less educated farmers.

Muthukrishnan (1982) also observed a positive correlation between education and perception of biogas plant owners in his study. Bhilegaonker and Dakh (1978), Sundaram (1986) and Balan (1987) had reported the same trend in their studies. Based on the observed results, the hypothesis that there would be a positive and significant relation between educational status and perception of users was accepted.

There was positive and significant correlation between annual income and perception of users of biogas technology. A higher annual income improves the general standard of living of the farmer. Biogas technology incurs a high initial installation cost which usually exceeds the loan provided. A farmer with higher annual income could afford this without

FIG.8 RELATIONSHIP BETWEEN PERCEPTION ABOUT THE EFFICIENCY OF BIOGAS TECHNOLOGY OF USERS AND SELECTED INDEPENDENT VARIABLES



X_1 EDUCATIONAL STATUS
X_2 ANNUAL INCOME
X_3 FARM SIZE
X_4 FAMILY EDUCATION
X_5 FAMILY SIZE
X_6 LIVESTOCK POSSESSION
X_7 INDEBTEDNESS
X_8 SOCIAL PARTICIPATION
X_9 UTILIZATION OF INTERPERSONAL INFORMATION SOURCES
X_{10} INNOVATION- PRONENESS
X_{11} RURAL BACKGROUND
X_{12} AVAILABILITY OF PERENNIAL WATER SOURCE
X_{13} AVAILABILITY OF OTHER FUEL SOURCES
X_{14} UTILIZATION OF OTHER FUEL SOURCES

much difficulty. Muthukrishnan (1982) also reported that persons with more annual income find it easy to install a gas plant compared to those with low income. All these aspects could explain the higher perception among users with higher annual income. Hence the hypothesis that there would be a positive and significant correlation between perception of users about efficiency of biogas technology and annual income was accepted.

It is evident from Table 13 that farm size, family educational status and family size did not have any significant association with the perception of users about efficiency of biogas technology. At the same time, family size showed a negative association indicating that larger the family, lower will be the perception about efficiency of biogas technology. Larger families make it impossible to meet the fuel requirement of entire family with the biogas produced from the plant leading to a low perception of need compatibility and profitability. Such families may also be forced to depend on other fuel sources, incurring additional burden. The hypothesis that family size would be negatively and significantly correlated with perception was rejected in accordance with the above results.

The findings of this study with respect to farm size is in contradiction to the findings of Muthukrishnan (1982) who observed a positive correlation between the two variables,

in his study on biogas technology. Balan (1987) also reported the opposite trend in his study. The hypothesis that there would be positive and significant correlation of perception of users about efficiency of biogas technology with their farm size and family educational status were rejected based on the findings.

A significant and positive correlation (0.470) was observed between the livestock possession and perception of users about efficiency of biogas technology. The livestock population is an important criterion in determining the size of the plant. More the number of cattle, more will be the input available for gas production, which in turn helps to develop a better perception of the fuel and fertilizer efficiency of the technology due to the steady and regular availability of gas. Muthukrishnan (1982) also observed the same trend in his study on utilization of biogas technology by farmers. Based on the findings, the hypothesis that there would be positive and significant correlation between livestock possession and perception of efficiency of biogas technology by users was accepted.

Indebtedness showed a negative but significant correlation (-0.391) with the perception of efficiency of biogas technology by users. The arguments put forth earlier to explain the association between attitude towards biogas technology and indebtedness hold good in this case also.

Inability to repay the loans in time could lead to a low perception of the technology in terms of its economics and profitability over other fuel sources. Based on the observed results, the hypothesis that there would be negative and significant relationship between indebtedness and perception of efficiency of biogas technology of users was accepted. Concrete steps are to be taken by the agencies engaged in popularising this technology to reduce the cost of installation and thus reduce the burden from debt on the potential adopters to improve the overall perception about the efficiency of this technology.

As for the three socio-psychological variables selected for the study, all showed a positive and significant relationship with perception of efficiency of biogas technology (Table 13). In the case of social participation, social perception may play a very important role in determining the individual's perception wherein things, situations and people are perceived according to the interests, attitudes and values of the group to which he belongs (Bhatia, 1978). Therefore, a significant correlation between perception and social participation is quite justifiable. Pillai (1978) and Sundaram (1986) also observed a positive relation between perception and social participation in their studies.

After installation, training on the principles and working of biogas plants is given to the farmers by the officials of the Department of Agriculture or KVIC officials, and interaction of farmers with such officials helps to develop a better perception about the technology. So also, contacts with other farmers who have installed biogas plants would have contributed to the development of a favourable perception. The above finding is in line with those of Sundaram (1986) and Balan (1987) who observed a positive correlation between perception and interpersonal sources utilization in their studies on soil conservation and soil testing respectively.

The significant relationship between innovation proneness and perception could be explained by Bem's (1972) theory of self perception, which states that people come to know their own attitudes, emotions and other internal states partially by inferring from their overt behaviour and the context in which this behaviour occurs. Farmers who are innovation prone will always have a tendency to gather more and more information about any new technology related to farming or allied aspects. This inclination in turn affects their overall behavioural pattern leading to a favourable perception.

Based on the results, the hypotheses that there would be positive and significant relation of perception of users

about the efficiency of biogas technology with their social participation, utilization of interpersonal sources of information and innovation proneness were accepted.

Among the situational variables selected for the study, rural background and extent of availability of perennial source of water indicated a positive but non-significant relationship with the perception of efficiency of biogas technology by the users. The results reveal that these two variables did not exert any significant influence on the perception of users. All the same, biogas is being projected as a farm oriented rural technology, which could probably explain the positive association between rural background and perception. So also, regular supply of water should be ensured which is an important input for the plant, and hence the positive relation between perception and availability of perennial source of water. Based on the results, the hypotheses that there would be a positive and significant relationship of rural background and extent of availability of perennial source of water with perception were rejected.

While extent of availability of other sources of fuel showed a negative but non-significant association with perception, extent of utilization of other sources of fuel revealed a negative and significant association. It is obvious that as long as other sources of fuel like firewood or agricultural wastes are readily and freely available to a

farmer from his farm, it is likely that he may not fully perceive the advantage of biogas technology. Moreover, when he has to incur a high cost on installation, the principle of recycling of on farm resources may not be readily accepted by him due to lack of direct source of income from the plant. A farmer who has to depend on other sources of fuel apart from biogas to meet the fuel requirement of his family is also not likely to perceive the efficiency of this technology. Inefficient working of the plant may also lead to dependability on other sources. Kretch and Crutchfield (1948) have rightly pointed out that the perceptual organisation of an individual is affected by his needs, moods and past experiences. Based on the results, the hypotheses that there would be negative relationship between extent of availability of other sources of fuel and perception was rejected while that of extent of utilization of other fuel sources and perception was accepted.

6.2 Step-wise regression analysis

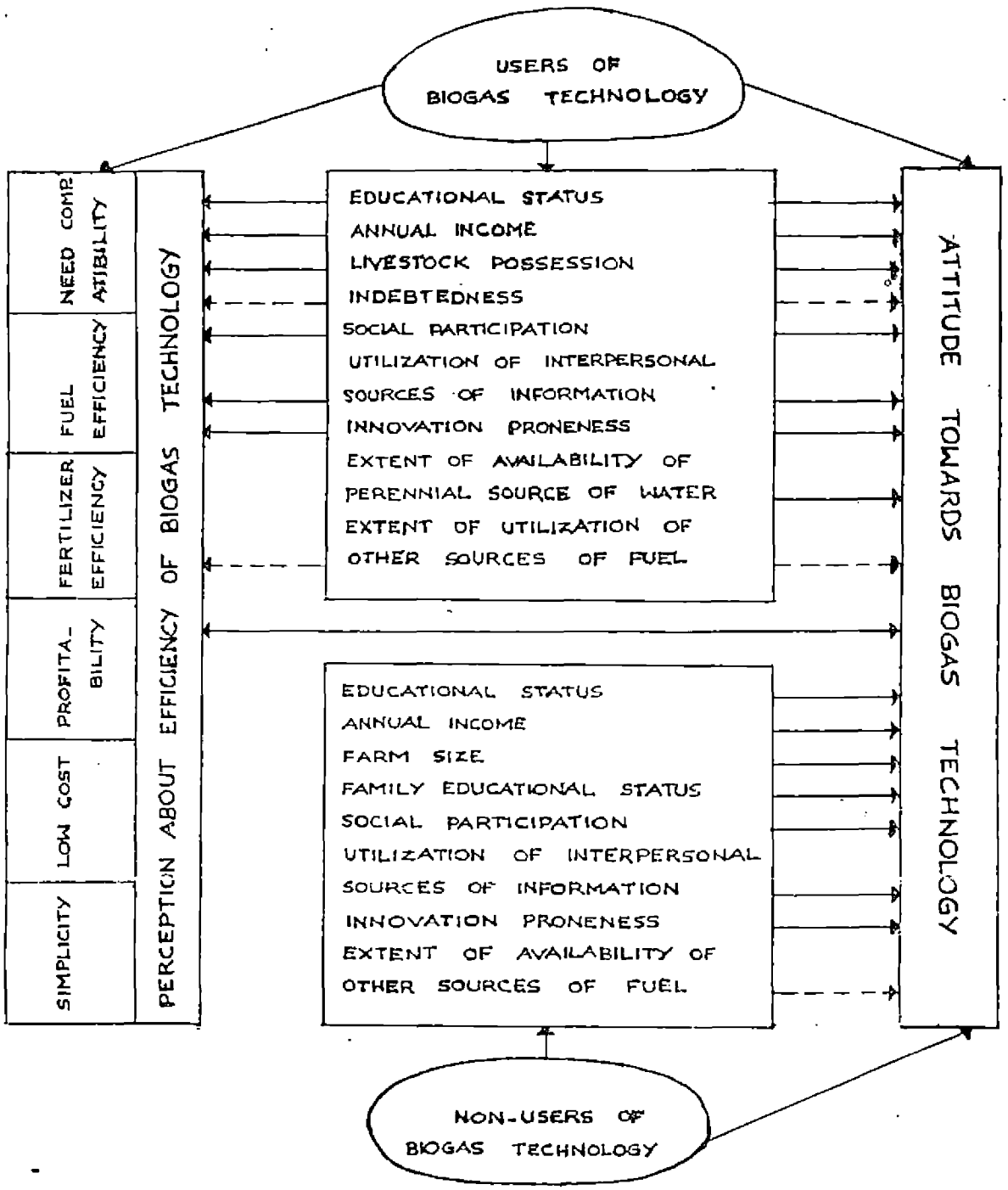
A clear idea of those variables which could explain the variation in the perception of users of biogas technology could be obtained from Table 14.

Out of the eight variables included in step-wise regression analysis, five variables entered the final step to explain the maximum variation in the dependent variable.

Table 14 Results of the step-wise regression analysis of perception of users with selected independent variables

Step No.	Variable/s entering into regression	Regression coefficient 'b'	S.E of 'b'	'F' value	Percentage of variation explained
I	Utilization of interpersonal sources of information	0.5635	0.1118	25.3866	24.55
II	Utilization of interpersonal sources of information	0.4775	0.1022	25.6563	39.99
	Utilization of other sources of fuel	-0.6847	0.1539		
III	Utilization of interpersonal sources of information	0.3320	0.1056		
	Utilization of other sources of fuel	-0.7597	0.1464	23.0407	47.63
	Indebtedness	-0.4253	0.1277		
IV	Utilization of interpersonal sources of information	0.2368	0.1067		
	Utilization of other sources of fuel	-0.6963	0.1427	20.7818	52.57
	Indebtedness	-0.4006	0.1227		
	Livestock possession	0.2152	0.0770		
V	Utilization of interpersonal sources of information	0.2096	0.1060		
	Utilization of other sources of fuel	-0.7217	0.1404		
	Indebtedness	-0.2844	0.1355	17.8948	54.73
	Livestock possession	0.2157	0.0757		
	Educational status	0.4261	0.2266		

FIG. 9 EMPIRICAL DIAGRAM SHOWING THE RELATIONSHIP BETWEEN THE DEPENDENT AND INDEPENDENT VARIABLES OF USERS AND NON-USERS OF BIOGAS TECHNOLOGY



These variables viz., utilization of interpersonal sources of information, utilization of other sources of fuel, indebtedness, livestock possession and educational status could together predict 54.73 per cent variation in perception of users. Thus these five variables could be considered as important in predicting the perception of users about the efficiency of biogas technology.

7. Constraints in utilization of biogas technology

The major constraints which were experienced by the user respondents in the utilization of biogas technology are presented in Table 15. The constraints were ranked based on the severity with which they were felt and expressed by the respondents.

A glance through the table reveals that the constraint, 'mixing slurry everyday is a botheration' obtained the highest rank followed by 'low gas production during monsoon', 'need for constant care of the plant', 'need for constant repair of the stove' and 'gas production not upto the requirement'. 'Non availability of loan in time' obtained the lowest rank among the constraints as felt by the users.

Biogas technology is highly labour intensive which requires daily mixing of cow dung with water in equal proportions to form a slurry which is the input for production of

Table 15 Constraints in utilization of biogas technology as felt by users

Sl. No.	Constraints	Weightage	Rank
1.	Non-availability of loan in-time	83	XII
2.	Lack of technical assistance from officials after installation	160	VI
3.	Gas production not upto the requirement	196	V
4.	Removal of scum required from time to time to maintain efficient gas production	88	X
5.	Low gas production during monsoon	231	II
6.	Need for constant care of the plant	225	III
7.	Lack of direct source of income from the plant	86	XI
8.	Need for constant repair of the stove	214	IV
9.	Mixing slurry everyday is a botheration	259	I
10.	Difficulty in transportation of the slurry	115	VIII
11.	Problem of storing excess gas	89	IX
12.	Commitment to maintain cattle after installation	140	VII

biogas. For efficient production of the gas, the input should have the correct proportion of the components and should be free from dirt or stones to avoid blocking of inlet. The mixing of slurry is done using hands and this is feared to cause rheumatism by the users. If labourers are employed, additional wages will have to be paid for the work and not only that, they may not mix the slurry according to the correct proportion. Moreover, with wages being too high in Kerala, this will definitely turn out as an additional burden on the farmer. With the changing life style of Kerala's rural masses, even tending cattle has become non-remunerative proposition among the cattle owners which used to be a part of household chores.

During rainy season, the availability of firewood is considerably reduced. Even if firewood is available, it may not burn efficiently during the monsoon season. As for the biogas plant which is considered as an alternative fuel source, due to lack of sufficient sunlight and heat, the activity of micro-organisms in the plant digestor also goes down lowering gas production. As pointed out by Malgaonker and Panandikar (1986), formation of gas requires a temperature of about 30°C. As this could not be maintained during rainy days, the fuel supply is likely to be affected. The low availability of biogas during a period when it is mostcrucial could be the reason for ranking this constraint as the second most important one by the users.

A biogas plant requires constant care and maintenance from the time it is installed. Mixing of slurry, painting the dome once in six months for the KVIC model, avoiding leaks and corrosion in the pipe-line and gas holder, avoiding the break-down of various components of the plant, preventing the choking of inlet or outlet and accumulation of water in the supply system are some of the aspects which have to be constantly looked into.

Apart from the plant, the stove was also found to require constant repair once in six months. This in turn hinders the efficient utilization of this technology. This also points out to the fact that from the technical point of view, the technology is yet to gain perfection.

8. Reasons for non-adoption of biogas technology

The probable reasons for the non-adoption of biogas technology are presented in Table 16. The reasons have been ranked based on the response of the non-users on the severity with which they were expressed.

'Botheration for maintenance of the plant' was the most important reason for non-adoption as indicated by the highest rank obtained. This was followed by 'availability of plenty of firewood', 'high installation cost of the plant', 'have seen biogas plants not working efficiently after installation' and 'risk involved in taking loan'. 'Lack of

Table 16 Reasons for non-adoption of biogas technology as felt by non-users

Sl. No.	Reason	Weightage	Rank
1.	High installation cost of the plant	216	III
2.	Availability of plenty of firewood	241	II
3.	Availability of LPG connection	107	XII
4.	High indebtedness	111	X
5.	Lack of sufficient space forinstallation of biogas plant	87	XIV
6.	Lack of faith in biogas plant	106	XIII
7.	Non-availability of perennial source of water	159	III
8.	Lack of sufficient information on the technology	155	VIII
9.	Lack of conviction on the advantages of biogas technology	150	IX
10.	Botheration for maintenance of the plant	254	I
11.	Firewood gives more heat than biogas	162	VI
12.	Have seen biogas plants not working efficiently after installation	175	IV
13.	Advice against installation from friends and relatives	110	XI
14.	Risk involved in taking loan	168	V

sufficient space for installation of the plant' was expressed as the least felt reason for non-adoption.

Any technology is not foolproof. Biogas technology also has its technical and practical constraints. The non-users could observe the constraints faced by their neighbouring farmers who had installed biogas plants. The need for mixing slurry everyday, the constant care and maintenance of the plants, botheration of stall feeding of the cattle once the plant is installed, the labour intensive nature of the technology - all these must have contributed to the non-adoption of technology inspite of possessing the required number of cattle.

For a farmer, who has free access to firewood and other agricultural wastes, who can obtain them from his own farm will not feel the need of a biogas plant to meet his fuel requirement. As long as he does not have to pay for firewood, he will be reluctant to adopt the technology. This could explain the reason for non-adoption based on the availability of plenty of firewood.

Biogas technology is popularised in Kerala through loans and subsidies. Even then the installation cost exceeds the loan amount due to the escalating cost of building materials and high transportation charges. This in turn must have prevented the non-users from adopting the technology

pointing out to the high installation cost as a major constraint.

Other findings :

During the course of study, a few other observations made by the researcher are presented below:

1. Biogas technology is mainly implemented by the KVIC and the Department of Agriculture in Kerala. Even though the plant is constructed for the beneficiaries by these agencies the fitting of pipelines and the gas stove have to be carried out independently by the farmer. This multi resource dependability itself affects the efficient utilization of this technology. For the repair of any of the plant components, the plant, the pipelines or the stove, the farmer has to approach diverse agencies to get the plant in working condition. If there was a single window delivery system for the implementation of this technology it would have reduced the burden on the beneficiaries and in turn hastened adoption.

2. At least 25 per cent of the users pointed out that provision of loans and subsidies by the Government was the main motive behind adoption of biogas plants. This aspect indicates the influence of extrinsic motivation in adoption of this technology. It also points out to the

fact that these users were not fully aware of the importance of biogas technology as an on farm, non-conventional, renewable source of fuel and had adopted it only because of the incentive. In the long run, provision of such incentives would only increase the dependability of the farming community on subsidies and such other incentives which may affect their self-reliance.

3. In Kavassery Krishi Bhavan area, none of the biogas plants visited by the researcher were working to their full efficiency. After installation, the farmers had repaired the plants many times to keep them working. This in turn had made it impossible for the users to repay the loan in time. Hence maximum indebtedness with respect to biogas technology was observed in this Panchayat. Moreover farmers who had adopted the technology were cautioning their neighbours not to install the plants in their house. This implies that, in the long run, unless more care is taken in the construction of the plants which are trouble free it is bound to reduce the rate of adoption.

. It would be observed that many of the respondents were shifting to other occupations and converting their paddy lands for cash crops or other non-farm purposes. Since the maintenance of cattle is dependent on farm resources, this is bound to reflect on the utilization of biogas technology in the long run. Hence, popularisation of

other organic wastes for gas generation besides cattle dung could be taken up immediately by the implementing agencies to reduce the dependability on a single source of input for generation of biogas.

Summary

CHAPTER V

SUMMARY

The growth of human population and the development of civilizations have led to the increasing consumption of various energy sources all over the world. As far as India is concerned, commercial sources which are non-renewable and expensive mostly cater to the urban and industrial needs. In the rural areas, non-commercial sources like firewood, cattle dung and agricultural wastes still form the main sources of energy. Over-exploitation of fossil fuels and firewood is environmentally destructive which poses many problems as well. So there has been an urgent need to harness viable renewable sources of energy like solar, wind, biomass, hydel or geothermal power to meet the ever increasing demand for energy.

Biogas technology, based on anaerobic decomposition of organic wastes has tremendous potential in the case of rural areas in India. With the largest cattle population in the world and the availability of plenty of biomass, biogas technology, by providing a valuable fuel and fetilizer source could reduce our energy problem to some extent. Realizing its importance in rural India, the Khadi and Village Industries Commission (KVIC) had launched the biogas movement way back in 1970s. However, it could not make much progress till the 1980s.

Against this background, the National Project for Biogas Development (NPBD) was launched in 1982 under the Ministry of Energy to intensify the popularisation of this technology in all the States. Since then, the State Department of Agriculture and the KVIC have been the main agencies responsible for its dissemination in Kerala. Inspite of their intensive efforts, to what extent this technology has been utilized and accepted by the farmers and their perception about its efficiency still remains unknown due to lack of any systematic empirical study. No research study has been found reported on this aspect in Kerala. Hence this study was undertaken with the following specific objectives.

1. To compare the attitude of users and non-users towards biogas technology

2. To study the perception of users about the efficiency of biogas technology

3. To find out the motivational pattern of users in the adoption of biogas technology

4. To find out the influence of selected socio-economic, socio- psychological and situational characteristics of the farmers on attitude and perception

5. To find out the constraints in utilization of biogas technology and reasons for non-adoption

The study was conducted in Palakkad district of Kerala State during the period 1989-1990. Alathur, Kavassery, Nemmara and Ayiloor Krishi Bhavans under Alathur Agricultural Subdivision were randomly selected for the study purpose. From each selected Krishi Bhavan, 20 users of biogas technology were randomly selected to make up the total of 80 user respondents. From the same areas, 80 non-users of biogas technology who owned cattle but had not yet installed the biogas plant were randomly selected to form another category of respondents.

Attitude towards biogas technology and perception about the efficiency of biogas technology were the dependent variables selected for the study. Fourteen independent variables were selected for the study, which included education, annual income, farm size, family educational status, family size, livestock possession, indebtedness, social participation, utilization of interpersonal sources of information, innovation proneness, rural background, extent of availability of perennial source of water, extent of availability of other sources of fuel and extent of utilization of other sources of fuel. The relationship between these independent variables and the two dependent variables was studied.

The data were collected from the farmers using a structured interview schedule developed for the purpose.

Analysis of the data was done using Student's 't' test, simple correlation and step-wise regression analysis.

The salient findings of the study are summarised and presented below.

1. There was no significant difference between the users and non-users with respect to their attitude towards biogas technology. Majority of the respondents of both the groups belonged to the medium attitude category.

2. Majority of the user respondents were found to possess a medium level of perception about the efficiency of biogas technology. Among the six attributes of biogas technology studied, simplicity obtained the highest rank followed by fuel efficiency, profitability, need compatibility, fertilizer efficiency and low cost respectively in that order.

3. "Safety" was found to be the most important motive influencing the adoption of biogas technology followed by security, utility, economy, achievement and prestige motives respectively in that order.

4. Correlation analysis revealed that perception, educational status, annual income, livestock possession, social participation, utilization of interpersonal sources of information, innovation proneness and extent of availability of perennial source of water had positive and significant relationship with attitude towards biogas

technology of users while indebtedness and utilization of other sources of fuel were negatively and significantly related with their attitude.

5. In the case of non-users, correlation analysis revealed that educational status, annual income, farm size, family educational status, social participation, utilization of interpersonal sources of information and innovation proneness were positively and significantly related with attitude towards biogas technology, while availability of other sources of fuel was negatively and significantly correlated with their attitude.

6. Inter-correlation analysis among the independent variables revealed that among users, farm size was related to the maximum number of other independent variables. As for non-users, family size was related to the maximum number of independent variables.

7. The step-wise regression analysis revealed that utilization of interpersonal sources of information, perception about the efficiency of biogas technology, indebtedness, utilization of other sources of fuel and innovation proneness contributed to the maximum variation in the attitude of users towards biogas technology. In the case of non-users, utilization of interpersonal sources of information, family educational status, social participation, availability of other sources of fuel and

educational status could predict the maximum variation in their attitude.

8. Educational status, annual income, livestock possession, social participation, utilization of interpersonal sources of information and innovation proneness were found to have positive and significant relationship with the perception of users about the efficiency of biogas technology. Indebtedness and extent of utilization of other sources of fuel were found to possess a significant but negative association with perception of users.

9. The step-wise multiple regression analysis revealed that five variables namely utilization of interpersonal sources of information, utilization of other sources of fuel, indebtedness, livestock possession and educational status could explain the maximum variation in perception of users about the efficiency of biogas technology.

10. "The need for mixing slurry every day" was the most important constraint in utilization of biogas technology felt by the users. Low gas production during monsoon, need for constant care of the plant and need for constant repair of the stove were other constraints felt by the users in the descending order of importance.

11. Among the various reasons cited for non-adoption of biogas technology, botheration for maintenance of the plant obtained the highest rank. Availability of plenty of

firewood, high installation cost of the plant and plants were seen not working efficiently after installation were other important reasons indicated by non-users.

Implications and recommendations

The following implications and recommendations emerge out of the findings of the study.

1. The study indicated only a medium level of perception and attitude among the users of biogas technology. This implies that the beneficiaries are not yet fully convinced of the long term advantages of this technology. Steps may be taken by extension workers of the implementing agencies to create conviction among the farmers about the importance of this technology in the present energy crunch situation. Efforts may be made to enable the farmers to perceive the different positive attributes of the technology especially the fertilizer efficiency of this technology in a practical perspective thereby enhancing the rate of adoption.

2. The commercial sources of energy are bound to become scarce for the years to come. If renewable energy sources like biogas are to become popular among the rural masses, there is an urgent need to make them technically foolproof. The requirement of constant care and maintenance and need for frequent repair may refrain the potential adopters

from accepting this technology. Research may be undertaken to make suitable technical modifications to reduce such burden on the users.

3. Biogas technology in Kerala is characterised by over dependence on cattle dung. With rice farming and cattle rearing becoming unprofitable enterprises, this dependency on a single input for the biogas plants is bound to create problems in the future. The implementing agencies may popularize other organic wastes besides cattle dung for fuel and fertilizer production. Necessary modifications may also be made in the models to enable the use of other organic wastes which are locally available.

4. High installation cost of the plant is an important aspect hindering the progress of biogas technology. Measures should be taken by the implementing agencies to reduce the installation cost through the development of efficient low cost models which would reduce the financial burden on the beneficiaries.

5. Even though the biogas plant is constructed for the user by the implementing agency, he has to depend on other agencies for pipe and stove fittings and put the plant into operation. Steps may be taken to deliver the technology completely through a single agency to make the installation easier.

6. Unlike in the past, farming is not an economic proposition anymore. With our farmers switching over to other profitable enterprises, such farm and organic waste based technologies like biogas are bound to disappear in the long run. Added to that, agricultural land is being converted for non-agricultural purposes. Therefore, the most urgent need is to check the tendency to shifting from farming and related activities. This could also help to restore self-reliance and reduce dependability on outside energy sources in the years to come.

Suggestions for future research

The present study was confined to four areas in a single district. A comprehensive study on the utilization of biogas technology covering all Districts with a larger sample size and including more variables could be undertaken. This would help the implementing agencies to get an over view of the impact of this technology on the farming community.

A comparitive study of the three models namely the floating drum, Janata and Deenabandhu could be undertaken to evaluate their merits and demerits as experienced by the farmers.

A comprehensive study on the influence of various sources of information, both mass media and interpersonal on

the adoption and utilization of biogas technology could be undertaken.

An evaluative research on the role of the different implementing agencies in the popularisation of biogas technology could be taken up to study the extent of extension efforts to popularize this technology.

An experimental study on the feasibility of other organic sources as input for biogas plant could also be undertaken to study their acceptance by the adopters.

Case studies on the feasibility of community biogas plants taking the social, economic and cultural factors into consideration could also be undertaken.

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Appendices

APPENDIX-I

THE STATEMENTS SELECTED FOR DEVELOPING THE SALE FOR MEASURING THE ATTITUDE OF USES AND NON-USERS TOWARDS BIOGAS TECHNOLOGY WITH THEIR 't' VALUES

ക്രമ നംബർ	പ്രസ്താവന	't' value
1.	ബയോഗ്യാസ് പ്ലാന്റ് ഇന്ധനവും വളവും പ്രദാനം ചെയ്യുവാൻ കഴിവുള്ള ഒരു ഉപാധിമാണ്	2.457
2.	ബയോഗ്യാസ് പ്ലാന്റിന്റെ ഉപയോഗത്തിലൂടെ ഇന്ധന്തിനു വേൽടി വൃക്ഷങ്ങൾ മുറിക്കുന്നത് തടയാൻ സാധിക്കും.	5.548
3.	പാവപ്പെട്ട കർഷകർക്ക് ബയോഗ്യാസ് പദ്ധതിയിലൂടെ ചെലവ് താങ്ങുവാൻ ബുദ്ധിമുട്ടാണ്	0.159
4.	ബയോഗ്യാസ് ഉപയോഗിക്കുന്നതിലൂടെ വിറകു ശേഖരിക്കാൻ വേൺടെ പ്രവൻത്തം ലാഭിക്കാം	2.535
5.	ബയോഗ്യാസ് ഉപയോഗിക്കുന്നതുവഴി കർഷകർക്ക് വീട്ടാവശ്യത്തിനുള്ള ഇന്ധനം ലഭിക്കുന്നതാണ്	5.037
6.	ബയോഗ്യാസ് പ്ലാന്റിൽ നിന്നും ലഭിക്കുന്ന വാതകത്തിനു വിറകിനേക്കാൾ ഇന്ധനക്ഷമത കൂടുതലാണ്	3.908
7.	അടുക്കളയിൽ പുകക്കൊൺടുള്ള പ്രശ്നങ്ങൾ ഒഴിവാക്കാൻ ബയോഗ്യാസ് പദ്ധതി നല്ലതാണ്	6.955
8.	ബയോഗ്യാസ് പ്ലാന്റിന്റെ നിർമ്മാണ ചെലവ് വളരെ കൂടുതലാണ്	1.736
9.	കന്നുകാലികളുടെ വിസർജ്ജന വസ്തുക്കൾ കാര്യക്ഷമമായി ഉപയോഗിക്കാൻ ബയോഗ്യാസ് പ്ലാന്റ് വഴി സാധിക്കും	5.328
10.	ബയോഗ്യാസ് പ്ലാന്റ് സ്ഥാപിക്കുന്നതു വഴി ഗ്രാമങ്ങളിലെ പരിസരം കൂടുതൽ വൃത്തിയായി സൂക്ഷിക്കുവാൻ സാധിക്കുന്നു.	1.15
11.	പാവപ്പെട്ട കർഷകർക്ക് പാചകത്തിനും വെളിച്ചത്തിനും ആവശ്യമായ ഇന്ധനം ലഭിക്കാൻ മെച്ചപ്പെട്ടൊരു മാർഗ്ഗമാണ് ബയോഗ്യാസ് പ്ലാന്റ്	3.562
12.	ഭാണകം ഉൺടാക്കി കത്തിക്കുന്നതിനേക്കാൾ കൂടുതൽ ചൂടു കിട്ടുവാനും വേഗത്തിൽ പാചകം ചെയ്യുവാനും ബയോഗ്യാസ് വഴി സാധിക്കും	2.248
13.	ബയോഗ്യാസിന് സാധാരണ നിലിൺടറിൽ കിട്ടുന്ന പെട്രോളിയം ഗ്യാസിനെ അപേക്ഷിച്ചു ചെലവ് കുറവാണ്	3.854
14.	പെട്രോളിയം വാതകത്തിനേക്കാൾ സുരക്ഷിതമായി ഉപയോഗിക്കാവുന്ന ഒന്നാണ് ബയോഗ്യാസ്	6.5
15.	ഊർജ്ജം കിട്ടുവാനുള്ള മറ്റു മാർഗ്ഗങ്ങളെ അപേക്ഷിച്ചു ബയോഗ്യാസ് കൂടുതൽ ലാഭകരമാണ്	6.571
16.	ബയോഗ്യാസ് ഉപയോഗിച്ചാലും വിറകിനു വേൺടി മരങ്ങൾ വെട്ടിമുറിക്കുന്നത് ഒരു തരത്തിലും കുറയ്ക്കാൻ സാധിക്കുകയില്ല	2.464

17.	ബയോഗ്യാസ് പ്ലാന്റ് സ്ഥിരമായി പ്രവർത്തിപ്പിക്കുന്നതിനു ദിവസേന കുറച്ച് പണിയെടുക്കണം	2.321
18.	പ്ലാന്റിലേക്കു വേണ്ട ചാണകമായിനി തയ്യാറാക്കാൻ കുറേയേറെ സമയം വിനിയോഗിക്കേണ്ടിവരുന്നു	2.325
19.	ബയോഗ്യാസ് പ്ലാന്റ് സ്ഥാപിച്ചു കഴിഞ്ഞാൽ നിരന്തരമായ റിപ്പയർ വേണ്ടി വരുന്നു	4.684
20.	എന്റെ അഭിപ്രായത്തിൽ ഇപ്പോൾ നമ്മൾ അനുഭവിക്കുന്ന ഇന്ധനക്ഷാമത്തിനു ഏക പരിഹാരം ബയോഗ്യാസ് പദ്ധതി മാത്രമാണ്	4.763
21.	ഗ്യാസുല്പാദനം കഴിഞ്ഞ ചാണക വെള്ളത്തിനു, വളക്കൂറ് കൂടുതലായിരിക്കും	3.755
22.	വാതകോല്പാദനത്തിനു ശേഷമുള്ള ചാണകം മണ്ണിന്റെ ഘടന മെച്ചപ്പെടുത്തുവാൻ സഹായിക്കുന്നു.	4.810
23.	ഗ്യാസുല്പാദനത്തിലൂടെ ചാണകത്തിൽ സാധാരണമായി കാണുന്ന കളകളുടെ നിയന്ത്രണം സാധ്യമാകുന്നു	4.397
24.	എന്റെ അഭിപ്രായത്തിൽ ബയോഗ്യാസിന് വിറകിനേക്കാൾ ചിലവു കുറവാണ്	4.062
25.	ഒരു വീട്ടിലേക്കാവശ്യമുള്ള ഇന്ധനം മുഴുവനും ബയോഗ്യാസ് പ്ലാന്റിൽ നിന്നും ലഭിക്കും	4.274
26.	ബയോഗ്യാസ് ഉപയോഗിക്കുക വഴിവീട്ടമ്മമാർക്ക് അടുക്കള ജോലി ലഘൂകരിക്കാൻ കഴിയുന്നു	3.858
27.	ഗ്രാമങ്ങളിൽ അഭ്യസ്തവിദ്യരും തൊഴിൽ രഹിതരുമായ യുവജനങ്ങൾക്കു തൊഴിലവസരങ്ങൾ സൃഷ്ടിക്കാൻ ബയോഗ്യാസ് പ്ലാന്റ് നിർമ്മാണം സഹായിക്കുന്നു.	1.327
28.	ബയോഗ്യാസ് ഉപയോഗിക്കുന്നതുവഴി, ഒരു പരിധിവരെ വിറകിനെ ആശ്രയിക്കുന്നത് കുറയ്ക്കാൻ സാധിക്കും	5.109
29.	ഗ്രാമപ്രദേശങ്ങളിൽ ബയോഗ്യാസ് കൂടുതൽ പ്രചരിപ്പിക്കണം	4.930
30.	ബയോഗ്യാസ് ശരിയായ രീതിയിൽ ഉപയോഗിക്കാനുള്ള സാങ്കേതിക വിവരങ്ങൾ കിട്ടുവാൻ എളുപ്പമല്ല	4.968
31.	ബയോഗ്യാസ് പദ്ധതിയും സർക്കാരിന്റെ മറ്റു പല പദ്ധതികൾപോലെ കർഷകന്റെ കണ്ണിൽ പൊടിയിടാൻ വേണ്ടിമാത്രം തയ്യാറാക്കിയ ഒന്നാണ്	3.677
32.	ഗ്രാമപ്രദേശങ്ങളിലെ ഇന്ധനക്ഷാമം കുറയ്ക്കാൻ ബയോഗ്യാസ് പദ്ധതിയ്ക്കു സാധിക്കുകയില്ല	3.87
33.	സബ്സിഡിയുണ്ടെങ്കിൽ പോലും ബയോഗ്യാസ് പ്ലാന്റിന്റെ നിർമ്മാണം ചെലവേറിയതാണ്	2.36

APPENDIX - IIa

F matrix of the paired comparison test

	1 Safety motive	2 Utilitarian motive	3 Security motive	4 Economic motive	5 Prestige motive	6 Achievement motive
1 Safety motive	40	7	35	17	2	23
2 Utilitarian motive	73	40	63	58	3	54
3 Security motive	45	17	40	17	4	20
4 Economic motive	63	22	63	40	5	30
5 Prestige motive	78	77	76	75	40	72
6 Achievement motive	57	26	60	50	8	40

APPENDIX - IIb

P matrix of the paired comparison test

	1 Safety motive	2 Utilitarian motive	3 Security motive	4 Economic motive	5 Prestige motive	6 Achievement motive
1 Safety motive	0.5	0.088	0.437	0.212	0.025	0.288
2 Utilitarian motive	0.912	0.5	0.788	0.725	0.037	0.675
3 Security motive	0.563	0.212	0.5	0.212	0.05	0.25
4 Economic motive	0.788	0.275	0.788	0.5	0.062	0.375
5 Prestige motive	0.975	0.963	0.95	0.938	0.5	0.9
6 Achievement motive	0.712	0.325	0.75	0.625	0.1	0.5
Sum	4.45	2.363	4.213	3.212	0.774	2.988

APPENDIX - IIc

P matrix (arranged in ascending order) of the paired comparison test

	1 Prestige motive	2 Utilitarian motive	3 Achievement motive	4 Economic motive	5 Security motive	6 Safety motive
1 Prestige motive	0.5	0.963	0.9	0.938	0.95	0.975
2 Utilitarian motive	0.037	0.5	0.675	0.725	0.788	0.912
3 Achievement motive	0.1	0.325	0.5	0.625	0.75	0.712
4 Economic motive	0.062	0.275	0.375	0.5	0.788	0.788
5 Security motive	0.05	0.212	0.25	0.212	0.5	0.563
6 Safety motive	0.025	0.088	0.288	0.212	0.437	0.5
Total	0.774	2.363	2.988	3.212	4.213	4.45

APPENDIX - III

UTILIZATION OF BIOGAS TECHNOLOGY BY FARMERS OF PALGHAT

Interview Schedule

Krishi Bhavan: Sub division: Respondent No.

1. Name of the farmer :
2. Address :

I SOCIO ECONOMIC VARIABLES

1. Education : Illiterate/functionally literate Lower primary/Upper primary/ High School/Vocational courses/ Collegiate
2. Economic status
   - (a) Main occupation : Farming/any other occupation (specify)
   - (b) Annual income (in Rs.) Agriculture :
     Other sources :
     Total :
   - (c) Farm size Wet land :
     Garden land :
     Total :
3. Family status

Sl. No.	Name	Relation-ship with the head of the family	Age	Educat-ion	Occupa-tion	Whether employed or family labour

4. Livestock possesion

Sl. No.	Type	Number
1		
2		
3		
4		
5		

5. Indebtedness

Sl. No.	Source	Purpose of borroving	Amount borrowed (in Rs.)	Amount repaid todate	Balance outstand-ing
1					
2					
3					
4					
5					

II SOCIO-PSYCHOLOGICAL VARIABLES

1. Social participation

(Please indicate whether you are member or office bearer in any one of the following organisations, if so, how frequently you attend the meetings/activities of the organisation)

Sl. No.	Organisation	Nature of participation		Frequency of taking part in meetings/ activities		
		Member	Office bearer	Always	Some-times	Never
1.	Panchayat					
2.	Milk Co-operatives					
3.	Service Co-operatives					
4.	Political organisations					
5.	Trade Union					
6.	Farmers' Organisation					
7.	Youth Club					
8.	Any other (Specify)					

2. Utilization of interpersonal sources of information

(Please indicate from which of the following sources you obtain technical information regarding biogas technology)

Sl. No.	Sources	Frequency		
		Always	Sometimes	Never
1.	Agricultural Officer			
2.	Demonstrator			
3.	KVIC Officials			
4.	Village Extension Officials			
5.	Relatives			
6.	Friends			
7.	Neighbours			
8.	Any other (specify)			

3. Innovation proneness

Mark your agreement/disagreement to the following sets of three statements

Sl. No.		Statements	Agree	Disagree
a	(i)	I try to keep myself uptodate with information on new farm practices, but that does not mean that I try all new methods in my farm		
	(ii)	I feel restless till I try out a new farm practice, I have heard about		
	(iii)	They talk of many new farm practices these days but who knows if they are better than the old ones		
b	(i)	From time to time I have heard of several new farm practices and I have tried out most of them in the last few years		
	(ii)	I usually wait to see what results my neighbours obtain before I try out the new farm practices		
	(iii)	Somehow I believe that the traditional ways of farming are the best		
c	(i)	I am cautious about trying a new practice		
	(ii)	After all our forefathers were wise in their farming practices and I do not see any reason for changing these old methods		
	(iii)	Often new practices are not successful, however if they are promising, I would surely like to adopt them		

4. Motivational pattern

Below are given some pairs of statements. From each pair select that statement to which you agree more and more and mark (✓) against the statement

1. (a) I have installed a biogas plant in my house to provide clean and safe fuel which facilitates smokeless cooking. (Safety)

   (b) I have installed a biogas plant to provide more efficient cooking fuel compared to kerosene or firewood (Utilitarian)

2. (a) Installation of biogas plant has helped me to reduce the dependability on firewood (Security)

   (b) I have installed a biogas plant because it provides a cheaper fuel compared to kerosene or firewood (Economic)

3. (a) I have installed a biogas plant in my house to increase my prestige in the village (Prestige)

   (b) I have installed a biogas plant for the efficient recycling of local resources thereby increasing our self-sufficiency (Achievement)

4. (a) I have installed a biogas plant to provide a more efficient cooking fuel compared to kerosene or firewood (Utilitarian)

   (b) Installation of biogas plant has helped me to reduce the dependability on firewood (Security)

5. (a) I have installed a biogas plant because it provides a cheaper fuel than firewood or kerosene (Economic)

   (b) I have installed a biogas plant in my house to increase my prestige in the village (Prestige)

6. (a) I have installed a biogas plant in my house to provide a clear and safe fuel which facilitates smokeless cooking (Safety)

   (b) Installation of biogas plant has helped me to reduce the dependability on firewood (Security)

7. (a) I have installed a biogas plant to provide a more efficient cooking fuel compared to kerosene or firewood (Utilitarian)

   (b) I have installed a biogas plant in my house to increase my prestige in the village (Prestige)

8. (a) I have installed a biogas plant because it provides a cheaper fuel than firewood or kerosene (Economic)

   (b) I have installed a biogas plant for the efficient recycling of local resources thereby increasing our self-sufficiency (Achievement)

9. (a) I have installed a biogas plant in my house to provide a clean and safe fuel which facilitates smokeless cooking (Safety)

(b) I have installed a biogas plant in my house to increase my prestige in the village (Prestige)

10. (a) I have installed a biogas plant to provide a more efficient cooking fuel compared to kerosene or firewood (Utilitarian)

(b) I have installed a biogas plant for the efficient recycling of local resources thereby increasing our self-sufficiency (Achievement)

11. (a) Installation of biogas plant has helped me to reduce the dependability on firewood (Security)

(b) I have installed a biogas plant in my house to increase my prestige in the village (Prestige)

12. (a) I have installed a biogas plant in my house to provide a clean and safe fuel which facilitates smokeless cooking (Safety)

(b) I have installed a biogas plant for the efficient recycling of local resources thereby increasing our self-sufficiency (Achievement)

13. (a) I have installed a biogas plant to provide a more efficient cooking fuel compared to kerosene or firewood (Utilitarian)

(b) I have installed a biogas plant because it provided a cheaper fuel than firewood or kerosene (Economic)

14. (a) Installation of biogas plant has helped me to reduce the dependability on firewood (Security)

(b) I have installed a biogas plant for the efficient recycling of local resources thereby increasing our self-sufficiency (Achievement)

15. (a) I have installed a biogas plant to provide a clean and safe fuel which facilitates smokeless cooking (Safety)

(b) I have installed a biogas plant because it provides a cheaper fuel than firewood or kerosene (Economic)

III ATTITUDE TOWARDS BIOGAS TECHNOLOGY

Below are given some statements on biogas technology. Please indicate your agreement or disagreement by marking (✓) in the appropriate columns, against each statement

Sl. No.	Statement	SA	A	UN	DA	SDA
1.	Utilization of biogas technology facilitates smokeless cooking					
2.	It is difficult to obtain proper technical guidance for the efficient utilization of biogas technology					
3.	Biogas is cheaper compared to other sources of fuel					
4.	Biogas plants once installed require constant repair and maintenance					
5.	Biogas is more safe compared to butane gas					
6.	Implementation of biogas technology cannot reduce the problem of fuel crisis in rural areas					
7.	Biogas technology helps in efficient utilization of animal wastes					
8.	Just like any other government programme, biogas scheme is also not going to benefit the farming community					
9.	Utilization of biogas technology helps to reduce the dependability on firewood					
10	Adoption of biogas technology helps to prevent the cutting down of forest trees for firewood					

IV. PERCEPTION ABOUT THE EFFICIENCY OF BIOGAS TECHNOLOGY

Please indicate your agreement to the following statements on biogas technology my marking a (✓) in the appropriate column

Sl. No.	Statement	Fully agree	Agree to some extent	Disagree
1.	I could understand the principles and working of my biogas plant with minimum effort			
2.	The initial installation cost of a biogas plant is affordable			
3.	Biogas technology is highly profitable			
4.	The slurry coming out of the biogas plant has higher fertilizer efficiency than ordinary cow dung			
5.	Biogas has more fuel efficiency compared to other fuels			
6.	It is possible to meet the fuel requirements of my family for cooking through the use of biogas plant			

V. CONSTRAINTS IN UTILIZATION OF BIOGAS TECHNOLOGY

Here are some constraints that may be experienced by the users of biogas technology. Please mark (✓) in the appropriate column against each constraint based on your experience

Sl. No.	Constraints	Most felt	Felt	Less felt	Least felt
1.	Non-availability of loan in time				
2.	Lack of technical assistance from the officials after installation				
3.	Gas production not upto the requirement of family				

Sl. No.	Contraints	Most felt	Felt	Less felt	Least felt
4.	Removal of scum required from time to time to maintain efficient gas production				
5.	Low gas production during monsoon				
6.	Need for constant care of the gas plant				
7.	Lack of direct source of income from the plant				
8.	Need for constant repair of the stove				
9.	Mixing slurry everyday is a botheration				
10.	Difficulty in transportation of the slurry				
11.	Problem of storing excess gas				
12.	Commitment to maintain cattle after installation				
13.	Any other (specify)				

VI. REASONS FOR NON-ADOPTION

Below are given some reasons why you might not have adopted biogas technology. Please mark (✓) in the appropriate column against each reasons as felt by you

Sl. No.	Reason	Most felt	Felt	Less felt	Least felt
1.	High installation cost of the plant				
2.	Availability of plenty of firewood				
3.	Availability of LPG connection				
4.	High indebtedness				
5.	Lack of sufficient space for installation of biogas plant				
6.	Lack of faith in biogas plant				
7.	Non-availability of perennial source of water				

Sl. No.	Reason	Most felt	Less felt	Least felt
8.	Lack of sufficient information on the technology			
9.	Lack of conviction on the advantages of biogas plant			
10.	Botheration for maintenance of the plant			
11.	Firewood gives more heat than biogas			
12.	Have seen biogas plants not working efficiently after installation			
13.	Advice against installation from friends and relatives			
14.	Any other reasons (specify)			

VII SITUATIONAL VARIABLES

1. Rural background: Rural/Semi rural/Semi urban
2. Extent of availability of perennial source of water: Available throughout the year/Except during summer/Not available
3. Extent of availability of other sources of fuel

Source	Always	Sometimes	Never
a. Firewood			
b. Kerosene			
c. LPG			
d. Any other			

4. Extent of utilization of other sources of fuel

Source	Always	Sometimes	Never
a. Firewood			
b. Kerosene			
c. LPG			
d. Any other			

APPENDIX - IV

Results of 'ANOVA' of the regression equation of attitude of users with all selected variables included

Source of variation	DF	Sum of squares	Mean sum of squares	F
Total	79	2358.8907		
Regression	7	1831.9227	261.6890	35.7480**
Residual	72	527.0678	7.3204	

Percentage of variation explained = 77.6561%

Standard deviation of residuals = 2.7056

** Significant at 1 per cent level

UTILIZATION OF BIOGAS TECHNOLOGY BY THE FARMERS OF PALAKKAD

By

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ABSTRACT OF A THESIS

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ABSTRACT

A study was undertaken to analyse the extent of utilization of biogas technology by the farmers of Palakkad district of Kerala State in relation to their attitude, perception and motivational pattern in the adoption of biogas technology. The respondents selected for study included both users (n = 80) and non-users (n = 80) of biogas technology.

The study revealed that there was no significant difference in the attitude of users and non-users towards biogas technology. Among the six attributes of biogas technology studied in relation to perception, simplicity obtained the highest rank followed by fuel efficiency, profitability, fertilizer efficiency, need compatibility and low cost in that order. 'Safety' was indicated as the most important motive governing the adoption of biogas technology and prestige motive, the least important.

Among the selected independent variables, utilization of interpersonal sources of information, perception about the efficiency of biogas technology, indebtedness, utilization of other sources of fuel and innovation proneness were found significant in predicting the maximum variation in attitude of users towards biogas technology, while utilization of interpersonal sources of information, family educational status,

social participation, availability of other sources of fuel and educational status were important in predicting the attitude of non-users. Utilization of interpersonal sources of information, utilization of other sources of fuel, indebtedness, livestock possession and educational status were found significant in predicting the perception of users about the efficiency of biogas technology.

'Mixing slurry everyday is a botheration' was expressed by users as the most important constraint in utilization of biogas technology followed by 'low gas production during monsoon' and 'need for constant care of the plant'. Most of the non-users had not adopted the technology due to the botheration for maintenance of the plant, availability of plenty of firewood and high installation cost of the plant.