

**A STUDY ON THE EFFICACY AND ECONOMY OF HAY BOX
AN IMPROVISED FIRELESS COOKER**

By

Pushpa V.

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I. INTRODUCTION

The Need for Time Management in Indian Homes

The responsibilities of women in India today have increased, taking them out beyond the four walls of their homes, to numerous jobs such as teaching, nursing, medicine, legislature, social work, extension and clerical work. However, working outside does not mean that the homemakers have given up their responsibilities in the home to outside agencies, or that they are neglecting them. Muntz (1953)¹ says, "Today's homemaker lives in a world completely different from that of her mother or her grand mother. Yet she, too, must feed, clothe, and shelter her family." If the homemaker is to combine the activities outside and inside the home, and still discharge her duties satisfactorily, without great strain on herself, she must manage her time efficiently.)

Role of Equipment in Time Management

(One of the methods for achieving efficient time management is the use of labour saving equipment. An equipment is a machine or tool necessary for doing a particular kind of work in a shorter time than when the work is done by hand. As Thabet (1957)² says, "Often it's the small appliance, or the kitchen tool, or something in that group of what we call housewares that helps us get the job done with the least amount of effort and in the best possible way." Good household equipment is a boon to homemakers, as its use helps in effective home management, resulting in increased production in the home and saving of enormous amounts of time, money and energy.

Equipment Suitable for the Indian Home

(In the Indian home, household work consumes a major part of the homemaker's time and energy, mainly due to the fact that very little use is made of labour saving equipment. Therefore, there is urgent need to provide suitable equipment on a large scale and also for educating the homemakers regarding their availability and use.

Two factors have to be borne in mind while procuring suitable equipment for the Indian home - their cost, and their simplicity in operation. The standard of living in India is very low with Rs. 291.50 as per capita income.⁽³⁾ Hence the cost of equipment should be within the means of the average person. Some of the equipment now available in the market, such as steam cookers, which cost about Rs.45.00 to Rs.50.00, while useful, are considered beyond the purchasing capacity of many. (Besides the initial cost which should be reasonable, the cost of operation of the equipment should also be minimum. Through the use of the equipment, the homemaker should be able to save money, which being the most limited of her resources, is one of the important yardsticks by which the utility of an equipment is measured.

The percentage of literacy in India, as indicated in the 1961 census,⁽⁴⁾ is as low as 23.7. Therefore, the average homemaker is not in a position to read the directions given on the equipment and use it accordingly. Hence, the mode of operation of the equipment should be so simple that she is able to put it to use, without the need to read any lengthy

series of instructions.) Thus, cost and simplicity in operation, are the two main criteria for determining the suitability of an equipment for the Indian home.

Importance of Equipment in the Indian Kitchen

The area which needs the labour-saving equipment most is the kitchen, which is the centre of life and all important activities for women in the Indian homes. A homemaker spends about 70 per cent of her working time in the kitchen⁴(5) on various activities connected with cooking, such as cleaning the food and utensils, storing foods, cooking, serving and preserving of foods. Therefore, she needs to have access to equipment which would help her to save the time spent by her in the kitchen and get some leisure. Saving of a considerable portion of the time involved in the daily cooking of cereals, pulses and tubers, which ordinarily take a long time to cook, should become one of the objectives, in selecting equipment.

4 According to Patwardhan (1952)⁶, rice forms the staple food of more than half the population of India.) Rice is one food which is cooked daily almost for every meal in several parts of the country, and many methods are employed for cooking it. However, all the methods have some problem or other in getting a good cooked product of rice. For example, when excess water is used for cooking the rice, and the cooking water strained, the important nutrients present in rice, such as thiamin, nicotinic acid and the other B complex vitamins are lost in the water; when rice is steamed with just enough water, the time taken for cooking is long, consuming much fuel;

if it is cooked with just sufficient quantity of water by 'Absorption method'* over a direct flame, there is the problem of the food getting charred or the product becoming sticky. Hence a device which would help to solve these problems in cooking rice would be a great relief to the homemakers.

As mentioned earlier, an increasingly large number of women are going outside their homes to work and have to cook the lunch for their family before they leave for work in the mornings. Hence, an equipment which would help them to cook rice without much attention and maintain the cooked rice hot till lunch time, would be a very welcome device.

The Hay Box

The Hay Box, which is an improvised fireless cooker, is one such equipment promoted by the Gram Sevikas and the Mukhya Sevikas, who are the Women Extension Workers in the Community Development and National Extension Service. Pointing out the several advantages in the working of the Hay Box, Devadas (1960)⁷ says, "The Hay Box is cheap, saves time, saves labour and fuel, gives time for the housewife to attend to other duties, makes rice cook evenly without charring or burning, saves the flavour and keeps the vitamins in them intact." In reply to a questionnaire sent by the investigator to the rural homemakers,

* Absorption method is the method of cooking cereals and pulses in just sufficient quantity of water over direct heat where all the water is absorbed by the food cooked during the cooking process.

who had studied about the use of Hay Box, in the Short Courses conducted in Sri Avinashilingam Home Science College in the year 1960-61, the sixteen women who had introduced the Hay Box in their homes, also expressed the advantages of the Hay Box as saving time, labour and fuel, keeping the food hot for a long time, easy to operate and making the food more palatable. An interview with seven homemakers residing in Coimbatore City who were using the Hay Box also recorded similar views regarding the advantages of the Hay Box.

However, a scientific study of the Hay Box has not yet been made to prove the above advantages. As Pearson (1957)⁸ says, "The scientific method is the sole gateway to the whole region of knowledge," and therefore, a scientific study of the Hay Box was considered necessary, in order to throw light on the actual amounts of time and fuel saved, and the palatability and heat retention of the foods cooked using a Hay Box. The present investigation is an effort in that direction, and it is hoped that the findings of this study will help to popularise the use of Hay Box in effective home management.

II. REVIEW OF LITERATURE

What is a Hay Box

The Hay Box is an improvised fireless cooker. It is called Hay Box, because hay is commonly used as the insulating material in this device. The term 'improvised' denotes that the Hay Box can be easily set up, with the materials available on hand, without the need for using elaborate tools or techniques.

The Hay Box is 'fireless' in the sense, that once the food is brought to the boiling point and placed in it, cooking is completed with the heat stored in the foods, without any further application of heat or fire, as is necessary in the ordinary method of cooking. According to Whitman (1951),⁹ "A fireless cooker is a device employing heat-insulating materials to prevent the loss of heat from the food and thus continue the cooking without the use of fire." Avery (1955)¹⁰ states, "Fireless cookers are based on the idea that if ^{hot,} a partly cooked ~~hot~~ food is placed in a closed, well-insulated container, the stored heat ~~in it~~ will finish the cooking process."

Scientific Principles Involved in the Working of the Hay Box

According to Dowd and Dent (1948),¹¹ cooking is the preparation of food by the application of heat. In the process of cooking, heat transference takes place from the fuel to the food by any one of the three methods: conduction, convection, and radiation, or through various combinations of these three methods.

Noakes (1957)¹² defines conduction as, "The transfer of heat through an unequally heated body, without visible motion of any part of the body; that is, it is the propagation of heat through a material, which itself remains stationary." According to the same author, "Convection is the transference of heat by a heated material which moves, carrying its heat with it. It can take place only in fluids." Slabaugh and Butler (1958)¹³ define radiation as, "That process by which energy is transmitted through space without the presence of matter, that is, the transfer of energy by means of electromagnetic waves." Trivedi and Shah (1961)¹⁴ state that in the method of heat transfer by radiation, the intervening medium is not affected at all.

When a frying pan with some groundnuts is placed over the fire, the groundnuts are roasted mainly through the conduction of heat from the walls of the frying pan to the groundnuts. When water in a utensil is left over the fire, the water gets heated through conduction from the walls of the utensil, as well as by convection currents in the heated water. When a piece of meat is left in an oven, it gets baked through the heat radiated from the walls of the oven which receive the heat from the fuel through conduction. Heat transference by all the three modes occur simultaneously, when bread is baked, or Appam * is made. The outer surfaces of the food products

*Appam is a breakfast preparation common in South India. From rice batter, which had been fermented by the addition of toddy or coconut water, it is baked in an earthenware utensil called "Appachatty", which is heated from bottom as usual and at the top with live coal.

are browned by radiant heat, and heat is distributed through the bread or appam, partly by conduction through the walls of the baking tin or 'Appachatty', and partly by convection currents present in the fluids of the dough.

In order to cook a food, it is not always necessary to apply heat continuously at the bottom of the utensil, because food gets cooked even at temperatures below the boiling point of the cooking medium. Whitman (1951)⁹ points out, "Since the cooking of most foods consist merely in keeping them at a temperature of approximately 180°F to 212°F for a certain time, it is not always necessary to have a fire burning under the utensil, during the entire cooking process. If a food warmed to 212°F over a fire, is removed from the fire, it will continue to cook until it has cooled 20 degrees to 40 degrees." This principle is utilised in the Hay Box, where the food is brought to the boiling point and transferred to the Hay Box in which it gets cooked at a temperature below the boiling point.

However, under ordinary conditions when a hot body is left in the atmosphere, it gets cooled rapidly and the resulting temperature is insufficient to cook the food. But if the hot food is surrounded by a material which does not conduct away the heat, the high temperature of the food would be retained for sometime, making it possible for cooking to continue without applying additional heat to the utensil. This process of retaining the heat in the food by

surrounding it with insulating material is called "insulation of conduction." Insulation of heat means, either to keep the heat in, or to keep it out of any desired place. Therefore, substances which facilitate insulation are very 'poor' or 'bad' conductors of heat.

Avery (1955)¹⁰ points out that the coefficient of thermal conductivity* varies with different substances. The coefficient of conductivity expressed in terms of calories/square centimeter/degree centigrade difference/second of some common materials are:-

Silver	:	0.99	Wood	:	0.0004
Copper	:	0.91	Soil	:	0.0004
Aluminium	:	0.49	Sawdust	:	0.00012
Asbestos	:	0.0005	Air	:	0.00005

Of these, silver, copper and aluminium are good conductors of heat, and asbestos, wood, soil, sawdust and air are poor conductors.

An insulator must not only be a poor conductor of heat, but must also have a low heat capacity, or specific heat,** so that it will absorb very little heat. Water, for example,

* "The coefficient of thermal conductivity of a material (in metric units) is the number of calories of heat transferred through a centimeter cube of the material in one second if the temperature difference between the two opposite surfaces is one Centigrade degree." Avery (1955)¹⁰

** Specific heat is the ratio of the quantity of heat required to raise the temperature of a body through one degree to that required to raise the temperature of an equal mass of water by one degree. Avery (1957)¹⁰

is such a poor conductor of heat that a sensitive air thermometer kept a few millimeters below the surface of water will not react to a flame played against the water. Yet, it has a high capacity to absorb and hold heat in itself, that it would be useless as an insulator. In other words, water, though a poor conductor of heat, has the highest specific heat, which makes it a poor insulating material.

This principle of insulation is utilised in appliances, such as boilers, where the exposed parts are "bagged"* with asbestos or some other poor conductor of heat in order to reduce the loss of heat. The same principle is used in fireless cookers, where the hot food is surrounded by a poor conductor of heat, such as hay, sawdust or crumpled paper, to retain the temperature of the hot food.

With the help of insulation, the latent heat of steam available in the utensil with the boiling contents is fully utilised in the Hay Box for enhancing the cooking rate. According to Whiteley (1959)¹⁵, "The latent heat of vaporisation of a substance is the quantity of heat required to change unit mass of it at its boiling point from liquid to vapour without change of temperature." He continues to say, "The latent heat of vaporisation of water involves a large quantity of heat. A gram of steam at 100°C in condensing, will lose without change of temperature nearly five and a half times as

* Bagged indicates covered

much heat as a gram of water loses in cooling from 100°C to 0°C. * This explains why steam is so effective as a heating agent, and why scalding by steam is likely to be much more severe than scalding by boiling water." Child and Niles (1938)¹⁶ point out that the steam from the boiled food, gives up its latent heat of vaporisation to the food on which it condenses as it cools down.

Ordinarily, when a utensil with boiling food is kept outside, the steam from the hot food condenses very rapidly, and the heat given out by it is conducted away without being available for the subsequent cooking of the food. On the contrary, in Hay Box, as the food is surrounded by an insulating material, the steam condenses on to the food giving out its heat facilitating the completion of cooking.

Child and Niles (1938)¹⁶ state, "The rate of evaporation when liquids are heated is increased when there is an increase in temperature, or an increase in amount of surface exposed, or when vapour is removed from the surface." In Hay Box cookery, there is little evaporation and consequently, care must be taken not to use too much water in food preparations. ⁽¹⁷⁾ Thus, the proportion of water used for the same amount of food taken is less in cooking using the Hay Box, than in cooking without using the Hay Box.

Based on these principles of heat retention through insulation to promote the continuation of cooking without applying additional heat, different types of fireless cookers have been

*Latent heat of steam is 537 calories/gram. Whiteley (1959)¹⁵

designed from time to time. All the types have an outside container* which is packed with the selected insulating material. Some have an inside container**, while others have only a depression called, "the pot well" into which the cooking utensil and heating stones,** if used, are placed. Variations in the different types of fireless cookers occur only in the nature of the insulating materials and containers used, and in the efficiency of insulation achieved. From the literature reviewed, descriptions of the following types of fireless cookers are available:-

(a) A Primitive Fireless Cooker A primitive fireless cooker has been described by the United States International Cooperation Administration (1957)¹⁸ as consisting of a cooking utensil placed over hot bricks or rocks in a hole in the earth which is lined with straw and plastered with mud.

(b) Norwegian Cooking-Box Osborn (1929)¹⁹ describes a fireless cooker as shown in Figure 1. According to him, this device was in use in Northern Europe even before 1867, and later became the "fireless cooker." It consists of a box A lined with a poor conductor of heat such as hay, straw or excelsior B. **** The cooking utensil C is tightly covered and

* 'Outside container' is also called 'outset container' and 'Outer case.'

** 'Inside Container' is also called 'inset container'

*** Heating stones are concrete blocks or ordinary stones which are heated and placed inside as the source of heat in some types of fireless cookers.

**** Excelsior is carbon black.

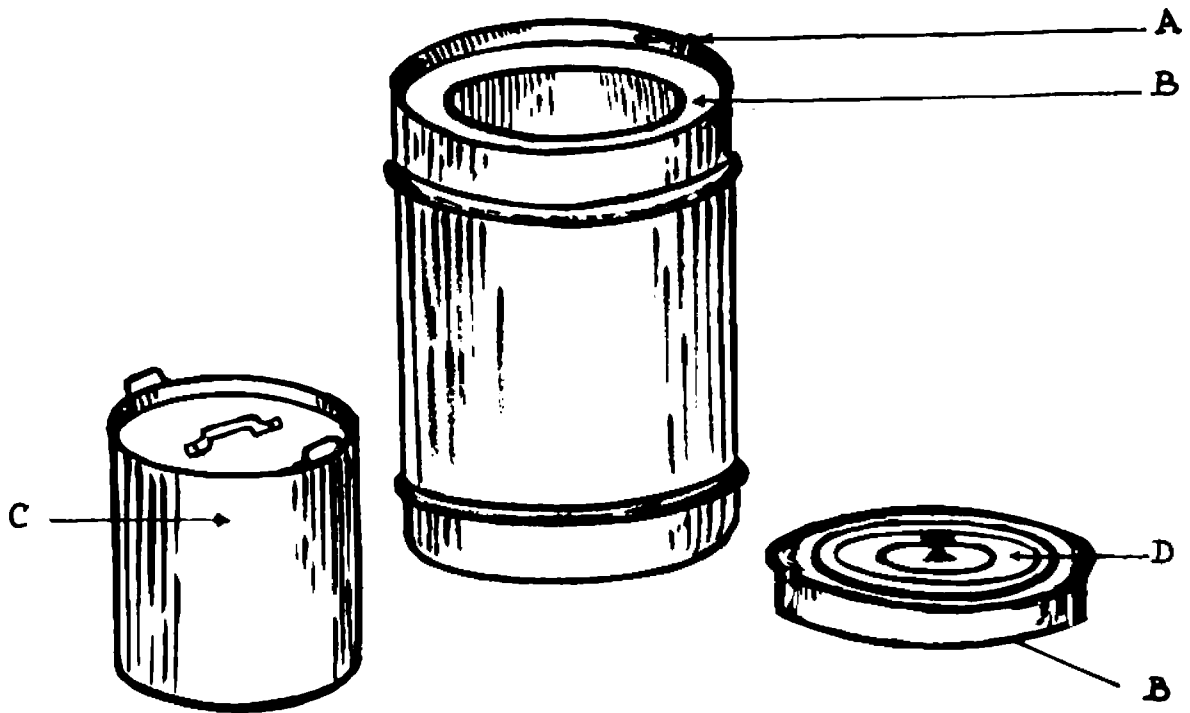


FIGURE 1

PARTS OF THE NORWEGIAN COOKING-BOX

A. OUTER CASE

B. INSULATION

C. KETTLE

D. COVER

placed in the pot well. A cloth cushion, packed with the same insulating material as used in the box, is placed on the cooking utensil, and the box is covered with the lid D.

(c) Homemade Fireless Cooker of 1917 (U.S.D.A) A home made fireless cooker shown in Figure 2, is described in the Farmer's Bulletin 771 of U.S.D.A. (1917)²⁰ and in the Journal of Home Economics (1917)²¹. This fireless cooker seems to have been introduced in the U.S.A. as early as 1917, through the publications and articles which appeared from time to time, regarding the Norwegian Cookery-box, or the "Norwegian Nest." It consists of an outside container A, which may be a wooden box or old trunk packed with insulating material B, which may be crumpled paper, cinders left from coal, ashes or wool, a hollow space in the centre with a metal lining C, for placing the cooking utensil D. The plate E, made of soapstone* is heated, and placed inside the box at the bottom to furnish heat. Over the soapstone plate is placed the cooking utensil D, and covered by a pad of excelsior F. The hinged cover G of the outside container closes the fireless cooker.

(d) Homemade Fireless Cooker of 1942 (U.S.D.A.) The United States Department of Agriculture (1942)²² describes another type of homemade fireless cooker, whose parts are shown in Figure 3. It consists of: an outside container A, made of

* Soapstone is hydrous silicate of Magnesia.

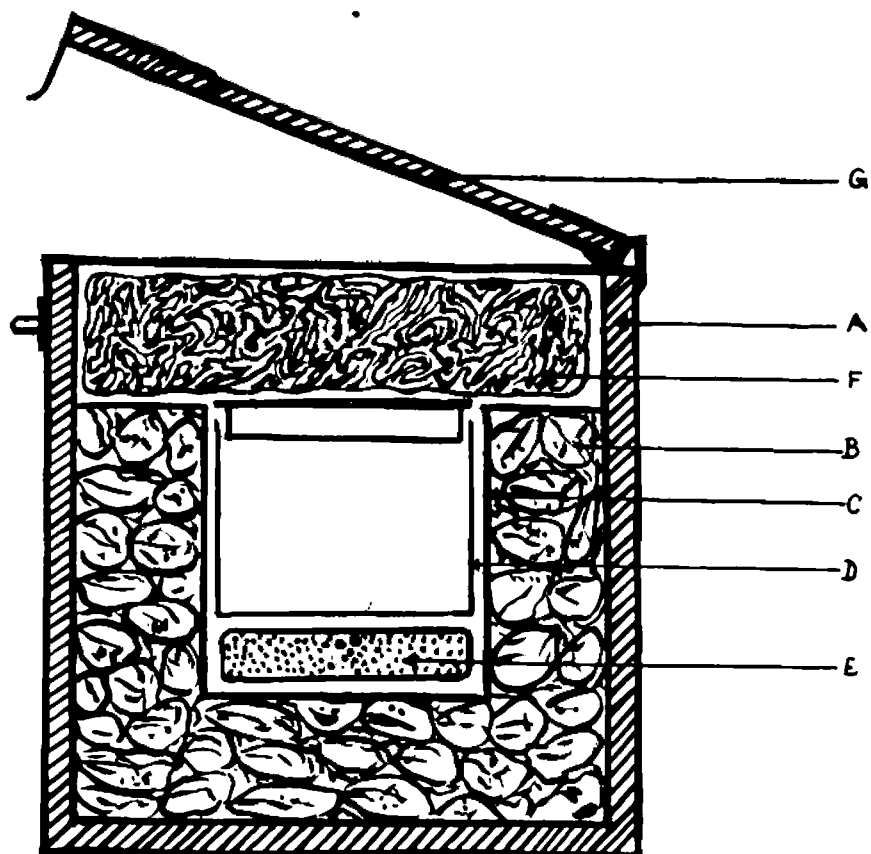


FIGURE 2

LONGITUDINAL SECTION OF THE HOMEMADE FIRELESS
COOKER OF 1917. (U.S.D.A)

- A. OUTSIDE CONTAINER
- B. INSULATING MATERIAL
- C. METAL LINING
- D. COOKING UTENSIL
- E. SOAPSTONE PLATE
- F. PAD OF EXCELSIOR
- G. HINGED COVER OF OUTSIDE CONTAINER.

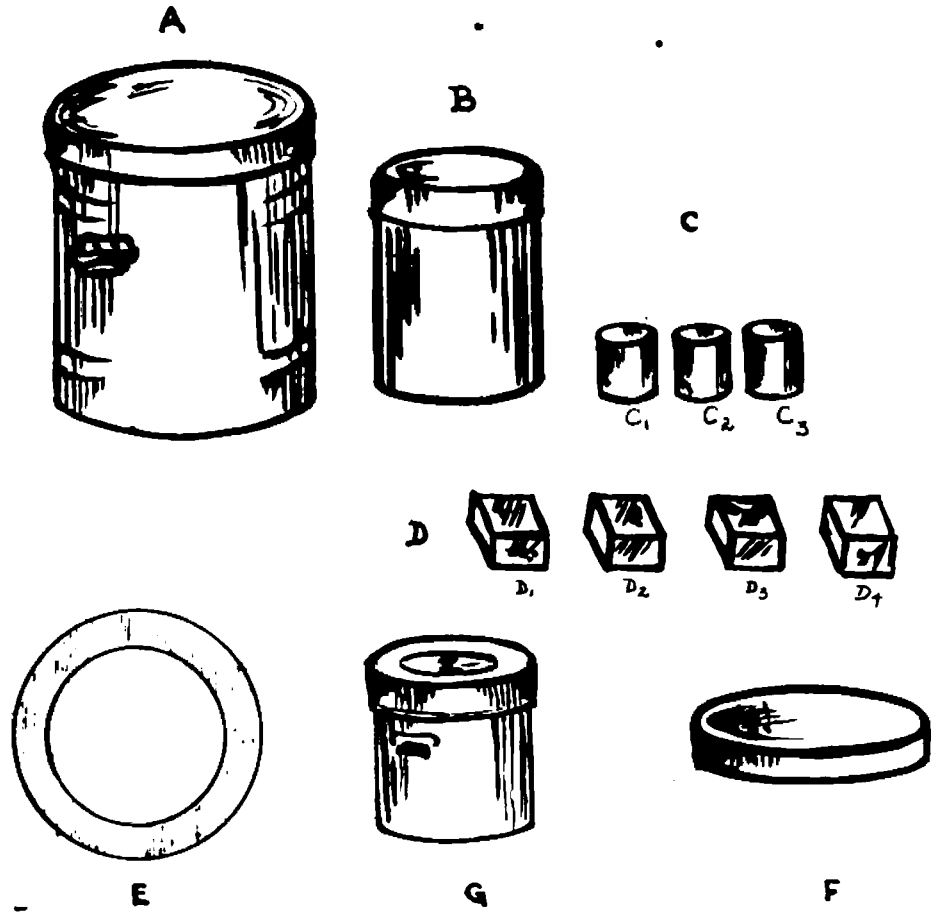


FIGURE 3

PARTS OF THE HOMEMADE FIRELESS COOKER OF 1942 (U.S.I.A)

- A. OUTSIDE CONTAINER
- B. INSIDE CONTAINER
- C. THREE SMALL METAL CANS
- D. FOUR WOODEN BLOCKS
- E. COLLAR
- F. INSULATING CUSHION
- G. COOKING UTENSIL

a wooden box or metal can with a tight cover; a smaller inside container B of metal to hold hot stones and cooking utensils; three small metal cans C_1, C_2, C_3 , of equal heights filled with insulating material, glass fibre or rock wool; four small wooden blocks D_1, D_2, D_3, D_4 , approximately one and a half inches thick, three inches in width, and as long as the space between the outside and inside containers; a collar E, made of wood, pressed board or battleship linoleum, to cover the insulating material between the containers; an insulating cushion F, made of the same material as the insulation at the sides and bottom; the cooking utensil G, made of any material suitable for top-of-stove cooking with a diameter same as that of the heating stones, to utilize fully the heat transferred by conduction from the soapstone. The bottom of the cooking utensil is flat for convenience in stacking when two or more utensils are used together in the fireless cooker. The utensil G has a tight fitting lid, and two handles at the sides convenient for lifting.

A metal or wire trivet carrying two heated stones of concrete or soapstone is placed at the bottom of the inside container. The trivet is used to protect the bottom of the inside container from intense heat of the stones.

This fireless cooker is set up in the following manner:- The three small cans C_1, C_2, C_3 , filled with the insulating material are placed about one inch apart in the centre of the bottom of the outside container. The bottom of the container

is packed with the insulating material upto the top of the small cans. The four small wooden blocks D₁, D₂, D₃, D₄, are placed at equal distances apart, between the walls of the two containers, the tops of the blocks being approximately two inches below the top of the inside container. They are screwed in place to the outside and inside containers. The space remaining between the walls of the outside and inside containers is packed to the top of the wooden blocks with the insulating material. The collar E is placed on the wooden blocks to cover the insulation and the insulation is made airtight with a calking* compound. The trivet is placed at the bottom of the inside container with the heated stones. The tightly covered cooking utensil G with a boiling food is placed on the soap stone. If a second utensil of food is to be cooked at the same time, it is placed on top of the first, and another heated soapstone placed either between two utensils or on top of the second utensil. The cushion F is placed over the top of the inside container, and finally the outside container is closed.

(e) The Hay Box in India The Hay Box described by Devadas (1960)⁷, is easy to make with locally available, inexpensive materials. It consists of a wooden case or box 30" long, 20" broad and 15" high. Hay, paddy husk, or sawdust is used as the insulating material. The bottom of the box is lined

*Calking is to plug up the crevices.

four inches high with hay. A pot, the size of which can hold the required quantity of water and the food to be cooked, is placed in the centre of the hay lined box, with a tight fitting cover. Hay is then pressed into the space, between the pot and the box on all sides upto the mouth of the pot. A hay cushion made of a gunny bag, the length and breadth of which are the same as of the top area of the box, is filled with hay three inches thick and placed over the pot with its boiling contents and lid, when transferred to the Hay Box and the Hay Box closed.

Previous experiments with Fireless Cookers

French (1944)²³ made a comparative study of the commercial fireless cooker with a hot-plate costing \$ 18.00 (Rs 6.50), a gas range, and a combination of gas range and fireless cooker, as to the economy of time and labour, and the palatability of the cooked products, cooking the same articles of food in the three appliances. She found that in the fireless cooker, the cost of fuel was reduced to 5/8 or more, as compared to cooking on the gas range; the pots used in the fireless cooker were easy to wash as the food did not stick to them; prunes, cereal, bacon, coffee, biscuit, beef, loaf, muffins and apples were cooked completely as when cooked on gas, in fact, cereals and prunes cooked in the fireless cooker were more desirable than those cooked over the gas range. However, potatoes cooked in the fireless cooker, were not as good as those cooked over the gas range. There was no heat radiating in

the kitchen when a fireless cooker was used, as there was no fire in it, whereas when a gas range was used, the kitchen got heated because of the radiation from the range.

French also experimented with a homemade fireless cooker, which cost only ₹ 1.28 (Rs.6.10) and concluded that, even if the use of homemade cooker was limited to cooking cereals and boiling meats, it would still be a worthwhile device as the cost of building the cooker and the labour involved were small.

In another study, Hood (1915)²⁴ compared the fireless cooker and the pressure cooker as to initial cost, durability, sanitation, ease of manipulation, cost of operation, efficiency, scope of use, and the palatability and digestibility of the foods cooked in them. She found that, as to the initial cost, the fireless cooker was preferable, although the pressure cooker was more durable and sanitary; the fireless cooker was more suitable to be put into the hands of the average kitchen employee because it was easier to operate than the pressure cooker; the fuel consumed in the use of the pressure cooker was much less than in the case of the fireless cooker in which due to use of heated plate as the source of heat, a large amount of fuel was used to heat the plate; with regard to palatability of the foods cooked in both the fireless and pressure cookers, there was an indescribable "closed

up taste" as compared to the ordinary method, in which there was some ventilation for the foods during the cooking process. However, the "closed up taste" disappeared after the utensil had been kept open for a few minutes. Due to the heating of the plate as source of heat in the fireless cooker, more labour was involved in its working than in the pressure cooker.

III EXPERIMENTAL

Part 1

The experiments in this study consisted of two parts:

- a) Study of the reactions of the homemakers who were using the Hay Box, as basis for the designing of the experiments and
- b) The experiments conducted with the Hay Box.

a) Study of the Reactions of the Homemakers who were Using the Hay Box

Two groups of homemakers who were using the Hay Box, one consisting of members who were residing in rural areas, and the other from an urban area, were approached to give their reactions about the Hay Box. From the rural areas, a group of 113 homemakers, who were among the past participants of short courses of one month's duration conducted by the Sri Avinashilingam Home Science College, for the rural homemakers, (in the year 1960-61) was selected. They had education up to the elementary or middle school level, and came from poor homes. A questionnaire, as shown in Appendix I was drawn in Tamil and printed on reply post cards in order to obtain maximum response from them without their having to incur any expenditure on postage. The questionnaire aimed at eliciting the following information: if they did or did not use Hay Box at home; if they did not use, the reasons for not using it, and if they did use, the reasons for using it, and the advantages and difficulties in using it.

The other group consisted of seven home makers who were

residing in Coimbatore city. The investigator interviewed them personally, and posed the questions to them as per the interview schedule ^{prepared for this purpose} shown in Appendix II, to elicit information on the cost of Hay Box, material of the box, and the insulating material used; the advantages and difficulties in using the Hay Box; the material and the shape of utensils used in the Hay Box; items of foods prepared using the Hay Box; the proportion of water used to cook rice; period of time the utensil was left over the fire, period of time the utensil was kept in the Hay Box to cook the food, and the length of heat retention of the food.

✓ B) The Experiment conducted with the Hay Box

The experiments were designed to compare the time taken, fuel consumption, palatability and heat retention of foods, in cooking the cereal, pulse and potatoes of a standardised typical lunch, using and without using a Hay Box.

x The different phases in the experimental procedure were:-

- a) Selection of foods and their quantities
- b) Selection of equipment
- c) Standardisation of procedures
- d) Conducting the experiments and collecting the data

(a) Selection of Foods and Their Quantities

As has already been mentioned, hay box cooking is suitable only for foods which ordinarily take a long time to cook. Therefore, rice, red gram dhal, and potatoes were selected for

the cooking experiments in this study. The quantities to be taken for cooking were derived from the constituents of a typical South Indian Vegetarian lunch for a family of five members - father, mother and three children of ten, seven, and three years of age. The total food requirement for a day for this family, were first calculated, using the allowances suggested by Swaminathan *et al* (1960)²⁵ as shown in Table I.

TABLE I
ALLOWANCES FOR BALANCED DIETS FOR AN AVERAGE
FAMILY OF FIVE MEMBERS
(Ounces per day)

Food Stuff	Light work		Children			Total
	Man	Woman	10 Yrs.	7 Yrs.	3 Yrs.	
Cereals	14	11	11	9	5	50
Pulses	3	3	2	2	1	11
Groundnut roasted	1	1	2	1	-	5
Gingelley seeds	-	-	1	1	0.5	2.5
Bengal gram puffed	1	1	2	1	1	6
Milk and curds	10	10	15	15	20	70
Green leafy vegetables	3	3	3	3	1.5	13.5
Roots and Tubers	4	4	4	2	1	19
Other vegetables	2	2	-	-	-	
Fruits	2	2	3	3	3	13
Oils and fats	1	1	1	0.5	0.5	4
Sugar and jaggery	2	2	2	2	2	10

Utilizing the quantities specified in Table I, the menu for the day was planned as given in Table II.

TABLE II .

THE MENU FOR THE DAY

Breakfast	Lunch	Dinner
Ragi dosai	Rice	Rice
Coconut chutney	Wheat chapati	Bengal gram
Milk	Potatoe sambar	curry
	Agatti Greens	Cluster beans
	poriyal	poriyal
	Tomato salad	Curds
	Curds	Guava

The quantities of the food ingredients required for preparing the lunch in the above menus were then calculated from the total daily allowances shown in Table I. They are presented in Table III.

TABLE III
QUANTITIES OF FOOD INGREDIENTS REQUIRED
FOR THE LUNCH

Food Ingredient	Weight		Capacity or number
	Ounces	Grams	
Rice	14.08	400	2 Cups*
Wheat	5.00	142	1 Cup
Red gram dhal	6.69	190	1 Cup
Potatoes	8.00	227	Eight medium potatoes of equal size and shape
Agathi greens	13.50	383	2 medium bundles
Tomatoes	3.00	85	--
Curds	15.00	--	--

* A standard measuring cup 8 oz. in volume.

Out of the foods mentioned in Table III, the 400 gms. of rice, 190 gms. of red gram dhal and 227 gms of potatoes were finally selected for the cooking experiments, since tomato salad and curds did not require cooking and greens could not be cooked in the Hay Box without losing its nutritive value.

(b) Selection of Equipment

The equipment required for the experiment in this study were: i) the Hay Box; ii) stoves; iii) utensils and iv) measuring devices.

1) Hay Box

The Hay Box selected for this experiment was the type described by Devadas (1960)? It was constructed as follows:- From the planks of an old deal wood box, a box of uniform thickness 0.76 cm and inside size 45.72 cm x 45.72 ~~cm~~ x 30.48 cm, as shown in Figure 4 A, was constructed, with a lid hinged on to one side of the box. A padlock to close the box tightly was fixed to the lid.

Hay was uniformly spread inside the box as shown in Figure 4B, to about 15.24 cm height from the bottom of the box. Clean bricks were placed on the surface of this layer of hay for 12 hours to compress it evenly. When the layer of hay was compressed to 10.16 cm thickness, the utensil selected for cooking rice was placed in the centre of the layer of hay. Additional hay was then placed all around



FIGURE 4
CONSTRUCTION OF THE HAY BOX

the utensil as shown in Figure 4C, and bricks were placed to compress the hay as before. By this arrangement, there was an insulation of tightly packed hay all around the utensil excepting the top.

In order to complete the insulation on the top also, a hay cushion was made with a gunny cloth 111.76 cm. in length and 55.88 cm. in width, folded widthwise, stitched on the three sides to form a bag. This bag was filled with hay to make a cushion of 10.16 cm thickness and stitched and kept over the utensil as shown in Figure 4D.

The dealwood box thus made into a Hay Box as shown in Figure 4 had a pot well in the centre into which the cooking utensil just fitted in, with 12.7 cm insulation of hay on the sides and 10.16 cm insulation on the top and bottom. The longitudinal section through the Hay Box is given in Figure 5. As the utensil for cooking dhal and potatoes were smaller in diameter than that used for cooking rice, the pot well of the Hay Box was reduced in size by adding more hay on the sides, when dhal and potatoes were cooked.

ii) Stoves

Two popular kerosene stoves with adjustable wicks, identical in all aspects - make, shape and size, costing Rs. 8.50 each were selected. The reason for choosing the kerosene stoves, instead of the more commonly used firewood chula,* was that the fuel consumption could be more accurately

*Chula is the Hindi word for "Aduppu", the cooking fire place.

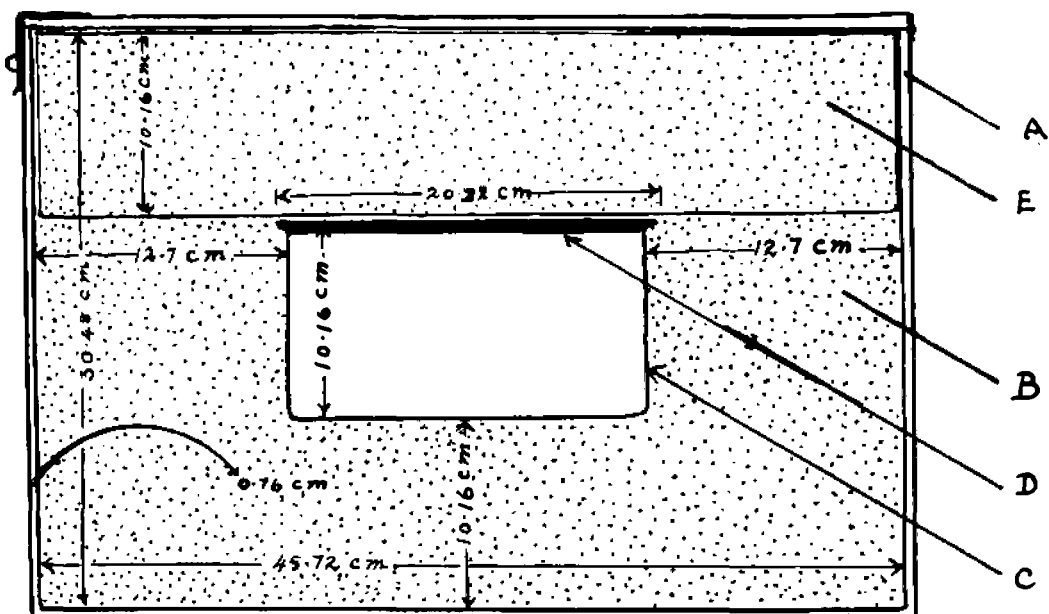


FIGURE 5

LONGITUDINAL SECTION OF THE HAYBOX.

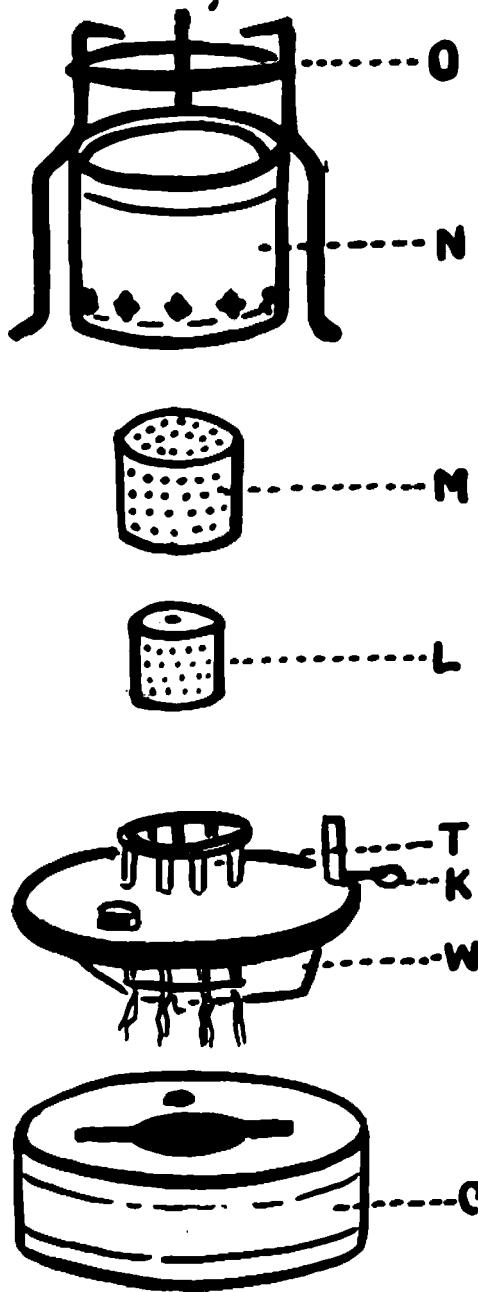
- A WOODEN BOX WITH LID
- B HAY
- C COOKING UTENSIL
- D LID FOR THE UTENSIL
- E HAY CUSHION

calculated and the flames controlled better in the kerosene stove, than with the firewood chula.

The stoves shown in Figure 6, consisted of a combustion chamber C, where kerosene was poured, fitted on top with a wick dish W, which in turn consisted of a wick control K, and ten tubes T, into which the wicks were inserted. On the wick dish W, was kept the inner cylinder L, the outer cylinder M, and the stove cap N, the smallest cylinder L being placed in the centre. The stand G was placed over the stove to hold the cooking utensils.

iii) Utensils

The utensils selected, included those for cooking and serving purposes. For cooking rice, two identical brass utensils, flat bottomed and straight sided, commonly known as dekchis, with a rim were selected. Brass was chosen, as a study conducted by Kanagaraj (1961)²⁶ revealed that brass utensils were used by a majority of households in Coimbatore. Flat bottomed utensils with straight sides were chosen as cooking utensils for top stove cooking should have broad flat bottoms and straight sides to save cooking fuel.⁽²⁷⁾ Two aluminium lids were selected for covering the utensils. Aluminium has an advantage to be used as lids, because of its lightness. When used for covering utensils in which rice is boiled, they are easily lifted by the pressure of emerging steam, giving way for the escape of steam, and thus helping to avoid



C - COMBUSTION CHAMBER. L - INNER CYLINDER.
 W - WICK DISH. M - OUTER CYLINDER.
 K - WICK REGULATOR. N - STOVE CAP.
 T - TUBES FOR WICKS. O - STAND

FIGURE - 6
 PARTS OF THE KEROSENE STOVE

the boiling over of the kancha. Similarly, for cooking dhal and potatoes, brass utensils (dekchis), identical in all aspects, with flat bottoms and straight sides, and identical aluminium lids were selected. They were smaller in size than those selected for cooking rice. The dimensions of the utensils and lids used are given in Table IV.

TABLE IV
THE DIMENSIONS AND WEIGHT OF THE UTENSILS

Utensil	Capacity cups	Diameter cm.	Height cm.	Thickness gauge*	Weight grams
For cooking rice	11	20.32	10.16	17 (0.056")	681.00
Lid for utensil for rice	-	21.25	--	--	72.50
For cooking dhal and potatoes	6	15.0	10.16	13 (0.092")	582.00
Lid for the above	-	16.25	--	--	45.80

The other utensils used for the study were two aluminium utensils and colanders for washing and draining foods respectively, and two stainless steel ladles for stirring the foods while cooking.

*Gauge: Unit measurement for thickness of metal sheets

Standard guage

Thickness in inches

0

0.324

1

0.300

2

0.276

.

(Smithels (1955)²⁸)

The utensils selected for serving the cooked foods to the panel of judges, consisted of: twelve white porcelain quarter plates; six plain glass tumblers for serving drinking water, and 12 stainless steel teaspoons. The white colour for the plates was selected in order to enable the members see clearly the difference in the colours of the foods served. Porcelain was selected, as it does not react with foods, or impart any odour to them.

iv) Measuring Devices

The following measuring devices were selected for use in this study. Aluminium standard measuring cups, for measuring water, a dietetic scale (dial type) of 500 gms capacity for weighing the food stuffs; a time-piece with a seconds hand for registering time; a centigrade thermometer -10°C to 110°C range, to register the temperature of the cooked foods; a measuring cylinder graduated to 100 c.c. and an ordinary bottle which was graduated upto 600 c.c. by sticking a marked strip of paper, for measuring kerosene.

(c) Standardisation of Procedures

The procedures which needed standardisation before commencing the experiments in this study were: i) buying and storing of provisions; ii) regulation of the use of the stoves; iii) methods of cooking rice, dhal and potatoes; iv) steps in cooking; v) selection of the tasting panel and vi) development of the score cards for assessing the palatability of the foods.

i) Buying and storing of Provisions Calculating on the basis that the lunch selected for the experiment in this study required 400 gms of rice, 190 gms of dhal and 227 gms of potatoes, and that approximately 44 lunches would have to be prepared during the period of standardisation, and experimentation, 12 Madras Measures of rice and 5 Madras Measures of red gram dhal were purchased in one lot, cleaned and stored in tight tin containers. Forty five pounds of potatoes were also purchased in one lot to last the 20 days during which the experiments with potatoes were conducted. Kerosene for fuel was purchased in a sealed tin of four gallons capacity.

ii) Regulation of the use of Stoves The regulation of the use of the stoves in this study included the rotation of the two stoves; control of the flames, measuring the kerosene, and lighting of the stoves.

Two sets of utensils and stoves, identical in all visible and measurable aspects were used in these experiments. In order to minimise any error which might occur due to the inherent qualities which were not visible and measurable, the following procedure for rotation of stoves and utensils was standardised:- The first stove was marked X and the Second Y. One of the utensils for cooking rice with its lid was marked E and the other F. One of the utensils used for cooking dhal and potatoes with its lid was marked G and the other H. During the experiments, these stoves and utensils

were rotated as shown in Table V so that each set of utensils was used for an equal number of times over both the stoves.

TABLE V
ROTATION OF STOVES AND UTENSILS FOR THE
COOKING OF RICE, DHAL AND POTATOES

Food	Replicates	Using the Hay Box		Without using the Hay Box	
		Stove	Utensil	Stove	Utensil
Rice	I	X	E	Y	F
	II	Y	F	X	E
	III	X	F	Y	E
	IV	Y	E	X	F
Dhal	I	X	G	Y	H
	II	Y	H	X	G
	III	X	H	Y	G
	IV	Y	G	X	H
Potatoes	I	X	G	Y	H
	II	Y	H	X	G
	III	X	H	Y	G
	IV	Y	G	X	H

From Table V, it can be seen that all the utensils were kept twice on each stove (once while using the Hay Box, and once without using the Hay Box) for cooking each item of the food.

Regulation of the flames

Through preliminary experiments the fixation at the desired levels, and control of the flames in the two stoves

were standardised as follows: The wick regulator was adjusted to the mid position of the groove of the wick control as shown in Figure 7A, and that point was marked P with a pencil. At this point, the tips of the wicks were adjusted to be in level with the base of the wick tubes T into which they were inserted, so that they were not visible outside, and were trimmed. The wick regulator was then raised to another half inch on the groove as shown in Figure 7B, and the point was marked P_1 which is the maximum intensity to which the flame could be raised whenever needed. The wick regulator was then lowered to point P_2 as shown in Figure 7C, half an inch below the point P, whenever the flame had to be maintained at the minimum intensity.

Measuring the kerosene Consumed

Measuring the kerosene consumed was standardised as follows: Before the commencement of each experiment, the stoves were filled with 600 c.c. kerosene, from the bottle graduated for the purpose. Another 100 c.c. kerosene were taken separately in the measuring cylinder and kept aside. At the end of each experiment, the wick dish W shown in Figure 6 was lifted, and after squeezing out the kerosene from the wicks into the tank, the wick dish was removed. The kerosene from the tank was then carefully transferred into the 600 c.c. graduated bottle, and the volume of kerosene made up to 600 c.c. with the kerosene from the

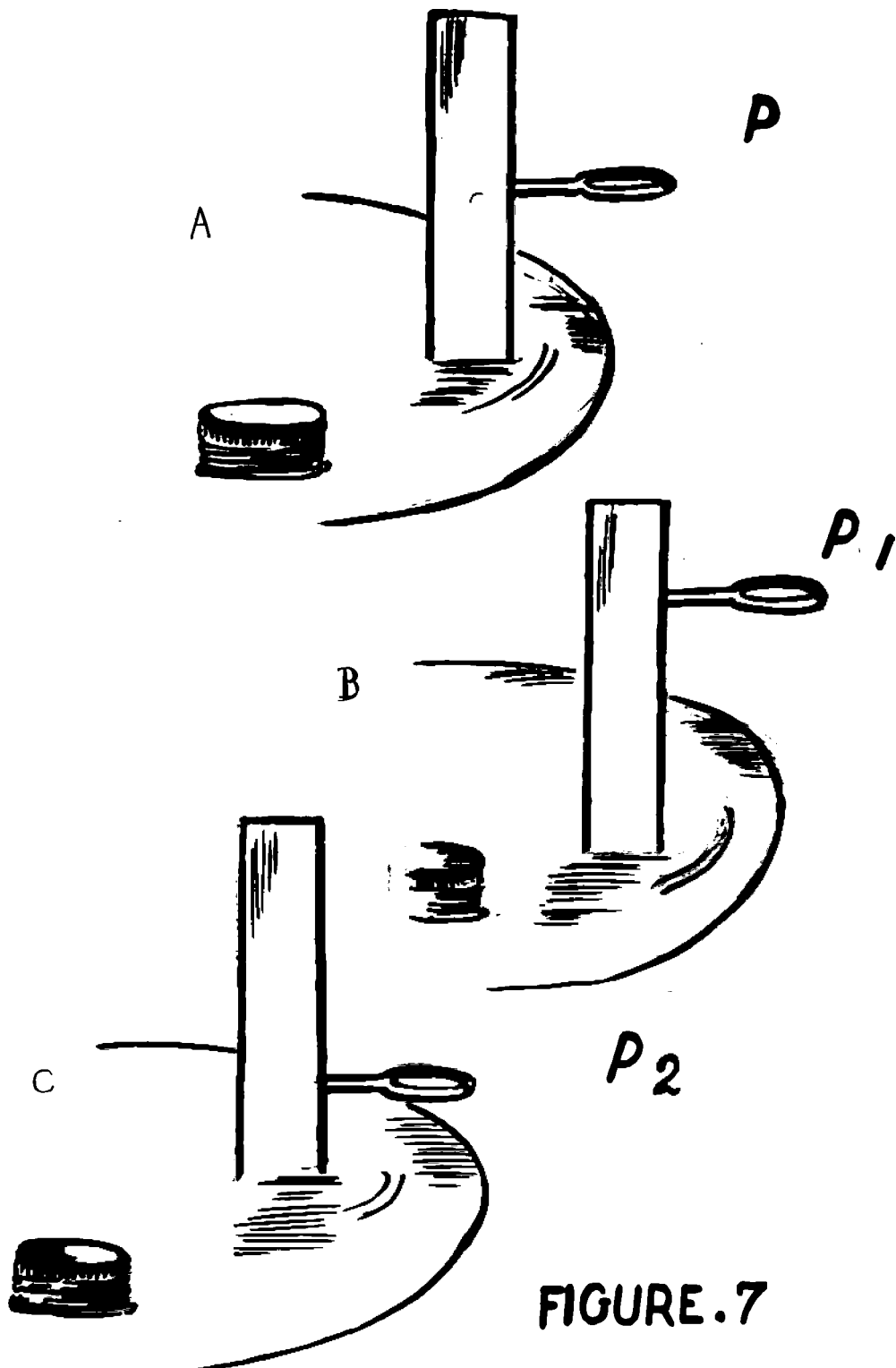


FIGURE.7

MANIPULATION OF THE WICK REGULATOR

measuring cylinder. The volume of kerosene poured from the measuring cylinder was noted as the quantity of kerosene consumed in the experiment.

Lighting of the Stoves

In order to light the stoves, the wick regulator was raised to point P and the wicks trimmed. It was then raised to P₁ and all the wicks were then lighted with a match stick. After two minutes, when the blue flame rose above the top of the stove, the utensil concerned was placed over the fire.

iii) Methods for Cooking Rice, Dhal and Potatoes

The methods standardised for cooking rice, dhal and potatoes were the same for the experiments using the Hay Box and those without using the Hay Box.

Rice

The method employed for cooking rice was the 'absorption method' over direct heat. In this method, thiamine, nicotinic acid and other B vitamins are fully retained, whereas in the traditional method where the gruel is strained, most of the water soluble B vitamins are carried away resulting in great nutritional losses. However, the absorption method is not generally practised, as it is not possible for a busy homemaker to give the attention it demands by way of constant stirring to prevent it from charring. Therefore, it was decided to experiment with this method, using the Hay Box, as

in Hay Box cooking, foods could be kept for a long time without attention.

Dhal

For cooking dhal, boiling in large quantities of water over low fire was the method selected. Unlike in the case of rice, the cooking water from dhal is not drained, but utilised in the preparations of dhal. According to Todhunter (1958)²⁹ "The higher the temperature of cooking, harder and tougher the protein becomes, and it is therefore a general rule in cooking of proteins to use a low temperature."

Potatoes

Boiling in their jackets was the method employed for the cooking of potatoes, as according to Streightoff et al (1945)³⁰ boiling or steaming of potatoes in jackets result in no loss of ascorbic acid.

iv) Steps in Cooking The following steps were standardised for cooking rice, dhal and potatoes using the Hay Box:

1. The measured quantity of water* was poured in the utensil selected for cooking the particular food and the utensil with its lid** and placed on the stove, two minutes after lighting.

* Throughout the experimentation, Sirvani water, the local source of drinking water, was used.

**Throughout the experimentation, the utensils were covered, when they were placed over the fire.

2. The raw food was washed and strained.
3. The water was brought to boil and the time was noted.
4. The washed, drained food was added to the boiling water and the time when it resumed boiling with the food was noted.
5. After allowing the foods to continue boiling for varying amounts of time depending upon the foods cooked, the covered utensil with the boiling contents was transferred to the Hay Box, recording the time, and the stove turned off.
6. The time needed for the food to get cooked while in the Hay Box, was noted.
7. The food was removed from the Hay Box and tested for palatability. For the studies on temperature retention, the food was retained in the Hay Box for the specified amounts of time.

The steps while cooking the foods without using the Hay Box were the same, as above, except at step (5), where, instead of removing the utensil to the Hay Box, it was left over the flame till it was cooked completely. In doing so, adjustments had to be made at the wick regulator depending on the foods cooked to regulate the flame, in order to prevent the cooking water from over-flowing and the food from

being charred. In order to ensure uniform cooking, the contents were stirred at 10 minutes intervals in all the experiments.

As the samples cooked using and without using the Hay Box were served simultaneously to the judges the temperature of the two samples had to be the same at the time of serving. The temperature of cooked rice when removed from the Hay Box was 82°C . But the temperature of rice cooked without using the Hay Box, when removed from the fire, was 95°C . Hence, the sample cooked without using the Hay Box had to be cooled down to 82°C . By preliminary experiments, it was found that when the cooked sample was left outside for 35 minutes, the temperature dropped to 82°C from 95°C .

Similarly, the temperature of the dhal when removed from the Hay Box was 80°C , while that cooked directly was at 95°C , and 30 minutes were required for the temperature of dhal cooked without using the Hay Box to cool down to 80°C . Thirty eight minutes were required to bring down the 97°C temperature of cooked potatoes to 85°C which was the temperature of cooked potatoes when removed from the Hay Box. The time for starting the cooking of rice, dhal and potatoes using and without using the Hay Box were adjusted accordingly.

v) Selection of the Tasting Panel Any food preparation should be satisfactory in terms of appearance, odour, flavour,

texture and taste for acceptability. Therefore, in cooking experiments, the quality and palatability of the cooked products must be judged scientifically. This is necessary when any new cooking equipment is introduced, when new recipes are developed, and when methods of cooking are compared. However efficient a cooking equipment might be in saving time and fuel, if it does not help to turn out palatable products, the equipment will not be acceptable. Therefore, in this study, judging the palatability of the cooked foods was included.

Judging foods can be accomplished through objective and subjective methods. Nason (1939)³¹ says that, as the names imply subjective methods depend to some extent upon the opinions and prejudices are largely eliminated. In subjective methods, the quality is determined largely through sensory organs by means of score cards, and in the objective methods, the quality is determined by means of various objective devices such as X-rays, photographs and imprints, and qualitative determinations of losses in weight, and temperature changes.

Sweetman and Mackellar (1954)³² remark "The BHNHE* and other researches have found that the most all round satisfactory way to test foods for flavour, texture and other properties is to serve samples to expert human judges and

*BHNHE is the former Bureau of Human Nutrition and Home Economics of the United States Department of Agriculture..

compare verdicts". One of the serious limitations of sensory tests, according to Mack (1949)³³ is the variability of the individual's response to a given stimulus, and the variability of the individual's response at different times. Individuals vary in their thresholds, and in ability to identify one flavour in the midst of others. Their variations can be decreased by selecting and training the judges.

Nevertheless, from the palatability point of view, subjective tests are considered more suitable and therefore, it was decided to use subjective testing for this study to assess the palatability of the foods cooked.

The Triangle Test described by Lowe (1955)³⁴ was adopted, to detect acuity of taste or smell in prospective members of the panel. According to her, the test unit in the Triangle Test consists of three food samples - two of which are aliquots of the same food sample. All three samples are coded, so that they are known only to the person who is administering the test and not to the administered. The members of the prospective panel are requested to pick the "different" sample, and sometimes to indicate the reasons for their decision. After studying their verdicts, those who had been consistent in pointing out the "different" sample correctly are selected to constitute the panel.

In addition to the ability to detect difference in taste and flavour, judges must fulfil the following criteria, as indicated by Lowe (1955)³⁴:— They should be healthy, free from cold, allergies and infections in the sense organs. They should have emotional stability, training in judging palatability, interest in the project in which the judging test is administered and free from fatigue.

Keeping these in view, the Triangle Test was administered to nine members of Sri Avinashilingam Home Science College, Coimbatore, all of whom were Home Science Graduates. They ranged in age from about 20 years to 40 years, and fulfilled all the criteria described by Lowe. They had a high degree of personal integrity, ability to concentrate, were interested in the study, and willing to cooperate and give the time necessary for judging the products.

Two equal parts of the same sample of parboiled rice were cooked separately, one using the Hay Box, and the other without using the Hay Box, to constitute the unit for the Triangle Test--two portions from one part, and one from the other. These three samples were presented simultaneously in random arrangement to the judges.

The Triangle test, and the subsequent testing of the experimental samples, were conducted in a quiet comfortable room with plenty of light and air, conducive to concentration

and free from interruptions and distractions. In order to avoid the judges from being influenced by discussions, and seeing the facial expressions of their colleagues, individual booths, where judges could be seated comfortably were set up.

The Triangle Test was administered five times. The cooked samples were served on the white porcelain plates in identical quantities, which were sufficient for the purpose of testing. A score sheet as shown in Table VI was given to each judge to mark the "different" sample and the reasons for marking so.

TABLE VI
SCORE SHEET FOR USE IN THE TRIANGLE TEST

To be filled by the Investigator	Date	No.	Sample
To be filled by the Judges	Different samples		How is it different?
Signature of the Judge:	-----		
Instructions to members:	<p>Among the three samples given, two are identical and one is different. Kindly mark which is the different sample, and write how it is different. After tasting each sample, please drink little water, and pause a while to remove the taste of that sample. Then taste the next sample.</p>		

The test was repeated five times and the results are given in Appendix III. Two of the members dropped out of the list in the middle, as one had caught a cold, and the other had to go out of station on an emergency. Of the remaining seven, five were correct in picking the "different" sample on more than three occasions, while the remaining two were inconsistent throughout. The five members who were consistent, were selected to constitute the panel, and according to Lowe (1955)³⁴ this number was more than adequate. No special training in tasting was given to the selected members of the panel, as they were all trained Home Scientists dealing Nutrition, with considerable scientific experience with foods.

(vi) Development of the Score Cards for Assessing the Palatability of the Foods

In order to assess objectively the difference in the palatability of rice, dal and potatoes cooked using and without using the Hay Box, the scoring test, through the use of score cards was considered the most suitable to rate the palatability of the foods. As mentioned by Lowe (1955),³⁴ in this test, "The scorer assigns a numerical rating to single palatability factors. The scorer is expected to detect differences in the sample, if differences exist, and to assign a quantity factor to these ratings." The score card contains a numerical scale accompanied by descriptive terms

in a graded manner. The numerical scores, according to Lowe may range from a three point-scale to a ten point scale. The scorer marks the score she wishes to assign to a particular quality. Thus, judging by the use of a score card necessitates a thorough and critical examination, and recorded judgement.

The score cards used in this study were developed on the basis of the main qualities usually looked for in foods, such as colour, texture, taste and other distinguishing characteristics, such as separateness of grains, in the case of rice. The scores were based on a five point scale. Accordingly, five descriptions for each of the qualities were tabulated, the descriptions ranging from the superior to the inferior.

The score card in Table VII developed for rice was based upon the following qualities expected of a good product: colour, separateness of grains, fluffiness, odour, tenderness and doneness.

TABLE VII

SCORE CARD FOR RICE

Date:

Judge:

Kindly judge without discussion and tick against any one description^{with} in your opinion best fits each quality.

Quality	Description	Samples	
		A	B
COLOUR	Very white		
	White		
	Slightly cream		
	Cream		
	Brownish		
SEPARATENESS OF GRAINS:	Each grain is separate		
	One or two grains stick together		
	Grains stick together in small lumps		
	Grains stick together in big lumps		
	Product is in a mass		
FLUFFINESS:	Very light and fluffy		
	Grains are quite fluffy		
	Grains are fairly fluffy		
	Grains are heavy		
	Grains are very heavy		
ODOUR:	Odour of well-cooked rice		
	No odour		
	Odour of uncooked rice		
	Slight foreign odour		
	Very unpleasant odour		
TENDERNESS	Very soft		
	Soft		
	Fairly soft		
	Hard		
	Very hard		
DONENESS:	Well cooked		
	Fairly well cooked		
	Just cooked		
	Slightly over cooked		
	Over cooked/Undercooked		
TASTE:	Very good		
	Good		
	Bland		
	Bad		
	Very bad		

Note: Any comments not covered by the above may be given here.

As can be seen from Table VII, the factors to be scored were in the following order: colour, separateness of grains, fluffiness, odour, tenderness, doneness and taste, the factors estimated by sight coming first, then those pertaining to odour, touch and taste respectively.

Score card for dhal, as given in Table VIII was developed likewise.

TABLE VIII
SCORE CARD FOR DHAL

Date:

Judge:

Kindly judge without discussion and tick against any one description which in your opinion best fits each quality.

Quality	Description	Samples	
		A	B
ODOUR:	Odour of well cooked dhal		
	No odour		
	Odour of uncooked dhal		
	Slight foreign odour		
	Very unpleasant odour		
TENDERNESS:	Very soft		
	Soft		
	Fairly soft		
	Hard		
	Very hard		
DONENESS:	Well-cooked		
	Fairly well cooked		
	Just cooked		
	Slightly under cooked/ Slightly over cooked		
	Overcooked/Undercooked		
TASTE:	Very good		
	Good		
	Bland		
	Bad		
	Very bad		

Note: Any comments not covered by the above may be given here:

As Table VIII shows, colour, as a quality to be tested in Dhal was omitted, because the colour of turmeric which is usually added to dhal, alters the natural colour of the dhal. The separateness of grains and fluffiness were also omitted, since they are not pertinent to dhal.

The score card developed for potatoes is given in Table IX.

TABLE IX
SCORE CARD FOR POTATOES

Date:

Judge:

Kindly judge without discussion and tick against any one description which in your opinion best fits each quality.

Quality	Description	Samples	
		A	B
ODOUR:	Odour of well cooked potatoes		
	No odour		
	Odour of uncooked potatoes		
	Slight foreign odour		
	Very unpleasant odour		
DONENESS:	Well cooked		
	Fairly well cooked		
	Just cooked		
	Slightly over cooked/slightly under cooked		
	Over cooked/Undercooked		
TASTE:	Very good		
	Good		
	Bland		
	Bad		
	Very bad		

Note: Any comments not covered by the above may be given here.

As can be seen from Table IX, the qualities included for judging the cooked potatoes were odour, doneness and taste.

d) Conducting Experiments

The experiments conducted were to compare:

- i) The time taken to cook rice, dhal and potatoes, using and without using the Hay Box.
- ii) The Kerosene consumed in cooking rice, dhal and potatoes using and without using the Hay Box.
- iii) The palatability of rice, dhal, and potatoes using and without using the Hay Box.
- iv) The heat retention of cooked rice kept in the Hay Box and outside.

i) Time Taken to Cook Rice, Dhal and Potatoes using and Without Using the Hay Box

A series of experiments was conducted with varying quantities of water, allowing varying amounts of time, for cooking 400 gms of rice, 190 gms of dhal and 227 gms of potatoes using and without using the Hay Box, in order to find the right amount of water to be used, the time to be allowed to get the best products of cooked rice.

With regard to cooking using the Hay Box, varying amounts of time were allowed for the boiling of rice prior to the transfer of the utensil to the Hay Box and for retention in the Hay Box. The time the utensil was over the fire, the

total time for cooking, that is, the time on the fire, plus the time allowed inside the Hay Box to give a desirable product, were noted.

Cooking without using the Hay Box

Similar experiments were conducted as mentioned earlier, without using the Hay Box, the only difference being that the cooking of rice was completed over the direct flame itself. The total time the utensil was on the fire to give a desirable product was noted. Both the products were tasted simultaneously to judge the palatability. This procedure was repeated, with dhal and potatoes. Since each of the foods was independently tested and since the time taken by each food to be cooked using the Hay Box was long, the series of experiments with rice were carried out first, then with dhal and finally with the potatoes. In each case, four replicates were carried out.

ii) Kerosene consumed in Cooking Rice, Dhal, and Potatoes Using and Without Using the Hay Box

After cooking the foods as described earlier, the kerosene consumption in each case was estimated. One hour after turning off the stove, the kerosene consumed was measured.

iii) Palatability of Rice, Dhal, and Potatoes using and Without using the Hay Box

The cooked foods were served simultaneously to the five judges and they were requested to score the foods using the score cards developed for the purpose.

iv) Heat Retention of Cooked Foods Kept in the Hay Box and Outside

Two series of experiments were carried out to study the extent of heat retention and its effect on palatability of the rice. (a) Four hundred grams of rice were cooked using and without using the Hay Box, and were tested for temperature and palatability five hours after removing the samples from the fire. This period was selected, since the working woman for whom the Hay Box is expected to be of great help as a labour saving device, ordinarily cooks her meals at 8 a.m. before she leaves for her job, and returns home for lunch around 1 p.m. (b) Four hundred grams of rice were cooked using and without using the Hay Box and one sample was kept in the Hay Box and the other, outside, noting the temperature of both the samples and the room temperature, every hour after removing the samples from the fire, for a period of twelve hours. >

IV RESULTS AND DISCUSSION

The data obtained in this study are presented and discussed in the following order:

- A) Reactions of the homemakers who were using the Hay Box
- B) Results of the experiments conducted with the Hay Box.

A) Reactions of the Homemakers Who Were Using the Hay Box

Out of the 45 homemakers who had replied the questionnaire, 16 were using the Hay Box. Their replies were analysed in terms of the reasons for or advantages, in their using the Hay Box and the difficulties encountered by them while using it. The advantages pointed out by them are given in Table X.

. TABLE X.

RURAL HOMEMAKERS' REASONS FOR USING THE HAY BOX

Reason or Advantage	No. of Homemakers Answering
Since there is no straining, nutritious food at no additional cost is obtained	14
Time, fuel and labour are saved ..	13
The food remains hot for a long time	12
Food is kept cleaner	6
Hay Box is easy to operate	5
Food does not get spoilt easily	4
Food is cooked uniformly to the same degree of doneness	3
Food is tastier	3
As there is no straining, there is no probability of accidents due to the kanchee water falling on the body	3
It is convenient for large families	2
Food grains are fluffy and the texture is good	2
Lunch and dinner can be cooked at the same time	1
Time taken to wash the cooking utensils is decreased, as food does not stick to the utensils	1
It is convenient for career women	1
It can be carried anywhere	1

From Table X, it is evident that the availability of additional nutrients at no cost, the saving of labour, fuel and time, and the heat retention of the cooked foods

were the main advantages pointed out by most of the homemakers. The difficulties in using the Hay Box, as pointed out by some of the homemakers from the same group are given in Table XI.

TABLE XI

DIFFICULTIES ENCOUNTERED IN USING THE HAY BOX BY
THE RURAL HOMEMAKERS

Difficulties	No. of Home- makers Answering.
To obtain the box	3
Fixing the right proportions of water and food to be used	2
In operation	2
Foreign odour, if hay is not changed frequently	2
In setting up the Hay Box	2
Need to use utensils with no curves	1
Level of the cooked food should reach the brim of the utensil	1
Kanchee water is not available for other purposes	1
It occupies a large area of space	1
It is difficult to handle a large utensil in the Hay Box	1

It can be clearly seen from Table XI, that as compared to the many advantages pointed out by several homemakers, only a few difficulties have been recorded by one to three

homemakers. Some of their 'difficulties' were mere precautions, for instance, 'foreign odour if hay is not changed frequently,' and 'fixing the proportion of water' while others like "need to use utensils with no curves," "the level of cooked food should reach the brim of the utensil," were imaginary without proof of experience.

The data collected through the interviews with seven homemakers in the city on the use of Hay Box, showed that six of them were using wooden boxes and one was using a cement cistern as the outside container. No expenditure had been incurred on the boxes by five of them since, the boxes were obtained free, while one homemaker spent Rs.3.00 to reconstruct an old deal wood box. The cement cistern was also free, as it formed part of the rented house. The cooking utensils used in the Hay Box by these homemakers were of different materials: aluminium, brass, stainless steel, bell metal and copper. All shapes - straight sided, flat bottomed and spherical utensils were included.

The items of food cooked in the Hay Box by these homemakers were parboiled rice, raw rice, dhal, Bengal gram (whole) and potatoes. The homemakers who cooked dhal remarked that the cooked product was not as soft as that cooked ^{WITHOUT} using the Hay Box. But, still they used the method since they benefitted on the saving of the fuel upto a point, and then cooked the dhal for an additional period

over direct fire. Biriyani, uppuma and pongal were some of the special food preparations made with the use of the Hay Box. The proportion of rice to water varied from 1 : 2 to 1 : 3 in case of parboiled rice, and from 1 : 2 to 1 : 2½ in the case of raw rice. This variation was reported to be due to the types of rice used in the different households.

The period of time the rice was initially left over the fire varied from five minutes to twenty five minutes in the case of parboiled rice, and from five minutes to "up to the time the food is half cooked," that is about 30 minutes, in the case of raw rice. This large variation seemed to be due to the lack of information on the part of the homemakers regarding the length of time the contents had to be heated directly over fire in order to get a desirable product after transfer to the Hay Box. The length of time, the rice was left in the Hay Box also varied from 45 minutes to 120 minutes in the case of parboiled rice, and from 30 to 45 minutes in the case of raw rice. With regard to heat retention, one homemaker remarked that the Hay Box retained the temperature of the foods even upto ten hours.

The advantages pointed out by the urban homemakers in using the Hay Box were that the Hay Box was time and fuel saving; (the absorption method of cooking was made easy in the hay box), it needed less attention, as stirring was eliminated; the cooked grains were soft and separate; the rice was not sticky; it did not get charred nor over cooked;

it was kept hot; the Hay Box was easy to handle and washing the cooking utensils was less strenuous as there was not much soot due to the shorter time for which the utensil was kept over the fire. Five of the homemakers experienced no difficulties in using the Hay Box, while the other two mentioned that it was difficult to keep the box clean and to handle large utensils with the Hay Box.

The data thus collected through the questionnaires and the interviews revealed that the Hay Box was an inexpensive simple equipment of considerable importance to the homemakers and furnished the background for the experiments conducted.

B) Results of the Experiments Conducted with the Hay Box

The data obtained through the experiments conducted on the Hay Box are presented and discussed under the following headings:-

- (a) Comparison of the time taken for cooking rice, dhal and potatoes using and without using the Hay Box.
- (b) Comparison of the kerosene consumed in cooking rice, dhal, and potatoes using and without using the Hay Box.
- (c) Comparison of the palatability of rice, dhal and potatoes cooked using and without using the Hay Box.
- (d) Comparison of the heat retention and palatability of the rice cooked, after five hours, using and without using the Hay Box.

(e) Heat retention of cooked rice kept in the Hay Box and outside, during 12 hours

and (f) Initial cost and care of the Hay Box.

a) Comparison of the Time Taken to Cook Rice, Dhal and Potatoes using and without Using the Hay Box:

Before studying the time taken to cook rice, dhal and potatoes using and without using the Hay Box, experiments were to be conducted with each of these food stuffs to find out the optimum quantity of water needed to cook a desirable product.

Table XII gives the amounts of water found to be the optimum for giving the best cooked products of rice, dhal and potatoes using and without using the Hay Box.

TABLE XII

AMOUNTS OF WATER TO BE USED FOR COOKING RICE, DHAL AND POTATOES

Food Stuff	Weight in grams	Water in Cups	
		Using the Hay Box	Without using the Hay Box
Rice	400	4½	5½
Dhal	190	1½	2
Potatoes	227	2	2

Keeping the quantities of water specified in Table XII constant, experiments were repeated four times noting the time taken in each case to give the desirable product of cooked rice, in terms of the total time the utensil had to be left on the stove, as given in Table XIII.

TABLE XIII

TOTAL TIME NEEDED ON THE STOVE TO COOK RICE, DHAL AND POTATOES USING, AND WITHOUT USING THE HAY BOX

Total time in Minutes for which the Utensils were placed on the Stove										
Using the Hay Box					Without Using the Hay Box					Difference between the means
I	II	III	IV	Mean	I	II	III	IV	Mean	
17.50	17.00	17.50	17.50	17.38	54.50	53.50	54.00	53.00	53.75	36.37
26.00	25.75	25.75	26.00	25.88	43.00	42.50	43.00	42.50	42.82	16.94
17.50	17.50	17.00	17.50	17.40	37.00	37.50	36.50	37.00	37.00	19.60

Table XIII gives the total time needed for the utensils to be placed on the stove to cook rice, dhal, and potatoes using the Hay Box and without using the Hay Box. In the case of using the Hay Box, this total time was the time taken to boil the water, plus the period of time the contents were left on the stove, whereas in the case of cooking without the Hay Box, the total time taken was the entire period for which the utensil was on the stove to complete cooking. For example, rice was left for four minutes after it was added to the boiling water prior to the transfer to the Hay Box, and dhal and potatoes were left for 20 minutes and 10 minutes respectively after adding them to the boiling water.

prior to transfer to the Hay Box. In the case of cooking without using the Hay Box, rice, dhal and potatoes were kept over the stove for 53.75, 42.82 and 37 minutes respectively.

The data obtained in Table XIII were appraised statistically*, using the analysis of variance described by Snedecor (1946)³⁵. The F values were obtained by dividing the mean square for the variation between the two sets by the mean square for the variation within sets. The t test, which is usually applied to test whether or not the difference between the means of two results of experimental treatments is significant, indicates the same level of significance as F, when the total number of treatments is limited to two. Thus in this case, when F is significant, t must also be significant and hence the t test was not separately calculated.

The F ratio for the results for rice given in Table XIII was found to be significant beyond the one per cent level as shown in Appendix IV and hence, the difference in time taken to cook 400 gms of rice using and without using the Hay Box was highly significant, the Hay Box registering a saving of 67.6 per cent of the time taken to cook rice without using the Hay Box in terms of the time for which the utensil had been placed on the stove.

The difference in time taken to cook 190 gms of dhal using and without using the Hay Box given in Table XIII was

*Throughout this Chapter, wherever reference is made to statistical appraisal, the analysis of variance has been used.

found to be significant beyond one per cent level as given in Appendix IV. The percentage of time saved by using the Hay Box as compared to the time taken without using the Hay Box, in the case of cooking of dhal was 39.56.

The difference in time taken to cook potatoes using and without using the Hay Box, shown in Table XIII was also found to be significant beyond one per cent level as shown in Appendix IV, and the percentage of time saved by using the Hay Box as compared to the time taken without using the Hay Box was 53 for cooking potatoes.

Thus from the data presented in Table XIII, it is concluded that the Hay Box is significantly superior in saving time the utensils are to be kept on the stove while cooking rice, dhal and potatoes, the percentage of saving of time varying with each food, the highest being in the case of rice, followed by potatoes and dhal.

Assuming that the Hay Box is used in a household as per the techniques standardised in this study, daily to cook rice, dhal and potatoes, the percentage of the total time which would be saved per day was calculated next. According to the day's menu given in Table I, rice is cooked twice a day, and dhal and potatoes once a day, by the reference family. The comparison of the time which will be taken to cook these foods using and without using the Hay Box is given in Table XIV.

TABLE XIV

TOTAL SAVING OF TIME IN A DAY BY THE REFERENCE
FAMILY BY USING A HAY BOX

Foods to be Cooked	Time taken in Minutes		
	Using the Hay Box	Without using the Hay Box	Time saved
Rice - twice	34.76	107.50	72.74
Dhal - once	25.88	42.82	16.94
Potatoes - once	17.40	37.00	19.60
Total	78.04	187.32	109.28

The figures in Table XIV show that by using the Hay Box, the homemaker can save 109.28 minutes a day amounting to 58 per cent of the time she would spend in cooking the meals without the use of the Hay Box. This will indeed give her the much needed time for the other managerial jobs in the home as well as some leisure.

Moreover, the shorter the cooking time over the stove, the lesser are the attention and labour needed for ensuring a good product. When foods are left over the direct fire, attention is needed at frequent intervals to prevent foods from boiling over, getting charred at the bottom, or getting overcooked. The homemaker therefore needs to sit near the fireplace and stir the contents at regular intervals, expending much energy and effort. Hence, the shorter the duration for which food is left over the fire, the greater will be the

saving of energy and effort through the reduction in attention given for cooking.

However, the Hay Box was slow in its functioning, considering the total time taken for cooking which is the time for which the utensils were placed on the stove plus the time they were kept in the Hay Box. Therefore, ^{(the use of the Hay Box} is limited in that it takes a longer time to cook, than cooking without using the Hay Box. In using the Hay Box, the homemaker should so plan her time and work that she is able to allow the time required for the Hay Box to be effective.)

(*) Comparison of the Kerosene Consumed in Cooking Rice, Dhal and Potatoes using and Without Using the Hay Box

Table XV gives the amount of kerosene consumed while cooking using and without using the Hay Box.

TABLE XV

KEROSENE CONSUMED IN COOKING RICE, DHAL AND POTATOES USING AND WITHOUT USING THE HAY BOX

Food.	Quantity of Kerosene Consumed in cc.								Difference in cc.		
	Using Hay Box				Without Using Hay Box						
	I	II	III	IV	Mean.	I	II	III		IV	Mean.
Rice	36.00	36.00	34.00	35.00	35.25	60.00	63.00	59.00	63.00	61.25	26.00
Dhal	24.00	23.00	23.00	25.00	23.75	37.00	37.00	34.00	38.00	36.50	12.75
Potatoes	36.00	34.00	36.00	35.00	35.25	73.00	69.00	72.00	72.00	71.50	36.25

The difference in kerosene consumption was significant beyond one percent level for rice, dhal and potatoes as given in Appendix V. It is seen from Table XV that the percentages of kerosene saved while cooking rice, dhal and potatoes using a Hay Box, as compared to the consumption of kerosene while cooking without using the Hay Box were 42.45, 34.94 and 50.7 respectively.

The percentage of kerosene saved in cooking potatoes was higher than in the case of cooking rice and dhal. This difference in kerosene consumption between rice and potatoes, inspite of the fact that the percentage of time saved in cooking rice was greater than in the case of potatoes was due to the higher intensity of the flame at the point P_1 , which was used to boil potatoes as compared to the lower intensity of flame P_2 at which the rice was boiled.

The amount of kerosene which will be saved per day for cooking rice twice, and dhal and potatoes once, by the reference family, through the use of the Hay Box is given in Table XVI

TABLE XVI
TOTAL SAVING OF KEROSENE IN A MONTH BY THE
REFERENCE FAMILY BY USING A HAY BOX

Foods to be cooked	Kerosene consumed in c.c.		
	Using the Hay Box	Without using the Hay Box	Kerosene saved
Rice twice	70.50	122.50	52.00
Dhal once	23.75	36.50	12.75
Potatoes once	35.25	71.50	36.25
Total/day	129.50	230.50	101.00
Total/month	3885.00	6915.00	3030.00
Cost*	Rs. 1.39	Rs. 2.47	Rs. 1.08

* Cost is calculated at Rs. 0.25 / bottle which is 700 c.c. in capacity.

As can be seen from Table XVI, ^{It is further estimated that the monthly consumption} the monthly consumption of kerosene using a Hay Box would be 3885.0 c.c. costing Rs.1.39, and the cost of 6915.0 c.c. kerosene, consumed while not using a Hay Box is Rs.2.47.

Thus, in using the Hay Box, there is a significant saving of Rs. 1.08 per month amounting to 44 percent of the kerosene cost, if the Hay Box was not used to cook rice, dhal and potatoes daily.)

(C) Comparison of Palatability of Rice, Dhal and Potatoes, Cooked Using and without using the Hay Box)

The scores for palatability awarded by the judges for the rice cooked using and without using the Hay Box are given in Table XVII.

TABLE XVII.

COMPARISON OF THE SCORES AWARDED TO RICE COOKED USING AND WITHOUT USING THE HAY BOX.

Food.	Qualities.	Using the Hay Box.				Mean.	Without Using the Hay Box.				Mean.
		I	II	III	IV		I	II	III	IV	
Rice	Colour	3.40	3.60	3.40	3.60	3.50	3.00	2.80	3.00	3.00	2.90
	Separateness of grains	4.00	4.00	4.00	4.00	4.00	3.00	2.80	3.00	2.80	2.90
	Fluffiness	4.00	4.20	3.20	4.20	3.90	3.40	3.80	3.20	4.00	3.60
	Odour	5.00	4.40	4.40	4.40	4.55	5.00	5.00	5.00	5.00	5.00
	Tenderness	3.20	3.60	3.60	3.60	3.65	3.20	3.00	3.00	3.20	3.10
	Doneness	4.00	4.20	3.80	4.40	4.10	3.60	3.40	3.80	4.40	3.80
	Taste	3.40	3.60	3.60	3.60	3.55	3.20	3.40	3.40	3.60	3.40
	Total points	27.00	27.60	27.60	27.60	27.45	24.40	24.20	26.00	26.00	25.15
Dhal	Odour	4.60	4.60	5.00	4.40	4.65	5.00	3.80	5.00	5.00	4.70
	Tenderness	2.60	2.40	3.20	2.40	2.65	3.60	4.00	3.20	4.20	3.75
	Doneness	3.20	3.00	3.80	2.40	3.10	3.60	4.00	4.00	4.60	4.05
	Taste	3.60	4.00	3.80	3.80	3.80	4.00	3.80	3.80	3.40	3.75
	Total points	14.00	14.00	15.80	13.00	14.20	16.20	15.60	16.00	17.20	16.25
Potatoes	Odour	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
	Doneness	5.00	4.20	4.80	4.60	4.65	4.00	3.80	3.80	3.20	3.70
	Taste	4.20	3.80	3.80	3.60	3.85	4.00	4.00	4.00	4.00	4.00
	Total points	14.20	13.00	13.60	13.20	13.50	13.00	12.80	12.80	12.20	12.70

According to the figures given in Table XVII rice cooked using the Hay Box scored higher than rice cooked without using the Hay Box in all qualities, except odour. As given in Appendix VI, the difference in scores for separateness of grains was significant beyond one per cent level, and odour, significant beyond five per cent level. The differences in scores for colour, fluffiness, tenderness, doneness and taste were not significant. Taking the total points, rice cooked using the Hay Box was superior to rice cooked without using the Hay Box, and the difference was significant beyond one per cent level.

The scores awarded by the judges for palatability of dhal cooked using and without using the Hay Box as given in Table XVII reveal that dhal cooked using the Hay Box was superior to dhal cooked without using the Hay Box in taste. Dhal cooked without using the Hay Box scored higher for tenderness, doneness and odour. Appendix VII shows that the difference in scores for tenderness was found to be significant beyond one per cent level and the differences for other scores were not significant. Taking the total points into consideration, dhal cooked without using the Hay Box scored higher than dhal cooked using the Hay Box. The difference was significant beyond five per cent level.

As can be seen in Table XVII potatoes cooked using the Hay Box were superior in taste and doneness and the difference in scores for doneness was statistically significant beyond

five per cent level and the difference in scores for taste was not significant) as shown in Appendix VIII. There was no difference in odour between the potatoes cooked using and without using the Hay Box. When the total points were considered, potatoes cooked using the Hay Box were superior to potatoes cooked without using the Hay Box. However, the difference in scores were not significant.

Thus when considering all the qualities together, rice and potatoes cooked using the Hay Box were superior to rice and potatoes cooked without using the Hay Box, while dhal was more palatable when cooked without using the Hay Box.

d) Heat Retention and Palatability of Rice Cooked Using and without using the Hay Box, Five Hours after Removal from the Stove

Table XVIII gives the temperature of the rice cooked using and without using the Hay Box, five hours after removing them from the stove, leaving the product cooked using the Hay Box in it and the product cooked without using the Hay Box outside. The initial temperatures in both the methods of cooking were taken just when the utensils were removed from the stove. Therefore they are almost identical.

TABLE XVIII

TEMPERATURES OF RICE COOKED USING AND WITHOUT USING THE HAY BOX, FIVE HOURS AFTER REMOVING FROM THE STOVE.

(In Degrees Centigrade.)

Replic- ates	Room Temperature		Methods of cooking.	Temperature of Rice.		Difference in fall.	
	Initial.	Final.		Initial.	After 5 Hrs. ence.		
I	22.0	24.0	Using the Hay Box.	98.0	62.0	36.0	--
			Without using the Hay Box.	97.5	36.5	61.0	25.0
II	24.0	24.5	Using the Hay Box.	97.0	61.0	36.0	
			Without using the Hay Box.	97.0	36.0	61.0	25.0
III	24.0	24.5	Using the Hay Box.	97.0	61.0	36.0	
			Without using the Hay Box.	97.0	36.5	60.5	24.5
Aver- age.			Using the Hay Box.	97.3	61.3	36.0	
			Without using the Hay Box.	97.2	36.3	60.8	24.8

From Table XVIII it is clear that although the initial temperature of the two samples was almost the same the sample kept in the Hay Box maintained a temperature of 61.3°C on an average, incurring an average fall in temperature of 36°C for the 5 hours, whereas the average temperature of the sample kept outside was only 36.3°C , with a greater fall in temperature amounting to 60.8°C on the average during the same period.

The difference in fall in temperature between the two samples was 24.8°C . That is the heat retention of rice kept in the Hay Box was 40.8 per cent more efficient than the sample cooked without using the Hay Box and left outside. This is because of the insulation in the Hay Box which helps in retaining the heat of the cooked rice.

The average scores for rice cooked using and without using the Hay Box, tasted five hours after removing the samples from the stoves are given in Table XIX.

TABLE XIX
AVERAGE PALATABILITY SCORES FOR RICE KEPT IN THE
HAY BOX AND OUTSIDE, TASTED FIVE HOURS AFTER
REMOVAL FROM THE STOVES

Qualities	Using the Hay Box				Without using the Hay Box			
	I	II	III	Mean	I	II	III	Mean
Colour	3.20	3.40	3.20	3.26	3.20	3.20	3.40	3.26
Separateness of grains	3.40	3.60	3.80	3.60	2.20	2.20	2.00	2.13
Odour	4.40	4.40	4.40	4.40	5.00	5.00	5.00	5.00
Textures	3.40	3.60	3.80	3.60	2.80	3.00	3.00	2.93
Taste	3.60	3.40	3.20	3.40	3.00	3.60	3.40	3.33
Total points	18.00	18.40	18.40	18.27	16.20	15.00	16.80	16.65

From Table XIX, it is seen that the rice cooked using the Hay Box was superior to the rice cooked without using the Hay Box in the qualities - separateness of grains; texture and taste. These differences were significant at one per cent level. The rice cooked without using the Hay Box was superior to the rice cooked using the Hay Box in odour, and the difference was significant at one per cent level. In colour, both the products received the same scores. When analysing the total points rice cooked using the Hay Box was superior to rice cooked without using the Hay Box and the difference was significant at one per cent level, as can be seen in Appendix IX.

Thus, rice cooked using the Hay Box was hotter, more tender, grains more separate and tastier than the rice cooked without using the Hay Box, when served five hours after removing the samples from the stoves. This makes the Hay Box a very useful equipment to the career woman, who has to prepare the lunch for the family in the mornings before she leaves home for her job, as stated by Heath (1961)³⁶. These benefits are ~~more~~ important considering that rice is a food which is always preferred to be served hot. As the Hay Box helps to retain the temperature of cooked rice, it enhances the palatability of the cooked product.

e) Heat Retention of Cooked Rice Left Inside the Hay Box and Outside during 12 hours

The average hourly temperature readings of cooked samples

of rice, one kept in the Hay Box and the other ^{OUT}side, along with the room temperature for the corresponding intervals, and the percentage of heat retention in them are given in Table XX. The percentage of temperature retention has been calculated from the ratio of the retained temperature to the initial temperature.

TABLE XX

PERCENTAGE OF TEMPERATURE RETENTION OF RICE COOKED AND KEPT INSIDE THE HAY BOX, AND OUTSIDE

Time in hours	Room Temperature.	Temperature in degrees Centigrade.		Percentage of Temperature Retention.	
		For rice kept inside Hay Box.	For rice kept outside.	In rice kept in Hay Box.	In rice kept outside.
0	26.1	95.00	95.00	0.00	0.00
1	26.0	83.20	77.60	87.58	81.70
2	26.6	74.20	61.80	79.93	65.06
3	26.8	67.20	51.40	70.74	54.12
4	27.0	61.60	45.20	64.85	47.57
5	27.2	57.00	40.20	60.01	42.32
6	27.0	53.60	36.60	55.80	38.53
7	27.2	50.60	34.20	53.27	35.99
8	27.0	47.60	32.40	49.48	34.10
9	26.4	45.60	31.20	48.00	32.85
10	26.2	43.40	29.80	45.47	31.59
11	26.0	41.60	29.40	43.79	30.94
12	25.6	40.20	28.20	42.32	29.68

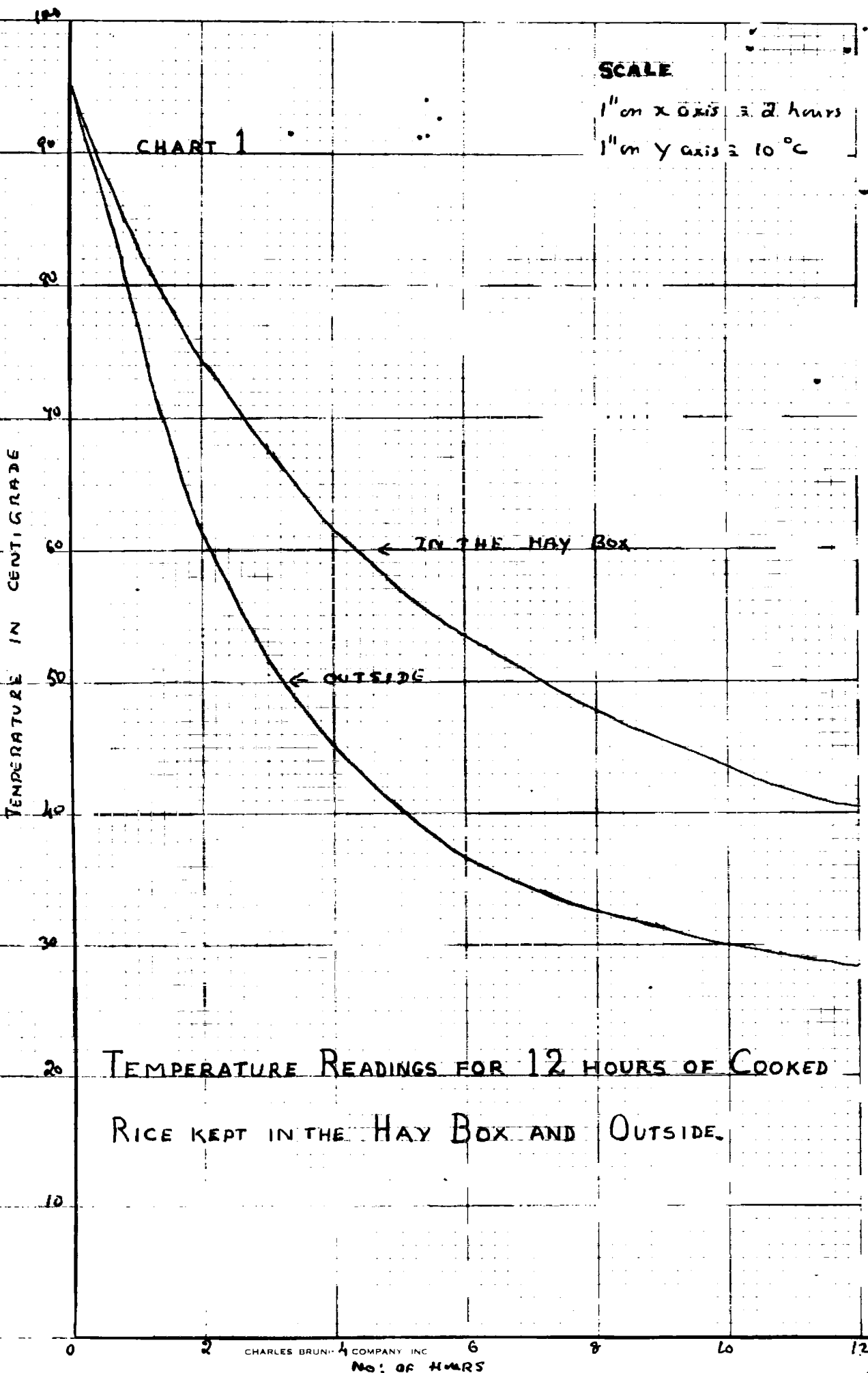
The room temperature was recorded in Table XX to see whether or not there was any great variation in it during the period studied. As the maximum change at any unit interval was only 0.6°C , the effect of the room temperature on the temperature retention was considered negligible.

From Table XX, it can be seen that the temperature of the rice kept in the Hay Box was 40.2°C , at the end of 12 hours, while that of rice left outside was only 28.2°C . The fall in temperature as shown in chart I of the rice in the Hay Box was very slow, while the fall in temperature of the rice left outside was rapid. Consequently the temperature retention for the rice kept inside the Hay Box was significantly greater than that left outside. This was because of the insulation in the Hay Box which prevented heat loss from the hot food. When the sample was left outside, heat from the hot food was transmitted more quickly to the atmosphere as there was no insulation, resulting in a rapid fall of temperature.

Thus, the Hay Box retained heat efficiently. Therefore, it can be used to store hot foods and keep them warm till the time of serving, provided the foods are of the type that will not incur nutritional losses due to remaining in prolonged heat.

f) Initial Cost and Care of the Hay Box

The Hay Box used in this study was made to special order, conforming to certain specifications, like uniform thickness of the planks, lid, padlock etc. Therefore, the cost of



construction was Rs. 5.80. However, when the Hay Box is improvised utilizing the available resources such as old boxes for outside containers, and old coarse cloth for the cushion, the cost may amount to nothing since labour is available free in many a rural home.

The maintenance of the Hay Box does not cost anything since all that is required is keeping the hay clean without getting soiled by soot, or cooked foods and daily drying in the sun for an hour or two.

The only recurring expense is likely to be with regard to purchasing new hay to change the old, once a fortnight, if hay is not available at home. Hence, the Hay Box is a very inexpensive equipment, with great possibilities for saving money, labour and time.

V SUMMARY AND CONCLUSIONS

1. A scientific study of the efficacy and economy of the Hay Box, an improvised fireless cooker was undertaken.
2. The reactions of some rural and urban homemakers who were using the Hay Box were collected through questionnaires and interviews, as basis for the experiments with the Hay Box.
3. The experiments on cooking using the Hay Box, as compared with cooking without using the Hay Box, with reference to the time and fuel consumption, palatability of cooked foods, and heat retention of cooked rice were conducted. Parboiled rice, red gram dhal and potatoes were selected for the study, since ordinarily they take a long time to be cooked.
4. In all, 58 per cent of the cooking time, and 44 per cent of the money spent on fuel, were found to have been saved through the use of the Hay Box, in the cooking of rice, dhal and potatoes.
5. In palatability, the rice and potatoes cooked using the Hay Box were significantly superior to those without using the Hay Box, while the dhal cooked without using the Hay Box was superior to the dhal cooked using the Hay Box.
6. The temperature of rice cooked and kept in the Hay Box was 61.3°C on an average for five hours, while that of rice

kept outside was only 36.3°C. In this case also, the palatability of rice cooked using the Hay Box was superior to the rice cooked without using the Hay Box.

7. The temperature retention of rice cooked using a Hay Box and kept in it was 42.32 per cent at the end of 12 hours, while that of rice cooked without using a Hay Box and kept outside was only 29.68 per cent.
8. The cost of the Hay Box used for this study was Rs. 5.80, which if improvised in the home would be negligible.
9. This study has thus shown that the Hay Box is a convenient, inexpensive, labour saving device for good home management.

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A P P E N D I C E S

APPENDIX I
QUESTIONNAIRE GIVEN TO THE RURAL HOMEMAKERS



POST CARD
புரூ கார்ட்
THE ANSWER CARD IS INTENDED FOR THE ANSWER
கேள்வி கார்டு என்பது கேள்வி
ADDRESS ONLY
மட்டும்

தேதி

என் பெயர்

கூர்..... விலாசம்.....

நான் மனையியல் முகாமில் இருந்த தேதி, மாதம், ஆண்டு

1. உங்கள் வீட்டில் சமைப்பதற்கு வைக்கோல் பெட்டி உபயோகிக்கிறீர்களா?
2. உபயோகிப்பதானால், அதை ஏன் உபயோகிக்கிறீர்கள் என்பதற்கு 5-காரணங்கள் எழுதவும்.

- 1.
- 2.
- 3.
- 4.
- 5.

அதனால் ஏற்படும் முக்கிய பிரமங்களில் மூன்று எழுதவும்.

- 1.
- 2.
- 3.

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APPENDIX II

INTERVIEW SCHEDULE TO THE RURAL HOMEMAKERS

Date:

Address:

No. in the family:

Age composition:

Income:

Occupation:

What is the cost of the Hay Box?

What is the material of the box used?

What is the packing material used in the Hay Box?

What is the material of the utensil used in the Hay Box?

What is the shape of the utensil used in the Hay Box?

What are the items of food cooked using the Hay Box?

What are the special preparations cooked using the Hay Box?

What is the proportion of water used for cooking rice?

What is the time for which the contents are kept on fire after adding the rice?

What according to you, are the advantages of a Hay Box?

What are the difficulties in using a Hay Box?

APPENDIX III

RESULTS OF THE TRIANGLE TEST ADMINISTERED ON THE PROSPECTIVE MEMBERS OF THE
PANEL FOR TASTING

Judges.	Number of times consistent in detecting the different sample.	Number of times correct reasons given.							Total.
		Taste.	Doneness.	Texture.	Flavour.	Separateness of grains.	Colour.		
A	5	5	3	3	1	3	2	17	
B	4	1	0	2	1	1	3	8	
C									
D	4	4	0	4	3	0	3	14	
E	4	0	0	1	3	2	2	8	
F	4	4	0	3	0	1	4	12	
G	3	1	1	1	3	1	0	7	
H	3	1	0	0	1	0	0	2	
I									

APPENDIX IV

ANALYSIS OF VARIANCE FOR THE TIME NEEDED ON THE STOVE TO COOK RICE, DHAL AND POTATOES USING AND WITHOUT USING THE HAY BOX

Food.	Source of variation.	Sum of squares.	df	Mean square \bar{p} .	F	Level of significance.
Rice	Total	2648.48	7			
	Between sets	2647.04	1	2647.04	11045	P < 0.01
	Within sets	1.44	6	0.24		
Dhal	Total	574.34	7			
	Between sets	573.76	1	573.76	47.81	P < 0.01
	Within sets	0.58	6	0.12		
Potatoes	Total	770.97	7			
	Between sets	770.28	1	770.28	64.19	P < 0.01
	Within sets	0.69	6	0.12		

Note: For 1 and 6, df., $F_{0.01} = 13.74$; $F_{0.05} = 5.99$

$P > 0.05$ means that the difference between the sets is not significant.

$P < 0.05$ means that the difference is significant beyond 5% level.

$P < 0.01$ means that the difference is significant beyond 1% level- Very significant.

APPENDIX V

ANALYSIS OF VARIANCE FOR THE KEROSENE CONSUMED IN COOKING RICE, DHAL AND POTATOES USING AND WITHOUT USING THE HAY BOX

Food.	Source of variation.	Sum of squares.	df	Mean square.	F	Level of significance.
Rice	Total	1369.5	7			
	Between sets	1352.0	1	1352	463.6	P < 0.01
	Within sets	17.5	6	2.92		
Dhal	Total	336.88	7			
	Between sets	325.13	1	325.13	165.9	P < 0.01
	Within sets	11.75	6	1.96		
Potatoes	Total	2639.88	7			
	Between sets	2628.13	1	2628.13	1340.9	P < 0.01
	Within sets	11.75	6	1.96		

APPENDIX VI

ANALYSIS OF VARIANCE FOR THE PALATABILITY SCORES FOR RICE COOKED USING AND WITHOUT USING THE HAY BOX

Qualities.	Source of variation.	Sum of squares	df	Mean square	F	Level of significance.
Colour	Total	0.12	7			
	Between sets	0.05	1	0.05	4.55	$P > 0.05$
	Within sets	0.07	6	0.011		
Separateness of grains	Total	2.46	7			
	Between sets	2.42	1	2.42	363.00	$P < 0.01$
	Within sets	0.04	6	0.0067		
Fluffiness	Total	1.26	7			
	Between sets	0.18	1	0.18	1.00	$P > 0.05$
	Within sets	1.08	6	0.18		
Odour	Total	0.68	7			
	Between sets	0.41	1	0.41	8.2	$P < 0.05$
	Within sets	0.27	6	0.045		
Tenderness	Total	0.40	7			
	Between sets	0.25	1	0.25	10.00	$P < 0.05$
	Within sets	0.15	6	0.025		

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Qualities	Source of variation	Sum of squares	df	Mean square	F	Level of significance.
Doneness	Total	0.94	7			
	Between sets	0.18	1	0.18	1.38	$P > 0.05$
	Within sets	0.76	6	0.13		
Taste	Total	0.76	7			
	Between sets	0.05	1	0.05		
	Within sets	0.71	6	0.12	0.42	$P > 0.05$
Total points	Total	13.76	7			
	Between sets	10.58	1	10.58	19.96	$P < 0.01$
	Within sets	3.18	6	0.53		

APPENDIX VII

ANALYSIS OF VARIANCE FOR THE PALATABILITY SCORES FOR DHAL COOKED USING AND WITHOUT USING THE HAY BOX

Qualities.	Source of variation.	Sum of squares	df	Mean square.	F	Level of significance.
Odour	Total	1.275	7			
	Between sets	0.005	1	0.005	0.024	$P > 0.05$
	Within sets	1.27	6	0.21		
Tenderness	Total	3.44	7			
	Between sets	2.42	1	2.42	14.25	$P < 0.01$
	Within sets	1.02	6	0.17		
Doneness	Total	3.88	7			
	Between sets	1.87	1	1.87	5.61	$P > 0.05$
	Within sets	2.005	6	0.34		
Taste	Total	0.28	7			
	Between sets	0.005	1	0.005	0.11	$P > 0.05$
	Within sets	0.27	6	0.045		
Total points	Total	13.88	7			
	Between sets	8.41	1	8.41	9.24	$P < 0.05$
	Within sets	5.49	6	0.91		

APPENDIX VIII

ANALYSIS OF VARIANCE FOR THE PALATABILITY SCORES FOR POTATOES COOKED USING AND WITHOUT USING THE HAY BOX

Qualities	Source of variation	Sum of squares	df	Mean square	F	Level of significance.
Odour	Total	0				
	Between sets	0				
	Within sets	0				
Doneness	Total	2.77	7			
	Between sets	1.81	1	1.81	11.51	$P < 0.05$
	Within sets	0.96	6	0.16		
Taste	Total	0.24	7			
	Between sets	0.05	1	0.05	1.60	$P > 0.05$
	Within sets	0.19	6	0.032		
Total points	Total	2.48	7			
	Between sets	1.28	1	1.28	6.40	$P < 0.05$
	Within sets	1.20	6	0.20		

APPENDIX IX

ANALYSIS OF VARIANCE FOR THE PALATABILITY SCORES FOR RICE COOKED USING AND WITHOUT USING THE HAY BOX, TASTED FIVE HOURS AFTER REMOVING THE SAMPLES FROM THE FIRE

Qualities	Source of variation	Sum of squares	df	Mean square.	F	Level of significance.
Colour	Total	0				
	Between sets	0				
	Within sets	0				
Separateness of grains	Total	3.35	5			
	Between sets	3.24	1	3.24	116	$P < 0.01$
	Within sets	0.11	4	0.028		
Odour	Total	0.84	5			
	Between sets	0.84	1	0.84	∞	$P < 0.01$
	Within sets	0.00	4	0.00		
Texture	Total	0.78	5			
	Between sets	0.67	1	0.67	23.9	$P < 0.01$
	Within sets	0.11	4	0.028		
Taste	Total	0.26	5			
	Between sets	0.008	1	0.008	0.13	$P > 0.05$
	Within sets	0.25	4	0.063		
Total points	Total	4.29	5			
	Between sets	3.84	1	3.84	34.9	$P < 0.01$
	Within sets	0.45	4	0.11		