A COMPARATIVE STUDY OF THE MANAGERIAL BENEFITS DERIVED USING SELECTED HOUSEHOLD FUELS

By

SRIDHARI DAS

A Dissertation submitted to the University of Madras
in partial fulfilment of the Masters
Degree in Science

April, 1968

ACKNOWLEDGEMENT

The investigator takes this opportunity to express her gratitude to Mrs. Lakshmi Santa Rajagopal, M.S. (Tenn) Professor in Home Management for her valuable suggestions and guidance throughout the study and to Dr. (Mrs.) Rajammal P. Devadas, M.A., M.Sc., Ph.D., (Ohio State), Principal, Sri Avinashilingam Home Science College, Coimbatore for her valuable suggestions throughout the study.

Sincere thanks are extended to Miss R.K. Thara Chandrika, M.Sc., Lecturer for her help, to Dr. Kannan, Ph. D. Pool Officer, CSIR for his assistance in the calculation of gas, to Miss R. Sethumadhavi for her assistance in the statistical analysis and to the homemakers and members of the taste panel for their cooperation.

TABLE OF CONTENTS

Chapter			Page

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

I. INTRODUCTION

The home is the basic unit of the nation and the nucleus of society. It is the centre of family living reflecting the ideals and aspirations of the society. (Srimali, 1960)[1]. Only healthy and happy homes can constitute a strong and dedicated nation. Therefore the home needs to be sensitive to the rapidly changing pulse and trends of a world of the twentieth century. In the midst of the sweeping currents of the swifty revolving environment, the home needs to continue to play its stabilising role and cater adequately to the demands of the community and nation at large. As Nehru (1961)[2] expressed, it is the woman who nurtures the child to become a worthy citizen. The homemaker should conserve the best in our ancient values and make the necessary adjustments to the present.

Without the cooperation of women who constitute half of the population, the developmental efforts cannot succeed nor can the standard of living in India be raised, Bhan, (1960)[3] and Ministry of Community Development and Cooperation (1960)[4]. Educating the homemakers in the skills necessary for the efficient use of resources is of prime importance in today's economy. Since all our resources, especially time, money and energy are limited, women need to recognise and imbibe the art of sound management of the resources in the home and outside, Nickell and Dorsey (1959)[5], Gross and Crandall (1954)[6], Goodyear and Khlor (1954)[7], Starr (1956)[8] and Moore (1957)[9]. They should search for possible ways of conserving and stretching further their resources.

Recent advances in technological and sociological fields have increased demands on the time of the modern homemaker. As Sengupta (1960)[10] states, she has to undertake careers outside the home. She needs to combine her career life with home, Rai (1964)[11]. Thus an increasing number of homemakers play a dual role and try to fulfil the objectives of both homemaking and wage-earning.

Among the activities performed by the homemaker in the home, cooking the daily meals consumes maximum time and effort. The Ministry of Food and Agriculture (1957)[12] has estimated that homemakers spend on an average 70 per cent of their working time in the kitchen. Therefore they find cooking arduous, time consuming and a drudgery. The use of work simplification principles, comfortable work heights, labour saving devices and appropriate fuels would help them conserve a great portion of the time and energy expended in the kitchen.

Fuel is an important item in everyday cooking in the kitchen for preparing palatable meals, heating water for drinking, cleaning and bathing. The average homemaker has to select the suitable fuel from a variety of alternative domestic fuels available, after considering their merits objectively with regard to convenience in use, the economy in running cost and the availability, Home Economic and Domestic subjects Review (1965)[13]. The types of fuels in the market are solid fuels such as firewood, charcoal and Leco, liquid fuels such as kerosene and gaseous fuels such as cowdung gas and Burshane. The homemaker is often puzzled to make her choice. Therefore it is necessary to evaluate the characteristics of different fuels in the market in order that homemakers can make their choice based on their operation techniques, cost and other practical implications in the kitchens.

This study is therefore aimed to find out the managerial benefits derived using three household fuels namely; kerosene, cowdung gas and Burshane in terms of time, money and labour. It is hoped that the results of this study will enlighten the homemakers to select the best type of fuel for their kitchens.

II. REVIEW OF LITERATURE

The available literature pertaining to this study is reviewed under the following headings:

A. Conserving resourses through wise management

B. Types of fuels available in India

C. Studies conducted on fuels

and D. Need for substitution of wood by other fuels.

A. Conserving Resources through Wise Management

The importance of wise management of family resources has been emphasised by many authors. As early as 1932, Monroe (1932)[14] called attention to the management of family resources. Devadas (1958)[15] stresses that management is a key to success in homemaking. She further states that management is making the best use of the available resources, material and human, in order to derive the best values and conserve time, energy, money, space and labour and avoid waste. Goodyear and Khlor (1954)[7], Starr (1956)[8] and Brown (1960)[16] state that management is the process of realising values and goals through the effective use of resources. Riebel (1960)[17] remarks that all resources are interrelated, but limited. Grandall (1956)[18] regards management as one where goals, resources and processes are integrated. Grandall (1948)[19], Malone and Malone (1958)[20] and Riebel (1960)[17] claim that the inevitability of limitations of human and non human resources need to be anticipated by the homemakers to achieve the best returns from their use. Malone and Malone (1958)[20] suggest the use of two principles for wise resource management namely finding out the resource combinations and making more effective use of the scarce resource by modifying or postponing the less important demands on it. Devadas (1958)[15] is of the view that finding short cuts in work and using labour saving devices help the homemaker to save her family resources. Andrews (1935)[21] is of opinion that a better selection of the required goods and services raise one's standard of living. Wiesendanger (1948)[22] adds that recognising resources, facing obstacles and gathering information aid in the wise use of available resources.

The changing modern world stresses on the homemaker, the need for the best resource management. Crandall (1956)[18] states that the dynamic modern concept of management deals constantly with change. Landis (1954)[23] remarks that decline of religious training and work activities, shift of education and recreation to outside agencies, working of married women outside the home and increased mobility are some significant characteristics of the modern family life. Abroal (1962)[24] interprets the impact of these changes as due to the emancipation and education of women. Nehru (1950)[25] had forecast the Indian family which is facing these tremendous changes. Because of this situation, Narayan (1962)[26] expresses that time management has become more important for women because of their role in the political, social and cultural fields in addition to fulfilling their dutieis in their homes.

Time and energy can be conserved by various processes. Gross and Crandall (1954)[6] and Nickell and Dorsey (1960)[5] indicate that Mundel's classification of changes can improve the homemaker's method of work by bringing out changes at five levels - in body positions and motions; tools, work place and equipment; production sequence; finished products; and raw materials.

Various studies conducted in the households indicate the pressure of time on homemakers. Nickell and Dorsey (1960)[5] report a study conducted by the Bureau of Home Economics in 1928, that in their sample of 1,500 rural and urban homemakers, the former spent 30 per cent of time on meal preparation while the latter spent 20 per cent. Steidle (1958)[27] refers to a time study, in which 23 per cent of the total time was taken for meal preparation. Cowles and Ruth (1956)[28] reveal the results of a study conducted at Wisconson that food preparation ranked first and cleaning away and care of the house second in the amount of time spent by the homemakers per week.

Rama Bai (1963)[29] points out that the 90 homemakers interviewed by her spent six to seven hours per day in performing household activities. Geldens (1960)[30] found that the homemakers in Uttar Pradesh spent two and a half hours per day for preparing a meal consisting of roti and a side dish.

The use of labour saving devices according to Sundari (1963)[31] results in a saving of one hour and 27 minutes of cooking time. Vijaya (1963)[32] found that the pressure cooker took the minimum time and the improvised steamer the maximum in preparing food items.

Evidently, the Indian women spend greater amount of time in homemaking activities as compared to the women in USA Therefore the Indian homemakers need assistance in reducing the time spent on household activities.

B. Types of Fuels Available in India

According to Osborne (1929)[33] and Avery (1955)[34] fuel is a material which on being oxidised or burned furnishes heat energy at a reasonable cost. Avery (1955)[34] states that all fuels contain the combustible elements carbon and hydrogen along with the non-combustible materials such as mineral salts, nitrogen, carbondi-oxide and moisture. According to Krauskopf (1953)[35], a good fuel should be strongly exothermic, inexpensive, easily storable and the products of combustion should be easily disposable. Partington (1957)[36] points out that the value of a fuel depends primarily upon its heat producing capacity per unit mass, or calorific value which is expressed as the number of British Thermal Units (B.T.U.) of heat evolved by the complete combustion of one pound of that fuel.

Haslett (1953)[37] points out that fuels fall under three main categories namely solid, liquid and gaseous, which are either naturally occurring or manufactured. Electicity is also used as a fuel for cooking purposes.

a. Solid fuels

Solid fuels are wood, peat, lignite and coal which are natural fuels while charcoal and coke are manufacturerd fuels which contain moisture and ash, Krishna and Ramaswamy (1932)[38]

Wood is used as a fuel from ancient times. Coal is defined in Encyclopaedia Britanica [39] as the stratified mineral formed by the action of decay, heat and pressure upon accumulation of vegetables and wood or cellulose matter laid down for ages. Charcoal is obtained when wood is destructively distilled or incomplete by burnt. The other solid fuels are saw dust, twigs, waste paper, cow-dung cake, husk, cocoanut shell and other organic wastes, Partington (1957)[36].

b. Liquid fuels

Partington (1957)[36] and Weaver and Foster (1954)[40] state that liquid fuels are obtained from vegetable oil, animal oil or petroleum. Many fuels such as gasolene, kerosene, fuel oil and paraffin can be obtained from petroleum. Osborne (1929)[33] found that liquid fuels usually contained impurities mixed with carbon compounds.

c. Gaseous fuels

Gaseous fuels are composed of molecules continuously in motion, Haslett (1953)[37]. Osborne (1949)[33] observed that in gaseous fuels, uncombined gases like hydrogen and oxygen might be present together with the carbon compounds. Coal gas, producer gas, naturalgas, water gas, acetylene, liquified petroleum gas and cow-dung gas are all gaseous fuels. Weaver and Foster (1954)[40] classify gaseous fuels under three main types namely, natural gas, coal tar derivatives and chemical derivatives.

Cow-dunggas as an organic fuel is a recent discovery. Desai and Biswas (1945)[41] and Gotaas (1956)[42] remark that it is a product of putrefactive breakdown of organic materials such as cattle-dung through the action of anaerobic organisms, which break down the organic components. The anaerobic organisms use nitrogen, phosphorus, and other nutrients present in the organic wastes, to develop their cell protoplasm, but reduces the organic nitrogen compounds to ammonia and organic acids and the unutilised carbon combined with hydrogen is liberated inthe form of methane (CH_4) gas which is combustible. They reveal that temperature, inorganic salts and saccharin affect the production of gas.

This method promises to provide a means of overcoming the present wasteful practice of burning cattle-dung in the form of dry cakes for fuel. Acharya (1953)[43] remarks that nearly half of the total cattle-dung produced in the country is burnt away due to the scarcity of alternative source of fuel, which otherwise could provide 200 million tons of farmyard manure. Iyengar (1967)[44] feels that by using cow-dung gas as fuel, every year the huge amount of foreign exchange needed to import nearly nine million tons of diesel petrol could be saved. Waksman(1932)[45] pointed out that when a cellulose material like filter paper was inoculated with horse-dung or river mud, along with mineral salt solutions and kept under anaerobic condition, it evolved methane and small quantity of hydrogen. Imhoff and Fair (1940)[46], Desai (1951)[47] and Patel (1951)[48] developed special tanks namely cow-dung gas plants for gas production. The Indian Agricultural Research Institute (1957)[49] defines cow-dung gas plant as a low cost and simply operated plant in which cow-dung is fermented so as to yield sufficient quantity of combustible gas which can be utilised for cooking purposes and the residue for manure without any loss of manurial constituents.

Symons and Buswell (1933)[50] and Tarwin and Buswell (1934)[51] observed that the combustible gas produced contained 50 to 60 per cent methane, 5 to 10 per cent hydrogen and 30 to 40 per cent carbon-di-oxide. Leake and Howard (1952)[52] state that this gas burns with a non-luminous flame, even without admixture with air in contrast to coal or oil gas. He further says that this gas can be compressed in cylinders at a pressure of 5,000 lbs. per square inch. Patel (1941)[53] determines the consumption of gas for cooking purposes per person per day as 12 to 15 cu. ft. Desai and Biswas (1945)[41] found that when cow-dung was added daily, the quantity of gas produced in their pilot plant ranged from 0.2 to 0.3 cu.ft. per pound of fresh dung in winter months and from 0.6 to 0.8 cu.ft. in summer months at 10 to 15° C and 20 to 30° C temperatures respectively.

Kamalaveni (1962)[54] proved that the cow-dung gas saves 25 per cent of time for cooking three meals for a family of three and 65 per cent of time in scrubbing the utensils while washing them. She claims that the foods cooked over cow-dung gas were acceptable to the same extent or more than those cooked over firewood. Moreover, its use promotes hygienic and sanitary condition in the cooking area and around the house.

Burshane produced by Burmah Shell Refineries Ltd., Trombay is considered to be simple to use. A short piece of special tubing connects the Cylinder carrying the gas to the appliance. The cylinder contains the liquified petroleum gas. The mixture consists of butylene, isobutane and normal butane with a pressure of about 50 lbs per square inch at ambient temperatures. When the cylinder value is opened, the liquid starts to evaporate into gas which passes through the regulator to the appliance. The regulator at the appliance ensures supply of gas at the required, correct and constant pressure.

d. Electricity

When a current of electricity passes through a conductor, heat is produced. The heat produced is proportional to the resistance offered; the passage of the current through the conductor and the media to be heated through appropriate devices. Haslett (1955)[37] is of the view that the absence of smoke, smell or ash and possibilities of ready adjustment and regulation are the advantages of electric devices.

C. Studies Conducted on Fuels

Chetty (1958)[55] carried out experiments with wood, charcoal, kerosene and electricity with a view to study the relative fuel consumption, cost and cooking time. She regrets the use of firewood as a fuel because of the prolonged time needed for ignition, frequent blowing, emission of smoke and the deposition of soot on the cooking utensils. As for charcoal, she noted that it soiled the hands during handling and feeding the sigri and the temperature lowered when stirred often. Electricity when a bit neglected burnt the foods. Kerosene was considered by her as the most economical fuel with regard to the amount of fuel consumed, time taken to light it, steady and intense heat given and moderate cost.

Study carried out by Lalitha (1960)[56] on the efficacy of firewood, charcoal, kerosene and electricity in terms of cooking time, cost and convenience showed that the time taken to cook rice and beans was longest when charcoal was used, firewood coming next.

D. Need for Substitution of Wood by Other Fuels

The more economical, convenient, clean and attractive the kitchen, the greater is the satisfaction it gives to the housewife. However when cooking has to be done with firewood or charcoal the kitchen becomes sooty and dirty. According to

Chittaranjan (1966)[57] the per capita energy consumption in India is low when compared to 7,999 kg in U.S.A; 4,887 kg. in U.K; and 2,855 kg. in U.S.S.R. While the quantum of energy consumption is small, the source from which it is derived causes a national drain. The National Council of Applied Economic Research (1959)[58] estimated that 55.5 million tons of coal equivalent of wood is burnt as fuel every year in India. This leads to a heavy depletion of forest resources which are required for more important tasks. Therefore, the extent to which firewood and charcoal can be substituted by other efficient fuels within this ceiling needs to be studied.

The per capita energy expenditure according to NCAER (1959)[58] per month on fuels for cooking works out to be Rs. 2.46 in Bombay; Rs. 1.52 in Calcutta and Rs. 1.70 in Delhi. Haslett (1953)[37] states that the cost of any fuel is an important factor in determining its efficiency. The cost of the fuel depends upon the kind, economy of production, availability and transportation. Haslett (1953)[37] further points out that the fuels differ in the case of handling, maintenance of cleanliness ofthe work area, labour involved in removing the residues left after burning, and convenience of storing. The selection of the fuel thus depends not only on its value, but also upon factors such as freedom from smoke; ease and completeness of combustion; and rapidity of burning and sparkling.

III. EXPERIMENTAL PROCEDURE

The experimental procedures carried out for this study were:

A. Conducting a household survey

and B. Conducting the cooking experiments with the selected household fuels.

A. Conducting a Household Survey

As a basis for the selection of fuels for the cooking experiments, a household survey was conducted. The steps for the survey included:

1. Selection of the households
2. Selection of the methods of survey
3. Evolving schedules for the survey
4. Conducting the survey

and 5. Analysis and interpretation of data

1. Selection of the Households

One hundred middle class households earning a monthly income of Rs. 400 to Rs. 1,000 were selected at random from the R.S. Puram area in Coimbatore city. The reason for selecting this income group was that the homemakers in this range used different types of fuels.

2. Selection of the methods of survey

Among the various methods available for conducting surveys, the interview method was selected for surveying the various types of fuels used by the homemakers because of its special adaptability to obtain information in direct manner within a short time. Varma (1965)[59] and Young (1956)[60] have indicated that the interview is a systematic method by which the interview enters more or less into the inner life of strangers. Good and Scates (1954)[61] and Moser (1958)[62] state that the interview is the most appropriate procedure to study family problems. Burchinal and Hawkes (1957)[63] opine that the interview method yields a high percentage of cooperation when the people are approached agreeably. The flexibility of the interview allows the investigator to adjust the level of conversation to the level of respondent.

The inventory method was employed to study the amount of fuel consumed per day for one week by the selected households. Reh (1962)[64] states that accurate information on food consumption can be obtained by inventories. The ICMR (1951)[65] points out that in checking the stock, the investigator must take an inventory of the foods already present in the house by actual weighment and make the necessary entries in the diary or booklet specially provided to each household.

3. Evolving schedules for the survey

An interview schedule as shown in Appendix I was framed to elicit information on the different types of fuels used by the homemakers, the extent of their use and the cost of fuels consumed. The interview schedule was finalised after pre-testing. An inventory schedule as indicated in Appendix II was evolved to find out the daily fuel consumption for a week.

4. Conducting the survey

The survey was conducted without any difficulty after establishing rapport through friendly conversation because of the cooperation extended by the interviewees. The data were recorded in the interview schedule.

The homemakers were given the inventory sheets and requested to record daily, the details regarding the fuel consumption for a week. They were requested to weigh the soild fuels such as firewood and charcoal for use. Kerosene was to be measured in a one litre capacity bottle and used. Since no gas meter was available for Burshane, the number of cylinders used per month was noted.

5. Analysis and interpretation of data

The data gathered from the household survey and the inventory study were analysed and interpreted. The data is presented under results and discussion.

B. Cooking Experiments with the Selected Household Fuels

The procedures for the cooking experiments involved:

1. Selection of fuels, equipment, menu and cleaning materials

2. Purchasing food items and fuels

3. Standardisation of the procedures

and 4. Administering the palatability tests.

1. Selection of fuels, equipment, menu and cleaning materials

a. Fuels

Based on the information gathered through the survey conducted in the selected 100 households, kerosene, cow-dung gas and Burshane were chosen for the study. It was found that Burshane was used by 18 households, who expressed their appreciation for the fuel and kerosene alone was used by 22 households. Eight homemakers used kerosene along with Burshane. None had used cow-dung gas.

b. Equipment

The equipment selected for the experiments included:

i. Containers for storing items required for the experiment

ii. Measuring devices

iii. Stoves

and iv. Utensils for food preparation and service.

i. Containers for storing items required for the experiments

Containers for storing the ingredients included tins for cereals, pulses and condiments; baskets for vegetables and bottles for oil. A kerosene tin was selected to store kerosene.

ii. Measuring devices

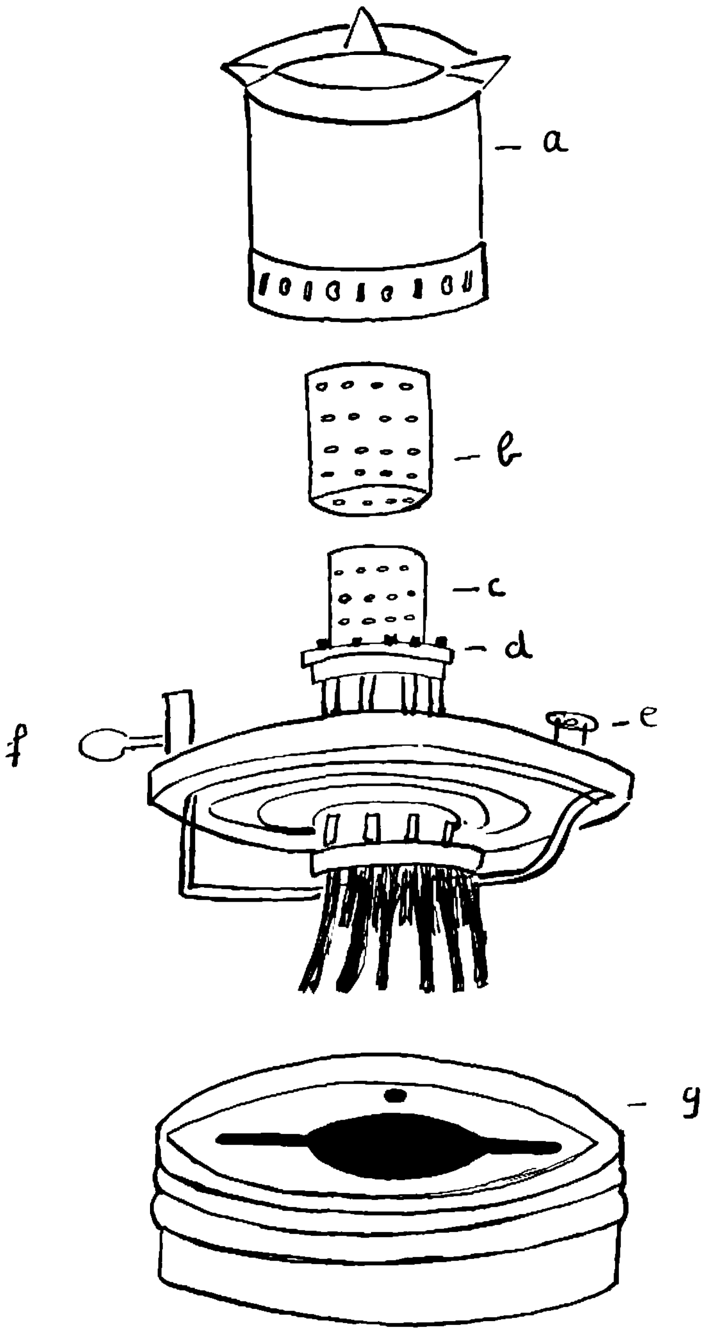
A Hanson Dietetic Balance was selected for weighing the food ingredients. Salt and curry powder were measured by using the tea spoons. Two graduated jars were selected for measuring kerosene and water for cooking.

iii. Stoves

Single burner was used for every fuels. A Janatha kerosene stove of the wick variety as seen in Figure 1 was selected for kerosene owing to its popularity and ease in handling. The burner as shown in Figure 2 for the use of cow-dung gas was attached to the pipe line leading from the cow-dung gas plant. For Burshane, the stove as given in Figure 3 was attached to the gas cylinder.

iv. Utensils for food preparation and service

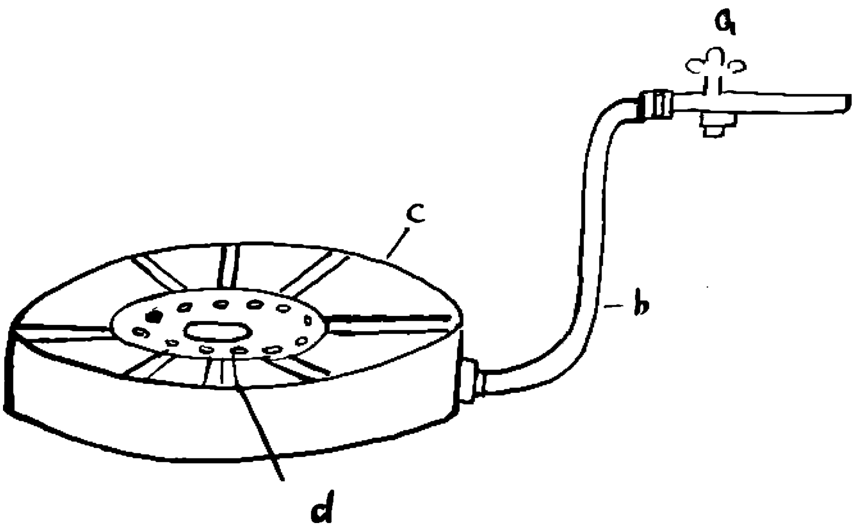
Rao (1966)[66] points out that aluminium is cheap and most frequently used in the Indian households. Therefore, three sets of aluminium utensils with flat bottoms, straight sides and identical dimensions for use over the three fuels were selected.



a) Stove Cover
b) Outer Cylinder
c) Inner Cylinder
d) Wick
e) Kerosene filler
f Wick Control
g) Combustion Chamber

Figure : 1

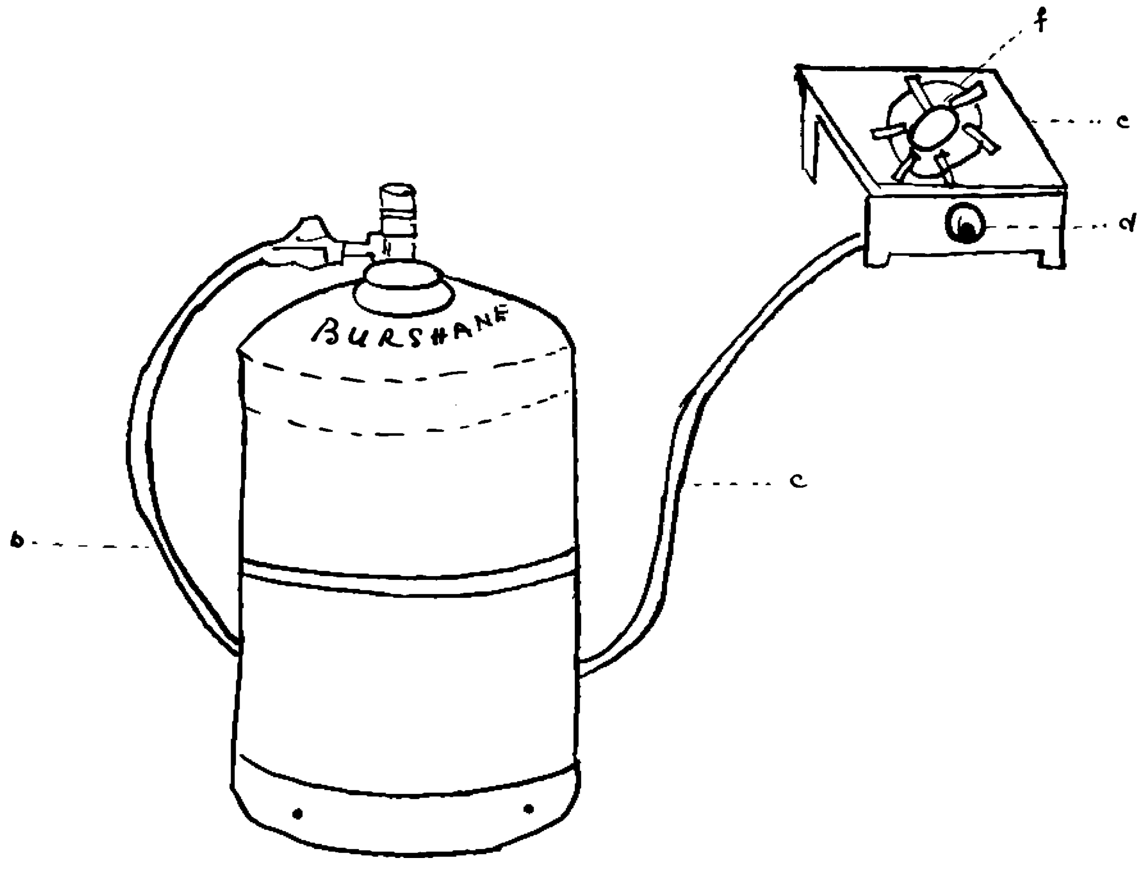
Janatha Kerosene Stove



a) Gas Regulator
b) Rubber Tube
c) Stand
d Orifices in the burner

Figure : 2

Cow - dung gas burner



a) Cylinder Valve
b) Cylinder
c) Rubber Tube
d) Regulator
e) Burner head
f) Stand

Figure: 3

Burshane Cylinder and Burner

Each set consisted of three utensils large, medium and small as shown in Figure 4. Table I shows the dimensions of the utensils selected.

TABLE I

DIMENSIONS OF THE UTENSILS SELECTED FOR COOKING

Size	Dimensions			
	Capacity in ml.	Diameter range in cm	Height in cm	Weight in gm
Large	2,500	20.30 to 20.32	10.16	190.00
Medium	1,500	16.96 to 17.00	7.14	131.66
Small	1,100	14.84 to 15.00	6.96	120.00

The dishes used for serving consisted of five sets of stainless steel quarter plates, tea spoons, glasses and porcelain cups. The quarter plates were used for rice and amaranth 'porial' and the cups for 'sambar'. Tea spoons were used for tasting the items.

c. Menu

The food items selected were based on the nutritional requirements specified by Swaminathan (1966)[67] which are presented in Appendix III. The food items to be included in the daily menu for two adult members in a beginning family, a man

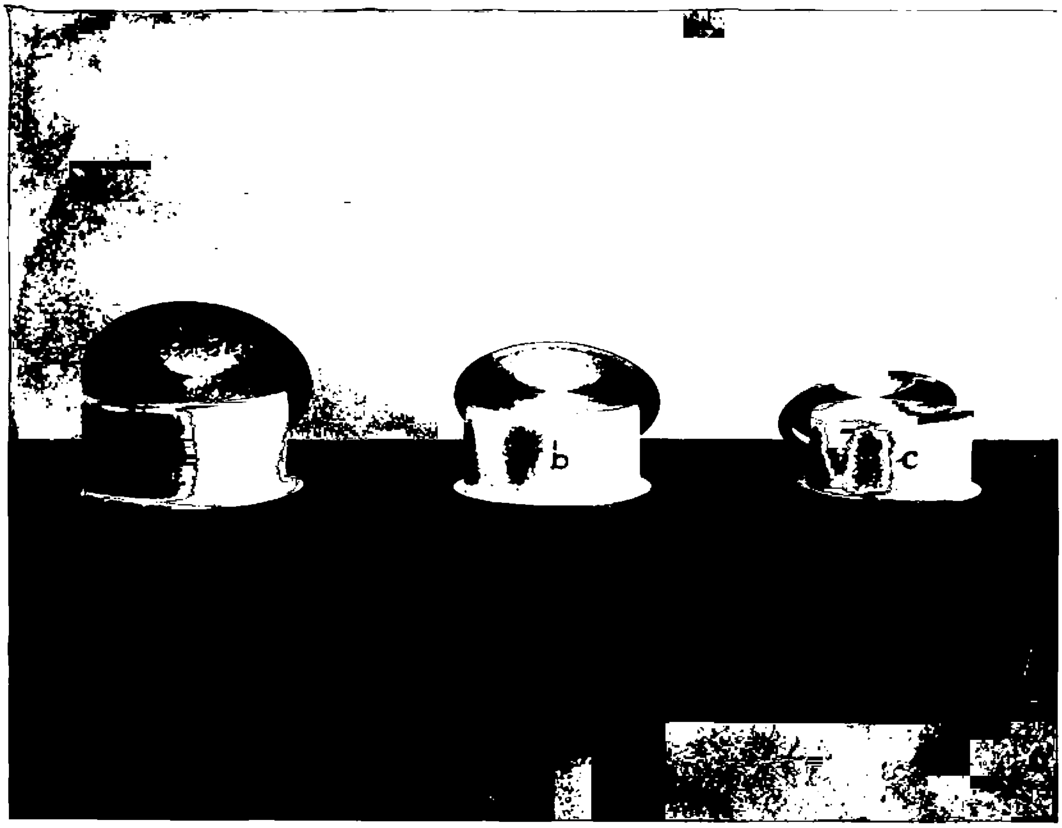


FIGURE - 4

UTENSILS SELECTED FOR THE COOKING EXPERIMENT and a woman doing moderate work were computed and the day's menu was planned for the reference family using the food items selected as presented in Table II.

TABLE II

MENU FOR A DAY

Meal	Items	Foodstuff	Amount in gms
Breakfast	Dosai	Rice	220
	Coconut 'Chutney'	Black gram dhal	30
	Coffee	Coconut	90
		Milk	100
		Sugar	30
		Oil	20
Lunch	Rice	Rice	200
	Drumstick 'sambar'	Red gram dhal	60
	Amaranth 'porial'	Drumstick	90
	Tomato and carrot 'pachadi'	Amaranth	240
		Carrot	60
	Papaya	Tomato	50
	Curds	Curds	100
		Papaya	100
Tea	Sundal	Bengal gram	90
	Coffee	Milk	100
		Sugar	30
Dinner	Chapathi	Wheat flour	800
	Potato and peas 'kuruma'	Potato	90
		Peas	90
	Plantain	Plantain	60
	Milk	Milk	200

From the daily menu presented, it was decided to prepare lunch for the experimental comparisons.

d. Cleaning materials

As indicated by Kamaleshpuri (1964)[68] a mixture of three parts of soapnut powder and one part of Vim was used for the satisfactory cleaning of aluminium with the use of tap water.

2. Purchasing food items and fuels

It was estimated that the menu would be cooked 30 times during standardisation and experimentation. The quantities of food items required to last the entire period of cooking were calculated and the non-perishables were purchased in one lot. Table III shows the quantities of the different foods purchased.

TABLE III

FOOD ITEMS PURCHASED

Ingredients	Quantity in kg.	Frequency of purchase
Rice	6.0	All at once
Red gram dhal	1.8	"
Curry powder	0.1	"
Table Salt	0.45	"
Onion	2.00	"
Mustard	0.05	"
Black gram dhal	0.05	"
Oil	0.05	"
Drumstick	2.7	Daily
Tomatoes	0.03	"
Amaranth	7.2	"

Perishable items such as amaranth were bought daily to ensure freshness. Four litres of kerosene was bought from the Indian Oil Company. Cow-dung gas was available from the plant situated in the College campus. Burshane was provided in cylinders from the Burmah Sehll agencies.

3. The standardisation of procedures

The following procedures were standardised:

a. Measuring the fuels

b. Cooking the selected menu

and c. Cleaning the utensils.

a. Measuring the fuels

The quantity of fuels consumed were measured as follows:

i. Kerosene

Measured quantity of kerosene was first poured into the empty tank of the stove. After each experiment the kerosene tank of the stove was emptied and the kerosene measured. The difference between the initial and final measurements gave the amount of oil consumed.

ii. Cow dung gas

The rate of flow of gas was measured by simple displacement method. A gas jar completely filled with water and covered with a ground glass plate was inverted over a beehive shelf placed in a trough of water and the cover was carefully removed under the water. The burner was detached and gas was collected for a known period of time in the jar by displacement of water. After turning off the gas, the levels of water inside the jar and outside were equalised in order to equalise the pressure of the gas collected to atmospheric pressure and temperature. By applying the gas equation PV = RT, where P, V and T stand for pressure, volume and temperature measured in absolute scale of the gas collected and R is a constant, the volume of gas per second at N.T.P. was calculated. By appropriate manipulation of the regulator, the rate of flow of gas under high, medium and low flames were obtained. This was repeated for two days and the average was taken. The readings are given in Table IV.

TABLE IV

RATE OF FLOW OF COW-DUNG GAS

Replicates	Volume of gas in c.c/Second at N.T.P. High flame level	Medium flam level	Low flame level
1	181	101	83
2	178	129	81
Average	180	115	82

By knowing the rate of flow of gas per second, under high, medium and low flames and the time taken for cooking under each adjustment, the total volume of gas consumed during the entire period of cooking was calculated.

iii. Burshane

Burshane gas is stored in the liquid form inside the cylinder and the volume of liquid will expand or contract with change in temperature. One pound of liquid Burshane yield 6.8 Cu.ft. of gas. The fuel is measured by weighing the cylinder and subtracting from it the tare weight and the weight of the valve and security nut. Thus, by knowing the volume of gas expended from the cylinder and the time taken for the experiment, the cost was calculated.

b. Cooking the selected menu

The procedures adopted for cooking the three selected items namely rice, 'sambar' and amaranth 'porial' were standardised through a series of preliminary experiments. The quantity of water required and the time needed to obtain desirable products were also standardised.

i. Rice

According to Pearson et al (1948)[69] and Stanley and Clive (1960),[70] cooking foods in just sufficient amount of water helps to conserve the nutrients. Therefore, the absorption method was used for cooking rice. Preliminary experiments were conducted with the three fuels varying the quantity of water and time for cooking, the minimum and maximum quantities of water being 900 ml. and 1,150 ml. to cook 200 gms. of rice. These experiments revealed that cooking 200 grams of rice in 1,100 ml. of water over kerosene, 12,00 ml. over cow-dung gas and 1,150 ml. over Burshane was satisfactory. Therefore the procedure of standardisation was as follows: Two hundred grams of rice were cleaned and washed in two cups of tap water and the water was drained off. The standard amount of water was poured in the cooking utensil, covered and brought to boil, over the selected stove. The washed, drained rice was added. The wick adjustment in all the stoves was kept at medium flame before adding the rice. In order to avoid spurting due to boiling, the utensil was only partially covered and the stoves were adjusted to low flame. The rice was kept on the stove until all the water was absorbed.

ii . 'Sambar'

Preliminary experiments were conducted using 900-925 and 1,150 ml. of water to standardise the quantity of water required to cook 60 gms of red gram dhal, over the three different fuels. The final products were found to have the required consistency when 950 ml. of water were used for cooking with all the fuels.

Sixty grams of red gram dhal were cleaned and washed in one cup of tap water and the excess water drained off.

The standardised amount of water was poured in the cooking utensil, covered, brought to boil over the selected stove, and the washed, drained dhal was added. The utensil was covered partially and the wicks were lowered to medium to reduce the flame. When the dhal was three fourth cooked, 90 gms of drumsticks and ten grams of tomatoes and five grams of curry powder were added and kept over the stove for ten minutes until the dhal became tender. Salt was added and the utensil removed from the stove. The 'sambar' was seasoned using weighed quantities of onion, mustard and black gram dhal.

iii. <u>Amaranth 'porial'</u>

The recipe for cooking amaranth was standardised using different quantities of water for the three fuels. The minimum and maximum quantities of water used were 20 ml. and 60 ml to cook 240 gms of amaranth. These experiments revealed that cooking 240 gms of amaranth for 15 to 20 minutes under low flame in 40 ml. of water over kerosene, 45 ml. of water over cow-dung gas and 50 ml. over Burshane gave satisfactory products.

e. <u>Cleaning the utensils</u>

The standardisation of cleaning procedures included:

i. Standardisation of soaking time

ii. Standardisation of number of strokes

and iii. Standardisation of cleaning time.

The cleaning agents as suggested by Kamaleshpuri (1964)[68] were used. The procedure standardised was as follows: Soon after serving rice, 'sambar' and amaranth 'porial' to the taste panel, the utensils were emptied. The preliminary experiments showed the need for soaking the utensils used over kerosene, cow-dung gas and Burshane for easy cleaning, in five, four and three and a half cups of water respectively. After soaking the utensils, they were scrubbed with the cleaning mixture spread over the coconut fibre cut to 4.5 cms and 2.25 cms, with the same speed, force and type of movement till they were found satisfactorily clean. Each utensil was rinsed in tap water and wiped dry. The time taken to clean the utensils and the quantity of cleaning agents required were recorded.

4. Administering the palatability tests

Judging foods can be accomplished through objective and subjective methods. Nason (1939)[71] says that as the name implies subjective methods depend to some extent upon the opinions and prejudices. In objective methods, the quality is determined by means of various objective devices such as photographs and qualitative determination of looses in weight and temperature.

The following steps were adopted to carry out the tests:

a. Formulation of the score cards

b. Selection of the taste panel

and c. Administering the test.

a. Formulation of the score cards

In order to facilitate the objective rating of the food preparation by the judges in the taste panel, score cards as shown in Appendices IV, V and VI for rice, 'Sambar' and amaranth 'porial' respectively were developed on a five point scale. The qualities to be judged were chosen according to the standards of Child and Nile (1938)[72] for scoring cereals and vegetables. They were appearance, colour, texture, doneness, odour and taste of the products.

b. Selection of the taste panel

Sweetman and Mackeller (1954)[73] state that the palatability of food may be evaluated onthe basis of the kinds, quality and intensity of sensory expressions involved. For selecting judges forthe taste panel, the "Triangle Test" described by Lowe (1957)[74] was administered to nine post graduate students.

Three samples of dhal, of which two were identical and one different were given to the judges and they were requested to identify the differing sample giving the reasons. The test was repeated five times. From the results shown in Appendix VII, five judges were selected based on their ability to identify the different sample consistently. A glass of water was provided in order to have a sip of water before tasting each sample, to find out the difference correctly.

c. Administering the test

The palatability of the foods prepared using the three selected fuels was tested by the selected panel of judges as follows: The samples were served in the serving dishes before the principal meal, so as to lessen variation in taste. The judges were requested to taste the products forthe different qualities and grade them on the score card according to the directions given. Five replicates were carried out for each item of the selected food cooked over each fuel.

IV. RESULTS AND DISCUSSION

The results of this study are discussed under two aspects:

A. Household survey on fuels

and B. Cooking experiments with the selected fuels.

A. Household Survey on Fuels

The data obtained from the household survey are presented under the following heads:

1. Size and income of the households
2. Types of fuels used in the households and their cost.
3. Merits and demerits of the fuels used

and 4. Mean daily fuel consumption

1. Size and income of the households

Table V gives the details regarding the size and income of the selected 100 households.

TABLE V

SIZE AND INCOME OF 100 HOUSEHOLDS

Number of Members	Income range in rupees			Total
	400-600	601-800	801 and above	
1 - 2	13	1	5	19
3 - 5	4	18	26	48
6 - 8	1	8	15	24
9 and above	-	2	7	9
Total	18	29	53	100

Table V reveals that a majority of the households surveyed consisted of three to five members. Fifty three per cent of the households received monthly income higher than Rs. 801/-

2. <u>Types of fuels used in the households and their cost</u>

Table VI presents the range of fuels used by the selected households for cooking and heating water for bathing and the cost.

TABLE VI

COST AND TYPES OF FUELS USED IN 100 HOUSEHOLDS

FUELS	Income range in Rupees														
	400–600					601–800					801 and above				
	Number of households spending for fuel Rupees per month														
	1–10	11–20	21–30	31–40	41 & above	1-10	11–20	21–30	31–40	41 & above	1–10	11–20	21–30	31–40	41 & above
Kerosene	5	3	–	–	–	1	6	–	–	–	–	3	4	–	–
Kerosene and firewood	–	–	–	–	–	–	–	2	–	–	–	–	1	3	–
Kerosene and Leco	2	–	2	–	–	–	1	6	–	–	–	4	2	4	–
Kerosene and Charcoal	–	5	–	–	–	–	1	2	–	–	–	3	–	–	–
Kerosene and Burshane	–	–	–	–	–	–	–	–	–	–	–	1	6	1	–
Kerosene and electricity	–	–	–	–	–	–	–	3	–	3	–	3	–	–	2
Burshane	–	–	–	–	–	–	1	–	–	–	–	–	2	2	–
Kerosene, firewood and Burshane	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2
Kerosene, fire wood & Charcoal	–	–	–	–	–	–	–	–	–	–	–	–	3	3	–
Kerosene, Leco and Charcoal	–	–	–	–	–	–	–	2	–	–	–	–	–	–	–
Kerosene fire-wood and Leco	–	–	1	–	–	–	–	1	–	–	–	–	–	–	–
Burshane, Leco and Charcoal	–	–	–	–	–	–	–	–	–	–	–	–	–	1	2
Electricity	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–
Total	7	8	3	–	–	1	9	16	–	3	–	14	19	14	6

Twenty two families used Kerosene alone for cooking, whereas five families used Burshane alone and one electricity alone. All the others used more than one fuel. Eight per-cent of the families spent Rs. 1.10 per month for fuel, whereas nine per cent spent Rs. 41/- and above. The monthly expenditure for fuel was greatest inthe households within the income range of Rs. 801/- and above.

3. Merits and demerits of the fuels used

Thirty to 52 per cent of the homemakers using kerosene reported that kerosene was easy to light, economical and convenient to handle. It helped to keep the working places clean. Twenty thre per cent of the homemakers reported that kerosene imparted an objectionable odour to food.

The homemakers who were using firewood reported that it was economical but the formation of soot on the utensils prolonged the cleaning time. Emission of smoke was another problem faced by them. Those who used Leco and charcoal found that these fuels needed considerable time to light. Furthermore they soiled the hands.

Burshane was considered convenient to handle by 78 per-cent of the homemakers, 73 per cent remarked that it kept the working place clean, 67 per cent said it lessens cooking time and 39 and 44 per cent considered it easy to light and economical respectively. None of the homemakers faced any problems while using Burshane.

4. Mean daily fuel consumption

Out of the 100 houses surveyed, 20 houses were studied in detail, to gather information on the mean daily fuel consumption for a week. The fuels used daily are given in Table VII.

TABLE VII

DAILY EXPENDITURE ON FUELS IN THE SELECTED 20 HOUSEHOLDS

FUELS	Income range in rupees											
	400 - 600				601-800			801-1000 and above				
	Number of households spending for fuel daily in paise											
	1-20	21-40	41-60	61-80	1-20	21-40	41-60	1-20	21-40	41-60	61-80	81-100
1. Kerosene	-	-	-	-	-	1	1	-	-	2	-	1
2. Kerosene	3	-	-	1	-	-	-	-	-	2	-	-
Leco	2	4	-	-	-	-	-	-	2	-	-	-
3. Kerosene	-	-	-	-	-	-	-	-	-	-	1	1
Firewood	-	-	-	-	-	-	-	-	2	-	-	-
4. Kerosene	-	-	1	-	-	-	-	-	-	-	-	-
Leco	-	1	-	-	-	-	-	-	-	-	-	-
Firewood	1	-	-	-	-	-	-	-	-	-	-	-
5. Kerosene	-	-	-	-	-	-	-	-	2	-	-	-
Leco	-	-	-	-	-	-	-	-	2	-	-	-
Charcoal	-	-	-	-	-	-	-	2	-	-	-	-
6. Kerosene	-	-	-	-	-	1	1	-	-	-	-	-
Electricity	-	-	-	-	2	-	-	-	-	-	2	-
7. Kerosene	-	-	-	-	-	-	-	1	1	-	-	-
Burshane	-	-	-	-	-	-	-	-	-	-	2	-

Table VII reveals that 40 to 60 paise per day were spent by two households using kerosene in the income range of Rs. 801 to Rs. 1,000. In the same income group, two households spent 60 to 80 paise per day on Burshane.

B. Cooking Experiments with Selected Household Fuels

The results of the cooking experiments conducted using the three selected fuels namely kerosene, cow-dung gas and Burshane are discussed under:

1. Time management

2. Money management

and 3. Palatability of cooked items.

1. Time management

The discussion for the management of time includes:

a. Time taken to cook the selected items

and b. Time taken to clean the utensils used for cooking.

a. Time taken to cook the selected items

This included time taken to cook rice, 'sambar' and amaranth 'porial' individually and the total time taken to cook the whole meal.

The time taken to cook rice, 'sambar' and amaranth 'porial' using each of the three fuels is given in Table VIII and Figure 5.

TABLE VIII

TIME TAKEN TO COOK RICE, 'SAMBAR' AND AMARANTH 'PORIAL' USING THE THREE SELECTED FUELS

Replicates	Kerosene			Cowdung gas			Burshane		
	Rice	'Sambar'	Amaranth 'porial'	Rice	'Sambar'	Amaranth 'porial	Rice	'Sambar'	Amaranth 'porial'
	Time in minutes								
1	58	68	20	50	64	18	49	56	15
2	58	68	20	50	64	18	49	56	15
3	58	68	20	50	64	18	49	56	15
4	58	68	20	50	64	18	49	56	15
5	58	68	20	50	64	18	49	56	15
Average	58	68	20	50	64	18	49	56	15
Total		146			132			120	

The time taken to prepare all the three items over kerosene was maximum and that taken over Burshane, the minimum. On an average, the time taken to prepare the whole meal was found to be 146, 132 and 120 minutes using kerosene, cow-dung gas and Burshane respectively. When analysed statistically using the 't' test*, vide Appendix VIII the mean differences

* 't' test according to Garret (1958)[73] is applied to find out which of the differences between the experimental variable taken are significant.

** Significant at 10% level.
* Significant at 50% level

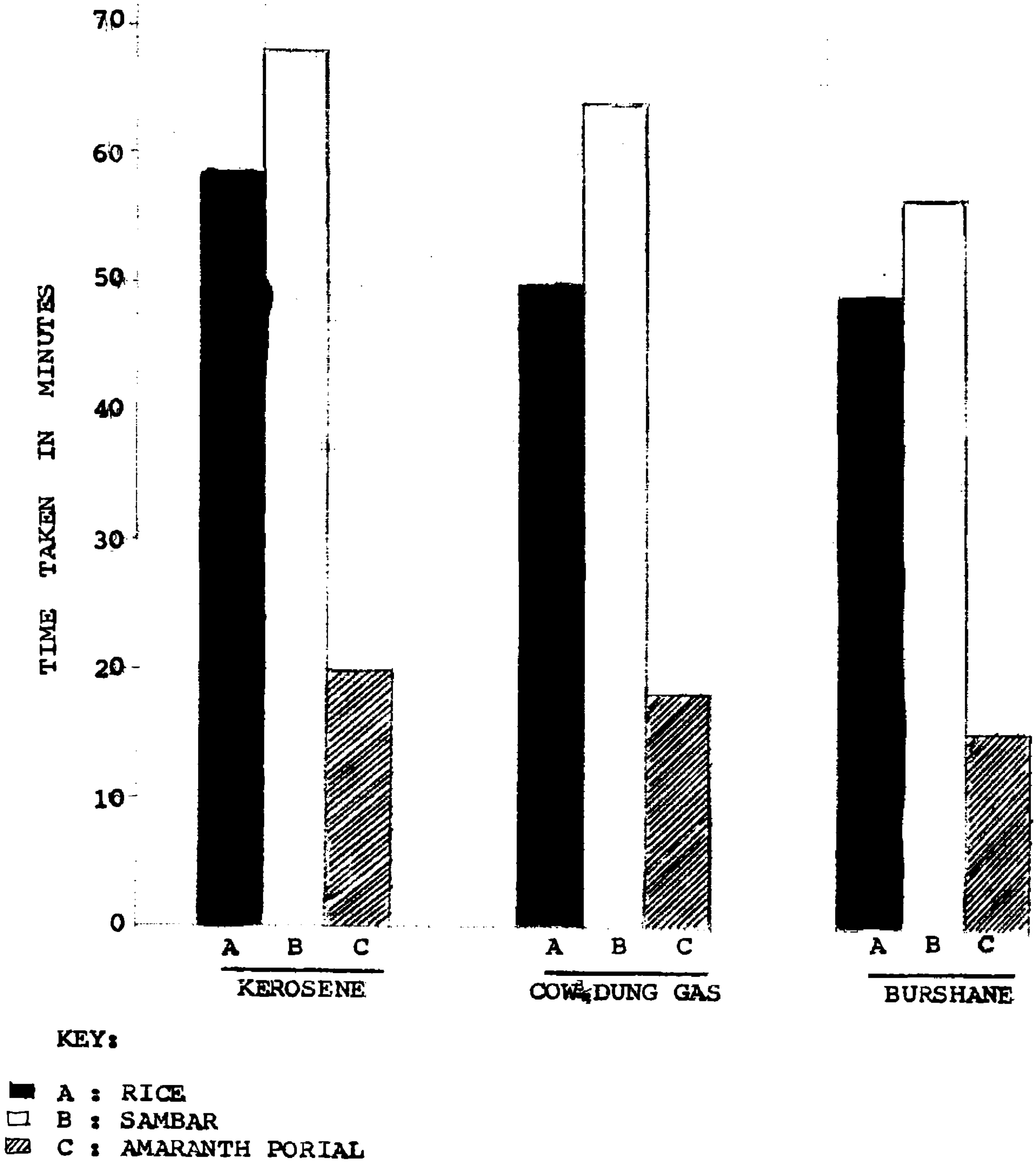


FIGURE 5

TIME TAKEN TO COOK THE REFERENCE MEAL USING THE THREE SELECTED FUELS between the time taken by kerosene and cow-dung gas and between cow-dung gas and Burshane were found to be significant at 80 per cent levels. In the case of kerosene and Burshane the difference was significant at 10 per cent level. This proved the superiority of Burshane over cow-dung gas and kerosene.

The time saving effect of Burshane may be due to the intensity of heat it is capable of producing and heating the utensil rapidly and hastening the cooking process.

b. <u>Time taken to clean the utensils used for cooking</u>

The time taken to clean the utensils used for preparing the selected meal over kerosene, cow-dung gas and Burshane is presented in Table IX and Figure 6.

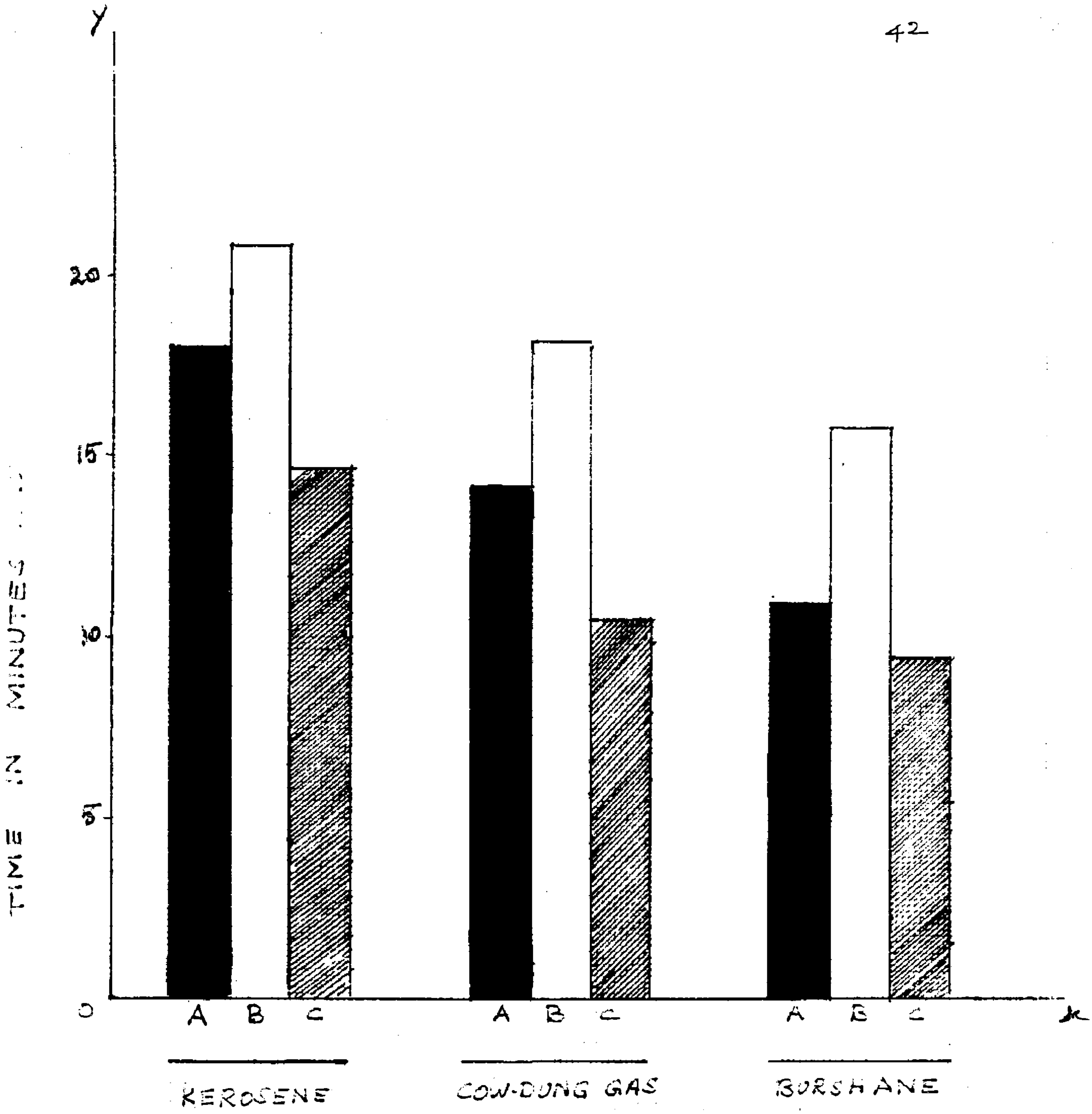
TABLE IX

TIME TAKEN TO CLEAN THE UTENSILS USED FOR COOKING

Replicates	Time in minutes and seconds																	
	Kerosene						Cow-dung gas						Burshane					
	Rice		'Sambar'		Amaranth 'porial'		Rice		'Sambar'		Amaranth 'porial'		Rice		'Sambar'		Amaranth 'porial'	
	S*	C*	S*	C*	S	C	S	C	S	C	S	C	S	C	S	C	S	C
	M.S.	M.S.	M.S.	M.S.	M.S.	M.S.	M.S.	M.S.	M.S.	M.S.	M.S.	M.S.	M.S.	M.S.	M.S.	M.S.	M.S.	M.S.
1	9.30	9.00	8.00	12.00	5.00	8.10	9.30	5.50	8.00	10.03	5.00	6.04	9.30	2.30	8.00	8.00	5.00	3.50
2	9.30	8.50	8.00	11.00	5.00	8.00	9.30	5.40	8.00	12.00	5.00	6.05	9.30	2.30	8.00	8.20	5.00	4.00
3	9.30	8.59	8.00	13.50	5.00	8.20	9.30	5.30	8.00	10.30	5.00	5.40	9.30	2.20	8.00	8.25	5.00	4.10
4	9.30	9.00	8.00	13.30	5.00	8.15	9.30	5.25	8.00	10.30	5.00	5.50	9.30	2.00	8.00	8.30	5.00	3.55
5	9.30	8.58	8.00	13.45	5.00	8.10	9.30	5.30	8.00	10.20	5.00	6.00	9.30	2.10	8.00	8.30	5.20	4.05
Mean	18.03		21.25		13.11		14.65		18.56		10.80		11.52		16.21		8.84	
Total	52.39						44.01						36.57					

* S - Soaking

C - Cleaning



KEY :
■ A : RICE
□ B : SAMBAR
▨ C : AMARANTH PORIAL

FIGURE : 6
TIME TAKEN TO CLEAN THE UTENSILS USED FOR COOKING

As can be seen from table IX the average time taken to clean was highest in the case of the utensils used over kerosene and least in the case of those used over Burshane and that those used over cow-dung gas was inbetween.

The statistical analysis vide Appendix IX shows that the difference between the time taken for cleaning the utensils used over kerosene and cow-dung gas, Burshane and kerosene as well as that between cow-dung gas and Burshane were xhighly significant. Therefore it is evident that cow-dung gas is better than kerosene and Burshane is better than kerosene and cow-dung gas, thus showing the superiority of Burshane. Figure 7 indicates the suit formation on the utensil used for cooking over kerosene.

2. Money Management

The amount of money spent on fuel to prepare the selected meal using kerosene, cow-dung gas and Burshane was computed as shown in Appendix X. It is clear from the calculation that on an average 16 paise were spent to prepare the selected meal using kerosene, ten paise using cow-dung gas and 26 paise using Burshane. Assuming that three meals would be prepared a day, the cost calculated for one month was (16 paise x 3 x 30) Rs. 14-40 for kerosene, (10 paise x 3 x 30) Rs. 9-00 for cow-dung gas and (26 paise x 3 x 30) Rs. 23-40 for Burshane. This shows that Burshane was most expensive and cow-dung gas least expensive.

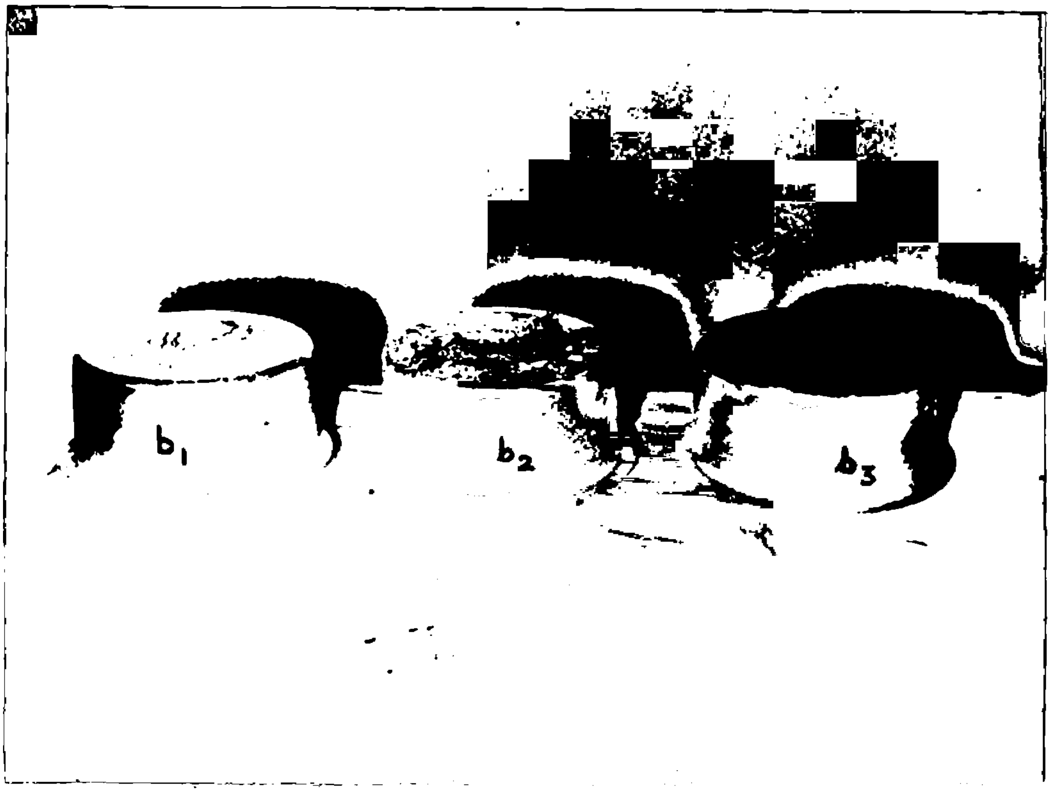


FIGURE - 7

UTENSILS USED OVER THE SELECTED THREE FUELS

KEY:

b_1 - VESSEL USED OVER COW DUNG GAS

b_2 - VESSEL USED OVER BURSHANE

b_3 - VESSEL USED OVER KEROSENE

3. <u>Palatability of cooked items</u>

The palatability of rice, 'sambar' and amaranth 'porial' are discussed under:

a. Appearance

b. Colour

c. Texture

d. Doneness

e. Flavour

f. Taste

and g. Palatability of the whole lunch

a. <u>Appearance</u>

The scores given by the judges for appearance to rice 'sambar' and amaranth 'porial' are given in Table X.

TABLE X

SCORES AWARDED FOR APPEARANCE OF THE COOKED ITEMS

Replicates	Kerosene			Cow-dung gas			Burshane		
	Rice	'Sambar'	Amaranth 'porial'	Rice	'Sambar'	Amaranth 'porial'	Rice	'Sambar'	Amaranth 'porial'
1	15	18	15	17	19	14	21	18	18
2	17	17	17	17	19	16	20	19	18
3	17	21	15	18	17	15	21	18	15
4	16	20	15	19	19	15	21	19	17
5	17	20	15	18	19	14	21	19	18
Average	16.4	19	15.2	17.8	18.6	14.8	20.8	18.6	17.2
Total		50.6			51.2			56.6	

Table X shows that the scores given for appearance were consistently the highest for rice cooked over Burshane and the least for that cooked over kerosene. Maximum scores were awarded for the appearance of 'sambar' cooked over kerosene whereas equal scores were given for the samples over cow-dung gas and Burshane. For amaranth 'porial' maximum scores for appearance were given for that cooked over Burshane and minimum for that over cow-dung gas. The statistical analysis vide Appendix XI shows that the difference between the mean scores awarded for the appearance of the items cooked over Burshane and kerosene and cow-dung gas are significant at 50 per cent levels.

b. Colour

The scores offered by the judges for colour are presented in Table XI.

TABLE XI

SCORES AWARDED FOR COLOUR OF THE COOKED ITEMS

Replicates	Kerosene			Cow-dung gas			Burshane		
	Rice	'Sambar'	Amaranth 'porial'	Rice	'Sambar'	Amaranth 'porial'	Rice	'Sambar'	Amaranth 'porial'
1	16	23	21	20	20	21	25	23	20
2	18	23	20	20	20	20	25	25	22
3	17	23	21	20	20	20	25	25	22
4	18	24	20	20	20	20	25	25	22
5	16	23	20	20	20	21	25	25	23
Average	17	23.2	20.4	20	20	20.4	25	24.6	21.8
Total		60.6			60.4			71.4	

Table XI shows that all the items prepared over Burshane received maximum scores for colour. Cow-dung gas and kerosene ranked only next. Statistical analysis videAppendix XII shows that the mean difference between the scores awarded for colour for the items prepared over cow-dung gas and kerosene was not significant, while for that between Burshane and cow-dung gas and Burshane and kerosene were significant at 50 and 10 per cent levels respectively. This clearly indicates the superiority of Burshane over the others in maintaining colour of the cooked items.

e. <u>Texture</u>

The scores awarded by the judges for the texture of the preparations are given in Table XII.

TABLE XII

SCORES AWARDED FOR TEXTURE OF THE COOKED ITEMS

Replicates	Kerosene			Cow-dung			Burshane		
	Rice	'Sambar'	Amaranth 'porial'	Rice	'Sambar'	Amaranth 'porial'	Rice	'Sambar'	Amaranth 'porial'
1	16	18	19	20	18	19	22	23	20
2	15	19	19	18	18	19	25	23	21
3	16	17	20	19	18	19	25	22	20
4	18	20	20	19	18	19	24	23	21
5	18	20	19	18	21	19	25	23	21
Average	16.6	18.8	19.4	18.8	18.6	19	24.2	22.8	20.6
Total		54.8			56.4			67.6	

From Table XII, it can be observed that all the three selected items prepared over Burshane received consistently greater scores for texture than those prepared over cow-dung gas or kerosene. The statistical analysis vide Appendix XIII shows that the differences are significant at 10 and 50 per-cent levels between the items prepared over Burshane against cow-dung gas and kerosene respectively.

d. Doneness

Table XIII indicates the scores given by the judges for the doneness of the three selected items cooked over kerosene, cow-dung gas and Burshane.

TABLE XIII

SCORES AWARDED FOR DONENESS OF THE COOKED ITEMS

Repli-cates	Kerosene			Cow-dung gas			Burshane		
	Rice	'Sambar'	Amaranth 'porial'	Rice	'Sambar'	Amaranth 'porial'	Rice	'Sambar'	Amaranth 'porial'
1	21	22	22	23	22	19	25	22	24
2	21	21	23	20	21	17	25	23	25
3	23	22	20	21	23	19	24	23	24
4	23	23	20	21	22	19	24	23	24
5	22	21	20	20	22	18	24	25	24
Average	22	21.8	21	21	22	18.4	24.4	23.4	23.8
Total		64.8			61.4			71.6	

The scores in Table XIII show that doneness was most acceptable when the selected items were cooked over Burshane, whereas it was least with cow-dung gas. Statistical analysis vide Appendix XIV shows that the difference between the doneness of the three items prepared over kerosene and Burshane is significant at five per cent level and the difference is significant at 50 per cent level between cow-dung gas and kerosene and cow-dung gas and Burshane. Therefore it is clear that the intensified heat evolved from Burshane makes the products cooked over it, most satisfactory.

e. <u>Flavour</u>

The scores awarded by the judges for the flavour of the prepared items are given in Table XIV.

TABLE XIV

SCORES AWARDED FOR FLAVOUR OF THE COOKED ITEMS

Replicates	Kerosene			Cow-dung gas			Burshane		
	Rice	'Sambar'	Amaranth 'porial'	Rice	'Sambar'	Amaranth 'porial'	Rice	'Sambar'	Amaranth 'porial'
1	23	22	20	22	22	20	22	22	22
2	23	24	19	22	22	20	25	23	24
3	24	24	19	23	22	21	24	24	24
4	23	23	18	22	22	20	24	24	24
5	23	23	20	24	23	21	25	24	24
Average	23.2	23.2	19.2	22.4	22.2	20.4	24	23.4	23.6
Total		65.6			65.0			71.0	

The average scores for flavour found in Table XIV show that the items cooked over Burshane received the maximum scores and those cooked over cow-dung gas the minimum. On statistical analysis vide Appendix XV, it was evident that the difference between the average scores awarded for flavour of the items cooked over kerosene and cow-dung gas was not at all significant, whereas the difference between cow-dung gas and Burshane was significant at 50 per cent level.

f. <u>Taste</u>

The scores for the taste of the cooked products are given in Table XV.

TABLE XV

SCORES AWARDED FOR TASTE OF THE COOKED ITEMS

Replicates	KEROSENE			COW-DUNG GAS			BURSHANE		
	Rice	'Sambar'	Amaranth 'porial'	Rice	'Sambar'	Amaranth 'porial'	Rice	'Sambar'	Amaranth 'porial'
1	20	20	18	25	21	16	25	24	17
2	19	21	17	20	21	17	25	24	18
3	20	21	17	20	20	17	25	23	19
4	19	22	17	20	21	16	25	24	20
5	19	22	18	20	21	17	25	24	20
Average	19.4	21.2	17.4	21	20.8	16.6	25	23.8	18.8
Total		58.0			58.4			67.6	

The Table XV reveals that the scores awarded for taste were maximum for all the items cooked over Burshane and minimum for kerosene. While comparing the mean scores of cow-dung gas and kerosene with Burshane, the scores between cow-dung gas and Burshane, the difference is found to be significant at 10 percent level and that between kerosene and Burshane at 50 percent level. There is no significant difference in the scores for taste between kerosene and cow-dung gas, vide Appendix XVI.

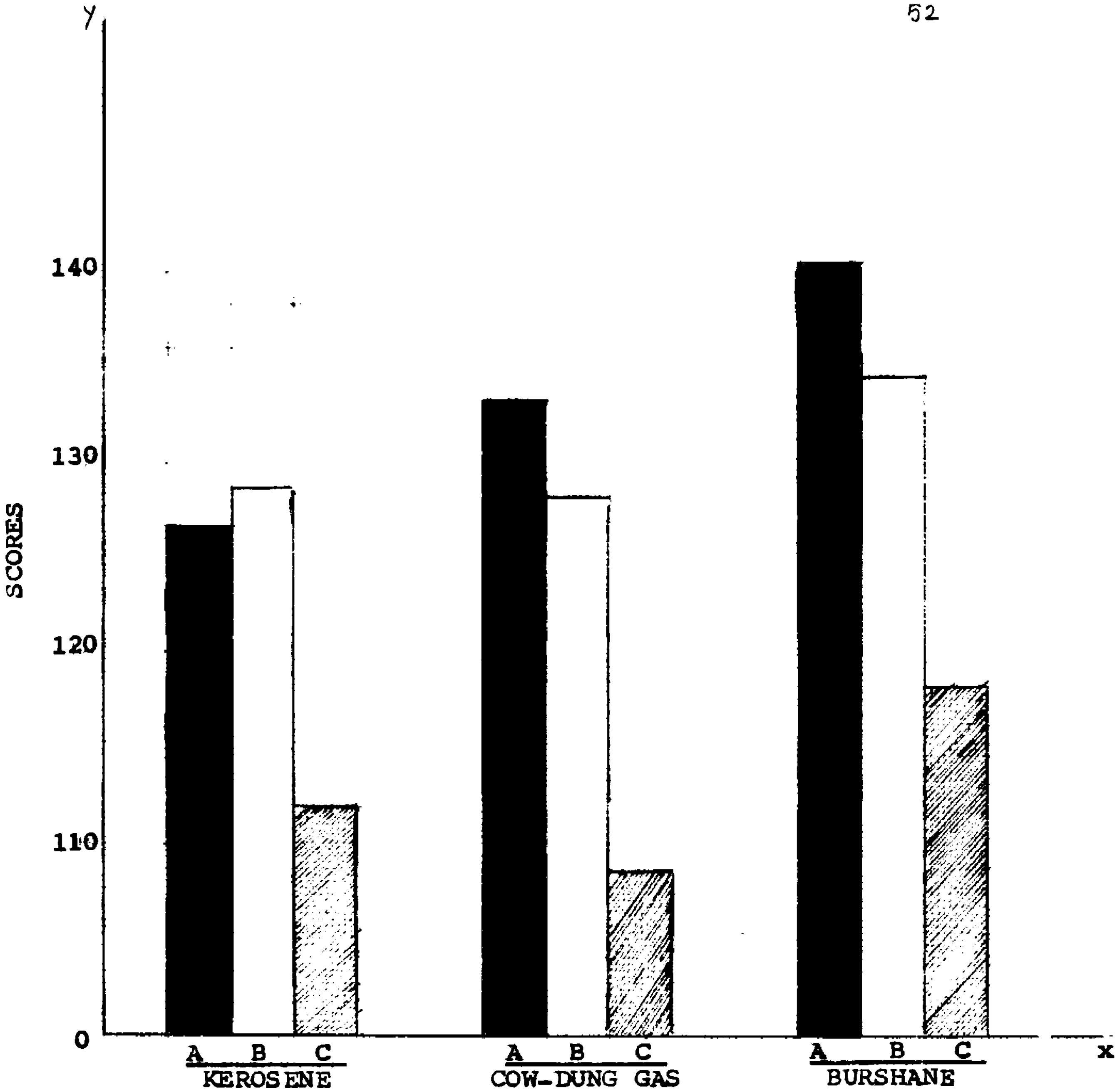
g. <u>Palatability of the whole lunch</u>

The scores awarded for the total palatability of the lunch by the judges are presented in Table XVI and Figure 8.

TABLE XVI

SCORES AWARDED FOR PALATABILITY OF LUNCH

Replicates	Kerosene			Cow-dung gas			Burshane		
	Rice	'Sambar'	Amaranth 'porial'	Rice	'Sambar'	Amaranth 'porial'	Rice	'Sambar'	Amaranth 'porial'
1	122	122	115	133	127	109	137	129	119
2	124	127	115	128	126	109	141	137	120
3	127	128	113	132	125	110	142	135	117
4	124	134	112	133	129	109	142	138	118
5	123	129	112	134	131	109	142	139	122
Average	124	128	113.4	132	129.6	109.2	140.8	135.6	119.2
Total		365.4			370.8			395.6	



KEY:

A : RICE
B : SAMBAR
C : AMARANTH PORIAL

FIGURE 8

SCORES AWARDED FOR PALATABILITY OF LUNCH

It is evident from Table XVI that the palatability of all the three preparations cooked over Burshane was consistently higher than those cooked over kerosene and cow-dung gas. When statistically analysed, (vide Appendix XVII) the difference between kerosene and cow-dung gas in the scores awarded to the lunch for palatability was not significant; but that between Burshane and cow-dung gas and between Burshane and kerosene was significant at 50 and 10 per cent levels respectively. This shows the superiority of Burshane.

V. SUMMARY AND CONCLUSION

One hundred selected households were surveyed to study the types of fuels used as basis for this study on the managerial benefits derived from the use of kerosene, cow-dung gas and Burshane in terms of time, money, labour and palatability. The findings arising out of the survey and the experimental work reveal that:

1. Kerosene was the commonly used household fuel. Ninety five per cent of the families used more than one fuel, whereas, five per cent used Burshane alone. The homemakers using kerosene reported that kerosene was easy to light, economical and convenient to handle. The homemakers using Burshane considered it as an economical, time saving, easy to handle and clean fuel.

2. The monthly expenditure on fuels incurred by the families increased with rise in income. The daily expenditure on fuels in all the income ranges exceeded 20 paise.

3. The time taken to prepare the selected meal was minimum with Burshane, resulting in a saving of 17.9 per cent when compared to cow-dung gas.

4. The time taken to clean the utensils used over Burshane was less than that required to clean the utensils used over the other two fuels. This involved a saving of

30.17 per cent of time when compared with kerosene and 16.9 per cent in relation to cow-dung gas.

5. Cow-dung gas was found to be the least expensive of the three fuels costing Rs. 9.00 per month and Burshane, the most expensive costing Rs. 23.40. The cost of kerosene came in between being Rs. 14.40 per month.

6. The food preparations cooked over Burshane obtained higher scores for palatability than those cooked over kerosene and cow-dung gas.

This study thus establishes the superiority of Burshane over cow-dung gas and kerosene from the stand point of time management and palatability of the foods cooked. However its cost may be prohibitive to lower income families.

BIBLIOGRAPHY

BIBLIOGRAPHY

1. Shrimali, K.L., PROCEEDINGS OF THE ALL INDIA HOME SCIENCE CONFERENCE. 1960, p. 14.

2. Nehru, J., WELFARE OF WOMEN AND CHILDREN FROM THE DEPTHS OF INDIA. Kurukshetra. Publications Divisions, Ministry of Information and Broadcasting, Government of India, New Delhi, 1961, pp. 244 - 245.

3. Bhan, R.K., SELF HELP AND THE VILLAGE WOMEN, Panchayati Raj, Vol. II, 1960, p. 14.

4. Ministry of Community Development and Cooperation, Gram Sevika, Government of India, 1960, pp. 1 - 2.

5. Nickell, P., and Dorsey, J.M., MANAGEMENT IN FAMILY LIVING. John Wiley and Sons Inc., London, 1960, pp. 2, 36, 37 and 100.

6. Gross, I.H., and Crandall, E.W., MANAGEMENT FOR MODERN FAMILIES. Appleton Century Crofts Inc., New York. 1954, p. 4.

7. Goodyear, M.R., and Khlor, M.C., MANAGING FOR EFFECTIVE LIVING. John Wiley and Sons, Inc., New-York. 1954, pp. 3, 11, 43-44.

8. Starr, M.C., MANAGEMENT FOR BETTER LIVING. D.C.Health and Co., Boston, 1959, p. 15.

9. Moore, B.M., TIME, TENSION AND MENTAL HEALTH, J. H. E. Vol. XXXXIX. 1957, p. 759.

10. Sengupta, P., WOMEN WORKERS IN INDIA., Asia Publishing House, Bombay, 1960, pp. 11 - 14.

11. Rai, P., INDIA'S WORKING WOMEN, Social Welfare, Vol. XI, 1964, p. 1.

12. Farm Information Unit. A BETTER HOME FOR THE RURAL FAMILY. The Directorate of Extension, Ministry of Food and Agriculture, New Delhi, 1957, p.14.

13. Home Economics and Domestic Subjects Review, FUEL WITH A FUTURE. Vol. XI, 1965, p. 37.

14. Monroe, D. et al. DETERMINATION OF STANDARDS FOR THE ESTABLISHMENT OF HOUSEHOLD BUDGETS FOR THE EXPENDITURE OF MONEY, TIME, AND ENERGY. J.H.E. Vol. XXIV. 1932. p. 1047.

15. Devadas, R.P., THE MEANING OF HOME SCIENCE, Sri Avinashilinga Home Science College, Coimbatore. 1958. pp. 2, 8, 14.

16. Brown, M., EFFECTIVE WORK MANAGEMENT. MacMillan Co., New York. 1960, p. 6.

17. Riebel, L.J., PHILOSOPHY OF MANAGEMENT. J. H. E. Vol. LII, 1960, p. 18.

18. Crandall, E.W., NEWER ASPECTS OF HOME MANAGEMENT. J. H. E. Vol. XXXXVIII, 1956, p. 631.

19. Crandall, E.W., THE FAMILY MANAGES ITS MONEY. J.H.E. Vol. XXXX. 1948, p. 565.

20. Malone, C.C., and Malone, L.H., DECISION MAKING AND MANAGEMENT FOR FARM AND HOME. The Iowa State College Press, Iowa. 1958, pp. 205.

21. Andrews, B.R., ECONOMICS OF THE HOUSEHOLD. The MacMillan Co., New York. 1935, pp. 112 - 113.

22. Wiesendanger, D.E., THE FAMILY MANAGES ITS WORK. J.H.E. Vol. XXXX. 1948, p. 515.

23. Landis, P.H., YOUR MARRIAGE AND FAMILY LIVING. McGraw-Hill Book Co. Inc., New York. 1954, pp. 15-17.

24. Abroal, M., MARRIAGE COUNSELLING, ITS NEEDS AND SCOPE IN INDIA. The Home Maker. Rajasthan Mahila Vidyalaya, Udaipur. 1962, p. 21.

25. Nehru, J., WOMEN OF INDIA. Publication Division, Ministry of Information and Broadcasting., Govt. of India, New Delhi, 1958, pp. 128-129.

26. Narayan, S., WOMEN AND THE THIRD PLAN. Kasturba Gandhi National Memorial Trust, Kasturba Gram. 1962, pp. 44 - 45.

27. Steidle, R.E., USE OF TIME DURING FAMILY MEAL PREPARATION AND CLEAN UP. J.H.E. Vol. XL. 1958, pp. 447 - 448.

28. Cowles, M.L., and Ruth, P.D., TIMES SPENT IN HOME MAKING ACTIVITIES BY A SELECTED GROUP OF WISCONSIN FARM HOMEMAKERS. J.H.E. Vol. XXXXVIII, 1956, p. 29.

29. Rama Bai, A., SOME HOMEMAKING PROBLEMS IN A TEXTILE MILL. A Thesis submitted to the University of Madras, 1963, Pp. 45 - 46.

30. Geldens, M., TWO RURAL FAMILIES OF UTTAR PRADESH, Directorate of Extension, Ministry of Food and Agriculture, Government of India, 1960, p. 28.

31. Sundari, V., THE USE OF SOME LABOUR SAVING KITCHEN DEVICIS IN RELATION TO TIME MANAGEMENT OF SELECTED URBAN HOMEMAKERS. A Thesis submitted to the University of Madras, 1963, Pp.70-71.

32. Vijaya, K.S., A COMPARATIVE STUDY OF THE TIME AND MONEY MANAGEMENT USING FOUR TYPES OF COOKERS A Thesis submitted to the University of Madras 1963, Pp. 80 - 81.

33. Osborne, F.A., PHYSICS OF THE HOME. McGraw-Hill Book Co. Inc., New York. 1929, p. 139.

34. Avery, M., HOUSEHOLD PHYSICS. MacMillan Co., New York. 1955, Pp. 152 - 154, 107.

35. Krauskopf, K.B., FUNDAMENTALS OF PHYSICAL SCIENCE. McGraw-Hill Book Co.Inc., New York. 1953.p. 382.

36. Partington, T.R., TEXT BOOK OF INORGANIC CHEMISTRY. MacMillan Co., London, 1957, Pp. 603 - 629.

37. Heslett, E., TEACH YOURSELF HOUSEHOLD ELECTRICITY. English Universities Press., London, 1953, Pp. 71 - 82.

38. Krishna, S., and Ramaswamy, S., CALORIFIC VALUE OF SOME INDIAN FOODS. Forest Bulletin No. 79, Government of India, Central Publication Branch, Calcutta, 1932, Pp. 1-4, 8-27.

39. Encyclopaedia Britanica. Vol. IX, Pp. 891 - 902.

40. Weaver, E.C., and Foster, W.E.C., CHEMISTRY FOR OUR TIMES. McGraw Hill Book Co., New York. 1954 Pp. 478 - 495.

41. Desai, S.V., and Biswas, S.C., MANURE AND GAS PRODUCTION BY ANAEROBIC FERMENTATION OF ORGANIC WASTES. Indian Farming. Vol. VI, 1945, Pp. 67 - 68.

42. Gotaas, H.B., COMPOSTING. World Health Organization Geneva. 1956, Pp. 15 - 18, 171 - 179.

43. Acharya, S.? COW-DUNG GAS PLANTS. Indian Farming, Vol. III, 1953, Pp. 16 - 18.

44. Iyengar, M.V.R., USES OF COW-DUNG. The Indian Express., March 1967, p. 6.

45. Waksman., PRINCIPLES OF SOIL MICROBIOLOGY. Williams and Wilkins Co., Inc., Baltimore, 1932, p. 40.

46. Imhoff and Fair, SEWAGE TREATMENT. John Wiley and Sons, Inc., New York. 1940, p. 17.

47. Desai, S.P., COMBUSTIBLE GAS FROM CATTLE DUNG. Agricultural College Magazine, Poona, 1951, Pp. 42, 74 - 82.

48. Patel, J.J., DIGESTION OF WASTE ORGANIC MATTER BY PRODUCTION OF METHANE AND ORGANIC FERTILISER AND A NEW ECONOMIC APPARATUS FOR SMALL SCALE DIGESTION. Agricultural College Magazine, Poona., Vol. XXXXIX. 1951, Pp. 150 - 159.

49. Indian Agricultural Research Institute, 1957.

50. Symons, G.E., and Buswell, A.M., THE METHANE FERMENTATION OF CARBOHYDRATES. Journal of American Chemical Science, Vol. IV. 1933, Pp. 20 - 28.

51. Tarvin, D., and Buswell, A.M., METHANE FERMENTATION OF ORGANIC ACIDS AND CARBOHYDRATES. Journal of American Chemical Science. Vol. LVI. 1934, Pp. 1751 - 1755.

52. Leake, M.H., and Howard, L.E., METHANE GAS FROM FARMYARD MANURE. Albert, Howard foundation of Organic Husbandry, England, No. 9, 1952, p.20.

53. Patel, J.J., DIGESTION OF WASTE ORGANIC MATTER BY PRODUCTION OF METHANE AND ORGANIC FERTILISER AND A NEW ECONOMIC APPARATUS FOR SMALL SCALE DIGESTION. Agricultural College Magazine, Poona. Vol. XXXXII, 1941, Pp. 150 - 159.

54. Kamalaveni, D., A STUDY OF CATTLE-DUNG GAS AS A HOUSE-HOLD FUEL. A Thesis submitted to the University of Madras, April, 1962, p. 60.

55. Chetty, M.C., A COMPARATIVE STUDY OF FOUR HOUSEHOLD FUELS WITH SPECIAL REFERENCE TO CONSUMPTION, COOKING TIME AND COST. A Thesis submitted to the University of Madras, 1958, Pp. 58-59.

56. Lalitha, M.S., HOUSEHOLD EQUIPMENT A Pilot study. A Comparative study of household fuels, firewood, charcoal, electricity, with special reference to cooking, time consumption, cost and convenience. The Vidyalaya Journal, Sri Ramakrishna Mission Vidyalaya, Coimbatore. Vol. II. 1960, Pp. 40 - 42.

57. Chittaranjan, P., POPULARISING BIO GAS (GOBAR GAS) PRODUCTION. Khadi Gramodyog., Vol. XII, 1966, Pp. 661 - 662.

58. National Council of Applied Economic Research DOMESTIC FUELS IN INDIA, Asia Publishing House, Madras 1959, Pp. 18-24, 19, 121-127, 73, 22 and 225.

59. Varma, M., AN INTRODUCTION TO EDUCATIONAL AND SOCIAL RESEARCH. Asia Publishing House, India, 1965, P. 184.

60. Young, P.V., SCIENTIFIC SURVEYS AND RESEARCH. Prentice Hall, Inc., New York, 1956, Pp. 643 - 644.

61. Good, C.V., and Scates, D.E., METHODS OF RESEARCH Appleton Century Crofts, Inc., New York, 1954. Pp. 637, 681 - 682.

62. Moser, C.A., SURVEY METHODS IN SOCIAL INVESTIGATION. William Hieneman Ltd., Melbourne, London, 1958 p. 4.

63. Burchinal, L.G. and Hawkes, G.R., HOME INTERVIEW WITH FAMILIES. J. H. E. Vol. XXXXIX, 1957, p. 167.

64. Reh, E., MANUAL OF HOUSEHOLD FOOD CONSUMPTION SURVEYS. FAO, Nutritional Studies, Rome, No. 8, 1962, Pp. 63 - 64.

65. Indian Council of Medical Research. A NOTE ON THE MANAGEMENT AND TECHNIQUES OF DIET SURVEYS IN INDIA. I.C.M.R., Special Report No.21, 1951.Pp.7-9

66. Rao, M.V. ALUMINIUM CAN REPLACE ZINC. Yojana, Vol. X March, 1966, p. 6.

67. Swaminathan, M., and Bhagawan, R.K., OUR FOOD, Ganesh and Co., Madras. 1960. p. 36.

68. Kamaleshpuri, THE PERFORMANCE OF FIVE COOKING UTENSILS DIFFERING IN METALS AND TREATMENT OF BOTTOMS. A Thesis submitted to the University Madras, 1964, Pp. 45 - 55.

69. Pearson, D.M. Phillip, M.E., Godavari, T.L., and Rowlands, R. NUTRITION NOTES. The Christian Literature Society for India, Madras, 1948, P. 164.

70. Stanley, L., and Clive, J.A., FOODS THEIR SELECTION AND PREPARATION. Boston. Guin and Company 1950, p. 93.

71. Mason, E.M., INTRODUCTION TO EXPERIMENTAL COOKING. McGraw Hill Book Company Inc., New York. 1939 Pp. 32 - 37.

72. Child, A.M., and Niles, K.B., FOOD PREPARATION STUDIES John Wiley and Sons, Inc., New York. 1938, Pp. 13 - 17.

73. Sweetman, M.D., and Mackeller, I., FOOD SELECTION AND PREPARATION. John Wiley and Sons. Inc., New-York. 1954, Pp. 74 - 85.

74. Lowe, B., EXPERIMENTAL COOKERY. John Wiley and Sons, Inc., New York. 1955, Pp. 41 - 44.

75. Garrett, H.E., STATISTICS IN PSYCHOLOGY AND EDUCATION. Longmans Green and Co., 1962, Pp. 181 - 192.

A P P E N D I C E S

APPENDIX I

SRI AVINASHILINGAM HOME SCIENCE COLLEGE
COIMBATORE-11

INTERVIEW SCHEDULE TO ELICIT INFORMATION REGARDING THE USE OF VARIOUS TYPES OF FUELS BY THE SELECTED 100 HOUSEHOLDS.

Date:

Name of Investigator :

1. Serial No.
2. Name of the Homemaker:
3. Address:
4. Age:
5. Gainfully employed: Yes ☐ No ☐
6. Family background:

S.No.	Name of family members	Relationship to homemaker	Age	Sex	Education	Occupation	Income per month

7. Types of fuel used:

Fuel used	Items for which used	Reasons for using the particular fuel	Advantages of the fuel	Problems faced if any

8. Quantity and cost of fuel:

Fuel used	Quantity used per month	Cost per month

9. Type of meal:

Vegetarian ☐ Non-vegetarian ☐

APPENDIX II

INVENTORY SCHEDULE TO FIND OUT THE DAILY FUEL CONSUMPTION FOR A WEEK BY THE SELECTED 20 HOUSEHOLDS

Date:

Name of the Investigator:

1. Serial No:

2. Name of the homemaker:

3. Address:

4. Quantity and cost of fuel:

Day	Quantity of fuel used	Cost
First day		
Second day		
Third day		
Forth day		
Fifth day		
Sixth day		
Seventh day		

APPENDIX III

FOOD ALLOWANCES FOR TWO ADULT MEMBERS

Food items	Requirements gms.
Cereals	420
Pulses	90
Green leafy vegetables	120
Root vegetables	90
Other vegetables	90
Fruits	90
Milk	300
Sugar	60
Oils and fats	60
Meat and fish	60
Egg	30

APPENDIX IV

SCORE CARD FOR RICE

Signature of the judge:

Note: Please judge the product without any discussion. Tick against the statement which you think best. Please take a sip of water before judging the next sample to remove the taste of the previous sample.

Quality	Description	Samples A	B	C	D	E	Marks
1. Appearance	Excellent						5
	Very good						4
	Good						3
	Fair						2
	Poor						1
2. Colour	Characteristic						5
	White						4
	Slightly white						3
	Off white						2
	Brownish cream						1
3. Texture	Soft						5
	Slightly hard						4
	Very soft						3
	Hard						2
	Very hard						1

contd.....

APPENDIX IV (contd..)

	Quality	Description	Samples A	B	C	D	E	Marks
4.	Doneness	Well cooked						5
		Just cooked						4
		Over cooked						3
		Under cooked						2
		Not cooked						1
5.	Flavour	Odour of well cooked rice						5
		Desirable						4
		Foreign						3
		Unpleasant						2
		Soda bicarbonate						1
6.	Taste	Excellent						5
		Very good						4
		Good						3
		Fair						2
		Poor						1

APPENDIX V

SCORE CARD FOR SAMBAR

Signature of the judge:

Note: Please judge the product without any discussion. Tick against the statement, which you think best. Please take a sip of water before judging the next sample to remove the taste of the previous sample.

Quality	Description	Samples A	B	C	D	E	Marks
1. Appearance	Excellent						5
	Very good						4
	Good						3
	Fair						2
	Poor						1
2. Colour	Characteristic						5
	Dhal colour						4
	Yellow						3
	Pungent yellow						2
	Yellowish brown						1
3. Texture	Very soft						5
	Soft						4
	Slightly hard						3
	Hard						2
	Very hard						1

contd......

APPENDIX V (contd..)

	Quality	Description	Samples A	B	C	D	E	Marks
4.	Doneness	Well cooked						5
		Just cooked						4
		Over cooked						3
		Under cooked						2
		Not cooked						1
5.	Flavour	Natural						5
		Pleasant						4
		Foreign						3
		Unpleasant						2
		Soda bicarbonate						1
6.	Taste	Excellent						5
		Very good						4
		Good						3
		Fair						2
		Poor						1

APPENDIX VI

SCORE CARD FOR AMARANTH 'PORIAL'

Signature of the judge:

Note: Please judge the product without any discussion. Tick against the statement, which you think best. Please take a sip of water before judging the next sample to remove the taste of the previous sample.

Quality	Description	A	B	C	D	E	Marks
1. Appearance	Excellent						5
	Very good						4
	Good						3
	Fair						2
	Poor						1
2. Colour	Intensified green						5
	Natural green						4
	Light green						3
	Pale green						2
	Brown green						1
3. Doneness	Well cooked						5
	Fairly well cooked						4
	Just cooked						3
	Slighly over cooked						2
	Uncooked						1

contd....

APPENDIX VI (contd..)

Quality	Description	A	B	C	D	E	Marks
4. Tenderness	Soft						5
	Fairly soft						4
	Very soft						3
	Hard						2
	Very hard						1
5. Flavour	Well cooked amaranth flavour						5
	Pleasant						4
	Uncooked amaranth flavour						3
	Unpleasant						2
	No flavour						1
6. Taste	Excellent						5
	Very good						4
	Good						3
	Fair						2
	Bad						1

APPENDIX VII

RESULT OF THE TRIANGLE TEST

Judges	Replicates					Total number of times the judges were correct
	1	2	3	4	5	
1	/	/	x	/	/	4*
2	/	/	/	/	/	5*
3	/	x	x	/	/	3
4	/	/	/	/	/	5*
5	x	x	/	/	x	2
6	/	/	/	/	x	4*
7	/	/	x	x	x	2
8	x	/	x	x	x	1
9	/	x	/	/	/	4*

* Judges who were selected for the taste panel

/ Indicates correct detection of the different samples

x Indicates wrong detection of the different samples.

APPENDIX VIII

TIME TAKEN FOR COOKING LUNCH

Items	Kerosene x	Cow-dung gas y	z (=x - y)
Rice	58	50	-8
'Sambar'	68	64	-4
Amaranth 'porial'	20	18	-2

$$\bar{z} = \frac{\Sigma z}{n} = \frac{14}{3} = 4.67 \quad s^2 = \frac{z^2}{n} - \bar{z}^2 = \frac{64+16+4}{3} - (4.65)^2$$

$$= \frac{84}{3} - (4.67)^2 = 28 - 21.8089 = 6.1911$$

$$t = \frac{\bar{z}}{\sqrt{\frac{s^2}{n-1}}} = \frac{4.67}{\sqrt{\frac{6.1911}{2}}} = \frac{4.67}{\sqrt{3.0956}} = \frac{4.67}{1.76} = 2.65$$

From t - tables for d . f = 2, P .05

The difference is significant at 50 per cent level.

Hence cow-dung gas is better than kerosene

Items	Kerosene	Burshane	z=(x-y)
Rice	58	49	9
'Sambar'	68	56	12
Amaranth 'porial'	20	15	5

$$\bar{x} = \frac{26}{3} = 8.67 \quad s^2 = \frac{81 + 144 + 25}{3} - (8.67)^2 = \frac{250}{3}$$

$$- 75.1689 = 83.3333 - 75.1689 = 8.1644$$

$$t = \frac{8.67}{\sqrt{\frac{8.1644}{2}}} = \frac{8.67}{\sqrt{4.822}} = \frac{8.67}{2.02} = 4.29$$

From t - tables for d.f = 2, we find it is nearly equal to .05. This is significant at 10 per-cent level. Hence burshane is better than kerosene

Items	Cow-dung gas	Burshane	Z
Rice	80	40	4/1
'Sambar'	64	56	8
Amaranth 'porial'	18	15	3

$$\bar{z} = 4$$

$$s^2 = \frac{1+64+9}{3} - 16 = \frac{74}{3} - 16$$

$$= 24.67 - 16 = 8.67$$

$$t = \frac{4}{\sqrt{\frac{8.67}{2}}} = \frac{4}{\sqrt{4.34}} = \frac{4}{2.08} = 1.92$$

From t - tables for d.f = 2 $P > .05$.
Hence the difference is significant at 80% level
Hence Burshane is better than cow-dung gas.

APPENDIX IX

TIME TAKEN FOR CLEANING THE UTENSILS AFTER COOKING

Kerosene	Cow-dung gas	y	x	s
9.30 + 8.73	9.30 + 5.35	14.65	18.03	3.38
8.00 + 13.25	8.00 + 10.56	18.56	21.25	2.69
5.00 + 8.11	5.00 + 5.80	10.80	13.11	2.31

$$\bar{s} = \frac{3.38 + 2.69 + 2.3}{3} = \frac{8.38}{3} = 2.79$$

$$s^2 = \frac{23.9966}{3} - (2.79)^2 = 7.9989 - 7.7841 = .2148$$

$$t = \frac{2.79}{\sqrt{\frac{.2148}{2}}} = \frac{2.79}{\sqrt{.1074}} = \frac{2.79}{.33} = 8.45$$

From t - tables for d. f = 2 $P < .05$

Hence there is significant difference between two.

So cow-dung gas is better than kerosene

Burshane(y)	Kerosene (x)	s
9.30 + 2.22 = 11.52	18.03	6.51
8.00 + 8.21 = 16.21	21.25	5.04
5.00 + 3.84 = 8.84	13.11	4.27

$$\bar{x} = \frac{15.82}{3} = 5.27 \quad s^2 = \frac{86.0146}{3} - (5.27)^2 = 28.6715 - 27.7729$$

$$= .8986$$

$$t = \frac{5.27}{\sqrt{\frac{.8986}{2}}} \quad \frac{5.27}{\sqrt{.4493}} \quad \frac{5.27}{.67} = 7.87$$

From t - tables for d.f = 2 $P < .05$

Hence there is significant différence between the two

So Burshane is better than Kerosene.

Cow-dung gas	Burshane	x
14.65	11.52	3.13
18.56	16.21	2.35
10.80	8.84	1.96

$$\bar{x} = \frac{[illegible]}{3} = 2.48$$

$$s^2 = \frac{19.1610}{3} - (2.48)^2 = 6.3870 - 6.1504 = .2366$$

$$t = \frac{2.48}{\sqrt{\frac{.2366}{2}}} \quad \frac{2.48}{\sqrt{.1183}} \quad \frac{2.48}{.34} = 7.29$$

From t - tables for d.f = 2. $P < .05$

Hence the difference is significant.

Burshane is better than cow-dung gas.

APPENDIX X

CALCULATION OF COST OF THE THREE SELECTED FUELS

The amount of money expended on the different fuels to cook the selected items was calculated as follows:

a. **Burshane**

1. Cylinder of Burshane = 200 cu.ft of gas.

Number of burning hours at medium flame = 180 hours

The average number of burning hours at medium flame used for one set of experiment 2.00 hours

= $\frac{200 \text{ C.ft}}{180}$ x 2.00 = Volume expended for the experiment

= 1.11 x 2.00 = 2.22 = Volume expended.

Cost of one (200 C.ft) cylinder = Rs. 23.50

Cost expended for the experiment = $\frac{23.50}{200}$ x Volume

= $\frac{23.50}{200}$ x 2.22 = 0.26

∴ Cost of fuel expended for experiment Rs. 0.26

b. **Kerosene:**

Cost of one litre of kerosene = Rs. 0.52

Amount of kerosene used at medium flame = 320 ml.

$\frac{8 \text{ ml}}{25 \text{ ml}} \times 52 = \frac{416}{25}$ = Rs. 0.16

∴ Cost of fuel expanded for experiment = Rs. 0.16

c. **Cow-dung gas:**

Cost of 1000 c ft. of gas = Rs. 3.00

Cost of 2,70,00,000 c.c of gas = Rs. 3.00

Amount of gas consumed per second = 115 c.c

Time taken to cook the three items of lunch = 7920 seconds

∴ Cost of fuel expended for experiment } $\frac{3 \times 115 \times 7920}{2,70,00,000}$

= Rs. 0.10

APPENDIX XI

ANALYSIS OF VARIANCE FOR APPEARANCE OF THE COOKED ITEMS

Items	Kerosene x	Cow-dung gas y	z = y-x
Rice	16.4	17.8	+ 1.4
'Sambar'	19.0	18.6	- 0.4
Amaranth 'porial'	15.2	14.8	- 0.4

$\bar{z} = \frac{.6}{3} = .2 \quad s^2 = \frac{2.28}{3} - .04 = .76 - .04 = .72$

$t = \frac{.2}{\sqrt{\frac{.72}{2}}} \quad \frac{.2}{\sqrt{.36}} \quad \frac{.2}{.6} = .33$

From t - tables, for d.f = 2, $P < .05$

The differences isnot significant.

Items	Cow-dung gas	Burshane	z
Rice	17.8	20.8	3.0
'Sambar'	18.6	18.6	0
Amaranth 'porial'	14.8	17.2	2.4

$$\bar{x} = \frac{5.4}{3} = 1.8 \quad s^2 = \frac{14.76}{3} - (1.8)^2 = 4.92 - 3.24$$

$$= 1.68$$

$$t = \frac{1.8}{\sqrt{\frac{1.68}{2}}} \quad \frac{1.8}{\sqrt{.84}} \quad \frac{1.8}{.92} = 1.96$$

From t - table for d.f = 2, $P > .05$.

It is significant at 50 per cent level

Items	Kerosne	Burshane	x
Rice	16.4	20.8	4.4
'Sambar'	19.0	18.6	-0.4
Amaranth 'porial'	15.2	17.2	2.0

$$\bar{x} \quad \frac{6}{3} = 2.0 \quad s^2 = \frac{23.52}{3} - 4 = 7.84 - 4 = 3.84$$

$$t = \frac{2.0}{\sqrt{\frac{3.84}{2}}} = \frac{2.0}{\sqrt{1.92}} = \frac{2.0}{1.39} = 1.44$$

From t - tables, for d.f = 2, $P > .05$

The differences is not significant at 5% level.

But it is significant at 50 per cent level.

APPENDIX XXI

ANALYSIS OF VARIANCE FOR COLOUR OF THE COOKED ITEMS

Items	Kerosene	Cow-dung gas	z
Rice	17.0	20	- 3
'Sambar'	23.2	20	3.2
Amaranth 'porial'	20.4	20.4	0

$$\bar{z} = \frac{.2}{3} = .07 \quad s^2 = \frac{19.24}{3} - .0049 = 6.4133 - .0049$$
$$= 6.4084$$

$$t = \frac{.07}{\sqrt{\frac{6.4084}{2}}} = \frac{.07}{\sqrt{3.2042}} = \frac{.07}{1.79} = .039$$

The difference is not significant.

Items	Cowdung gas	Burshane	z
Rice	20.0	25.0	5.0
'Sambar'	20.0	24.6	4.6
Amaranth 'porial'	20.4	21.6	1.2

$$\bar{x} = \frac{10.8}{3} = 3.6 \quad s^2 = \frac{47.60}{3} - (3.6)^2 = 15.87 - 12.96$$

$$= 2.91$$

$$t = \frac{3.6}{\sqrt{\frac{2.92}{2}}} = \frac{3.6}{\sqrt{1.455}} = \frac{3.6}{1.21} = 2.98$$

From t - tables, for d.f = 2, P $>$ .05

The difference is significant at 50% level

Items	Kerosene	Burshane	x
Rice	17.0	25.0	8.0
'Sambar'	23.2	24.6	1.4
Amaranth 'porial'	20.4	21.6	1.2

$$\bar{x} = \frac{10.6}{3} = 3.53 \quad s^2 = \frac{67.40}{3} - (3.53)^2 = 22.4667$$

$$- 12.4609 = 10.0058$$

$$t = \frac{3.53}{\sqrt{\frac{10.0058}{2}}} = \frac{3.53}{\sqrt{5.0029}} = \frac{3.53}{2.24} = 1.58$$

From t - tables for d. f = 2, P $>$ .05.

The difference is significant at 10% level.

APPENDIX XIII

ANALYSIS OF VARIANCE FOR TEXTURE OF THE COOKED ITEMS

Items	Kerosene	Cow-dung gas	Z
Rice	18.6	18.8	−0.2
'Sambar'	18.8	18.6	+ .2
Amaranth 'porial'	19.4	19.0	.4

$$\bar{Z} = \frac{.4}{3} = .13 \qquad s^2 = \frac{.32}{3} - .0169 = .1067$$

$$- .0169 = .0898$$

$$t = \frac{.13}{\sqrt{\frac{.0898}{2}}} = \frac{.13}{\sqrt{.449}} = \frac{.13}{.21} = .062$$

From t - tables for d.f = 2, $P > .05$.

The difference is not significant

Items	Cow-dung gas	Burshane	Z
Rice	18.8	24.4	5.4
'Sambar'	18.6	22.8	4.2
Amaranth 'porial'	19.00	20.6	1.6

$$\bar{Z} = \frac{11.2}{3} = 3.73 \quad s^2 = \frac{49.36}{3} - (3.73)^2 = 16.4533$$

$$- 13.9129 = 2.5404.$$

$$t = \frac{3.73}{\sqrt{\frac{2.5404}{2}}} = \frac{3.73}{\sqrt{1.2702}} = \frac{3.73}{1.13} = 3.30$$

From t - tables, for d.f = 2, P $>$ .05

The difference is significant at 10% level

Items	Kerosene	Burshane	Z
Rice	18.6	24.2	5.6
'Sambar'	18.8	22.8	4.0
Amaranth 'porial'	19.4	20.6	1.2

$$\bar{Z} = \frac{10.8}{3} = 3.6 \quad s^2 = \frac{48.80}{3} - (3.6)^2 = 16.2667$$

$$- 12.96 = 3.3067$$

$$t = \frac{3.6}{\sqrt{\frac{3.3067}{2}}} = \frac{3.6}{\sqrt{1.6534}} = \frac{3.6}{1.29} = 2.79$$

From t - tables, for d.f = 2, P. $>$ .05

The difference is significant at 50 per cent level

APPENDIX XIV

ANALYSIS OF VARIANCE FOR DONENESS OF THE COOKED ITEMS

Items	Kerosene	Cow-dung gas	X
Rice	22.0	21.0	1
'Sambar'	21.8	22.0	- .2
Amaranth 'porial'	21.0	18.4	2.6

$$\bar{X} = 1.13 \qquad s^2 = \frac{7.8}{3} - (1.13)^2 = 2.6 - 1.2769 = 1.3231$$

$$t = \frac{1.13}{\sqrt{\frac{1.3231}{2}}} = \frac{1.13}{\sqrt{.6616}} = \frac{1.13}{.81} = 1.40$$

From t - tables for d.f = 2, $P > .05$

The difference is significant at 50% level.

Items	Cow-dung gas	Burshane	X
Rice	21.0	24.4	3.4
'Sambar'	22.0	23.4	1.4
Amaranth 'porial'	18.4	23.8	5.4

$$\bar{X} = \frac{10.2}{3} = 3.4 \qquad s^2 = \frac{42.68}{3} - (3.4)^2 = 14.23 - 11.56$$
$$= 2.67$$

$$t = \frac{3.4}{\sqrt{\frac{2.67}{2}}} = \frac{3.4}{\sqrt{1.335}} = \frac{3.4}{1.16} = 2.93$$

From t - tables for d.f = 2, $P > .05$

The differences is significant at 50% level

Items	Kerosene	Burshane	X
Rice	22.0	24.4	2.4
'Samber'	21.8	23.4	1.6
Amaranth 'porial'	21.0	23.8	2.8

$$\bar{X} = \frac{6.8}{3} = 2.27 \quad s^2 = \frac{16.16}{3} - (2.27)^2 = 5.3867 - 5.1529$$

$$= .2338$$

$$t = \frac{2.27}{\sqrt{\frac{.2338}{2}}} = \frac{2.27}{\sqrt{.1169}} = \frac{2.27}{.34} = 6.68$$

From t - tables for d.f = 2, $P < .05$

The difference is significant at 5% level

APPENDIX XV

ANALYSIS OF VARIANCE FOR FLAVOUR OF THE COOKED ITEMS

Items	Kerosene	Cow-dung gas	Z
Rice	23.2	22.4	.8
'Sambar'	23.2	22.2	1.0
Amaranth 'porial'	19.2	20.4	-1.2

$$\bar{Z} = \frac{.6}{3} = .2 \quad s^2 = \frac{3.08}{3} - .04 = 1.03 - .04 = .99$$

$$t = \frac{.2}{\sqrt{\frac{.99}{2}}} = \frac{.2}{\sqrt{.495}} = \frac{.2}{.7} = .29$$

The difference is not significant

Items	Cow-dung gas	Burshane	Z
Rice	22.4	24.0	1.6
'Sambar'	22.2	23.4	1.2
Amaranth 'porial'	20.4	23.6	3.2

$$\bar{Z} = \frac{6.0}{3} = 2. \quad s^2 = \frac{14.24}{3} = - 4 = 4.7467 - 4$$

$$= .7467$$

xxxx

$$t = \frac{2}{\sqrt{.3734}} = \frac{2}{.61} = 3.28$$

From t - tables for d. f = 2, P > .05

The difference is significant at 10% level.

Items	Kerosene	Burshane	d
Rice	23.2	24.0	0.8
'Sambar'	23.2	23.4	0.2
Amaranth 'porial'	19.2	23.6	4.4

$$\bar{x} = \frac{5.4}{3} = 1.8 \quad s^2 = \frac{20.04}{3} - (1.8)^2 = 6.68 - 3.24 = 3.44$$

$$t = \frac{1.8}{\sqrt{1.72}} = \frac{1.8}{1.31} = 1.37$$

From t - tables for d. f = 2, P > .05

The difference is significant at 50% level.

APPENDIX XVI

ANALYSIS OF VARIANCE FOR TASTE OF THE COOKED ITEMS

Items	Kerosen	Cow-dung gas	Z
Rice	19.4	20.0	- .6
'Samber'	21.2	20.8	.4
Amaranth 'porial'	17.2	16.6	.6

$\bar{Z} = .13 \quad s^2 = \frac{.88}{3} - .13 = .2933 - .13 = .1633$

$t = \frac{.13}{\sqrt{.0817}} = \frac{.13}{.29} = .45$

The difference isnot at all significant.

Items	Cow-dung gas	Burshane	Z
Rice	20.0	25.0	5.0
'Samber'	20.8	23.8	3.0
Amaranth 'porial'	16.6	18.8	2.2

$\bar{Z} \quad \frac{10.2}{3} = 3.4 \quad s^2 = \frac{38.84}{3} - (.34)^2 = 12.9467 - 11.56$

$= 1.3867$

$$t = \frac{3.4}{\sqrt{.6934}} = \frac{3.4}{.83} = 4.10$$

From t - tables for d f = 2, P is slightly $> .05$

The difference is significant at 10 per cent level

Items	Kerosene	Burshane	Z
Rice	19.4	25.0	5.6
'Sambar'	21.2	23.8	2.6
Amaranth 'porial'	17.2	18.8	1.6

$$\bar{Z} = \frac{9.8}{3} = 3.27 \quad S^2 = \frac{40.68}{3} - (.327)^2 = 13.56 - 10.6929$$

$$= 2.8671$$

$$t = \frac{3.27}{\sqrt{1.4336}} = \frac{3.27}{1.20} = 2.73$$

From t - tables for d. f = 2. P $>$ .05

The differance is significant at 50 per bent level

APPENDIX XVII

ANALYSIS OF VARIANCE FOR PALATABILITY OF THE COOKED ITEMS

Kerosene (y)	Cow-dung gas (x)	x
124	132	8
128	128	0
113	109	-4

$\bar{x} = \frac{4}{3} = 1.33$

$s^2 = \frac{80}{3} - (1.33)^2 = 26.6667 - 1.7689 = 24.8978$

$t = .38$

From t - tables for d. f = 2. P $>$ .05

The difference is not significant

Kerosene (y)	Cow-dung gas (x)	x
124	141	17
128	136	8
113	119	6

$\bar{x} = \frac{31}{3} = 10.33$

$s^2 = \frac{389}{3} - (10.33)^2 = 129.6667 - 106.7089 = 22.9578$

$$t = \frac{10.33}{\sqrt{\frac{22.9578}{2}}} = \frac{10.33}{\sqrt{11.4789}} = \frac{10.33}{3.39} = 3.05$$

From t - table for d. f = 2. P $>$ .05

The difference is significant at 10 % level

Cow-dung gas (y)	Burshane (x)	z
132	141	9
128	136	8
109	119	10

$$\bar{z} = 27/3 = 9$$

$$s^2 = \frac{245}{3} - 81 = 81.67 - 81 = .67$$

$$t = \frac{9}{\sqrt{\frac{.6667}{2}}} = \frac{9}{\sqrt{.3334}} = \frac{9}{.58} = 1.55$$

From t - tables for d. f = 2. P. $>$ .05

The difference is significant at 50% level