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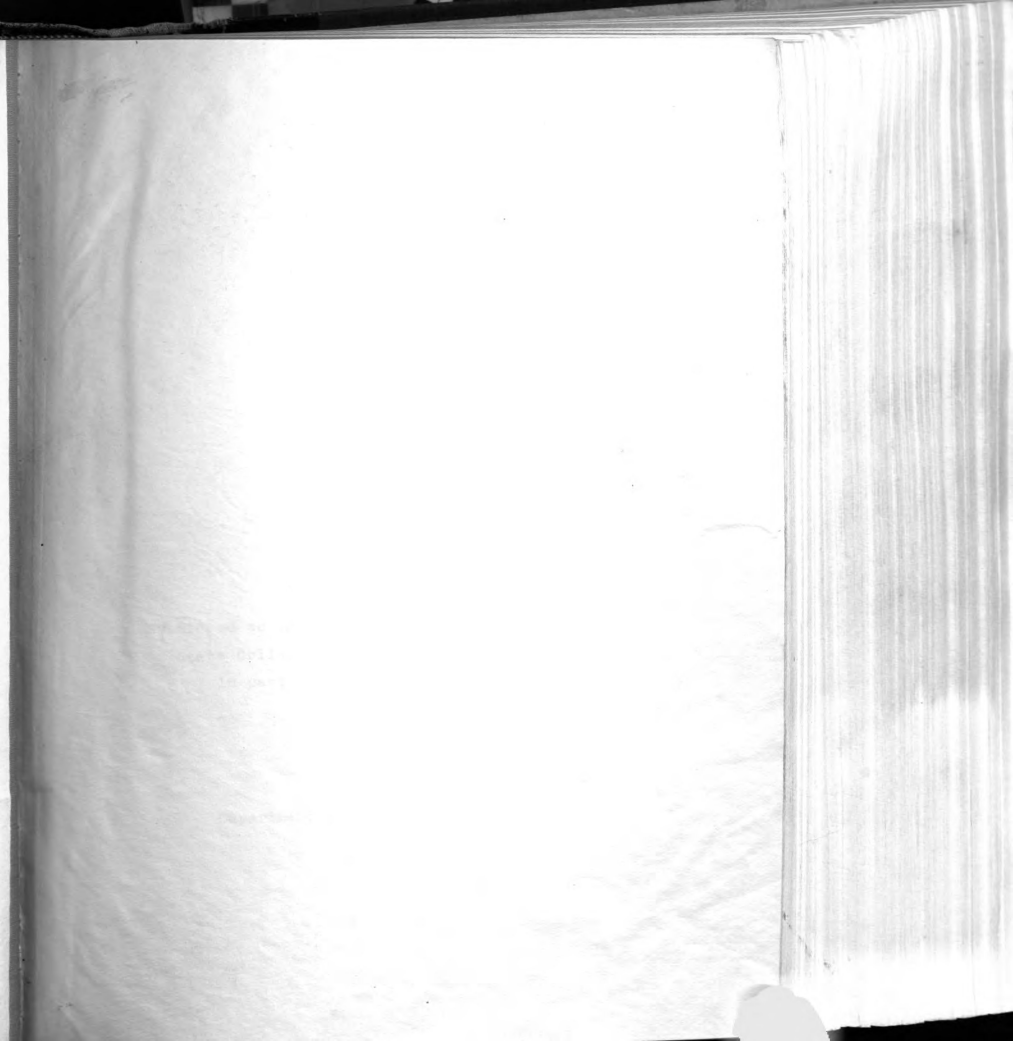
GURBUX KODUMAL CHUGANI

has been accepted towards fulfillment
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W. Farrell
Major professor

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"ELECTRIFICATION OF RURAL INDIA"

by

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Agricultural Engineering

A THESIS

Submitted to the School of Graduate Studies of Michigan

State College of Agriculture and Applied Science

in partial fulfillment of the requirements

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MASTER OF SCIENCE

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OUTLINE OF WORK

- I. FOREWORD.
- II. PREFACE.
- III. ACKNOWLEDGMENTS.
- IV. TABLE OF CONTENTS
- V. LIST OF ILLUSTRATIONS.
- VI. INTRODUCTION:

General Introduction to the Problem:

General conditions of food and agriculture in India. Famines. Early agriculture progress.

Need for This Work:

The present agricultural conditions in India. Existing food shortage and shortage of agricultural labor in various parts of India.

Objects of This Work:

1. To review the history of rural electrification in the United States.
2. To review the difficulties that arose in the way of extending electricity to the farms in the U.S.A.
3. To study the methods employed by the Government and private agencies in the extension of electricity to the American farms.
4. To study the social and economic importance of rural electrification in the United States.
5. To study the various possible uses of electricity on the farms in the U.S.A
6. To study the cost of ownership and operation of the electrical appliances and equipment most commonly used on American farms.

7. To study the present status and the future program of the development of rural electrification in the U.S.A.
8. To study the agricultural conditions existing in India.
9. To study the extent of electrical power consumption in India as compared to other countries.
10. To examine the probable difficulties in the extension of electricity to the farms in India.
11. To determine the factors essential for widespread use of electricity on the farms in India.
12. To draw conclusions regarding the future of rural electrification in India.

Scope of This Work:

No previous literature directly pertaining to the electrification of rural areas in India, has been published either in India or in the U.S.A. This work is intended to survey the existing literature and the work done on rural electrification in the two countries. It is a maiden attempt to correlate the data and the statistics available in the field of rural electrification in India and in the U.S.A. The data is obtained from the government publications, government departments and the manufacturers by request. No experimental or laboratory work is involved. Wherever necessary or desirable, the author undertook tours to get first hand information and picturesque impressions concerning various projects.

Due to the almost entire absence of rural electrification in India, the cost of ownership and operation of electrical appliances, could not be worked out for the Indian conditions.

Personal views of the author are avoided as far as possible. Only authentic views are quoted indicating the source of information wherever possible.

This text deals with the development of the rural electrification in an attempt to bring out as clearly as possible the fundamentals of a successful effort in extending electricity to the rural areas. These fundamentals are arrived at by studying the various stages of the development of rural electrification and the methods developed as a result of experience in the United States. An attempt is made at applying these fundamentals to the existing agriculture conditions in India. Finally the conclusions are drawn regarding the possibility of electrifying Indian farms and the future of rural electrification in India.

Method of Procedure:

In the earlier chapters of this text, a study of the rural electrification and the methods

of using electricity on the farms in the United States is made. Its social and economic importance to the nation is indicated. Later chapters deal with the various uses of electricity and the economics of the most commonly used electrical equipment on the farms in the U.S.A.

A chapter indicating the probable obstacles in the way of rural electrification in India is included.

Based on the study and comparisons above, conclusions are drawn regarding the future of rural electrification in India.

A summary of this work is given at the end of the text. Then follow the footnotes, literature cited and bibliography respectively.

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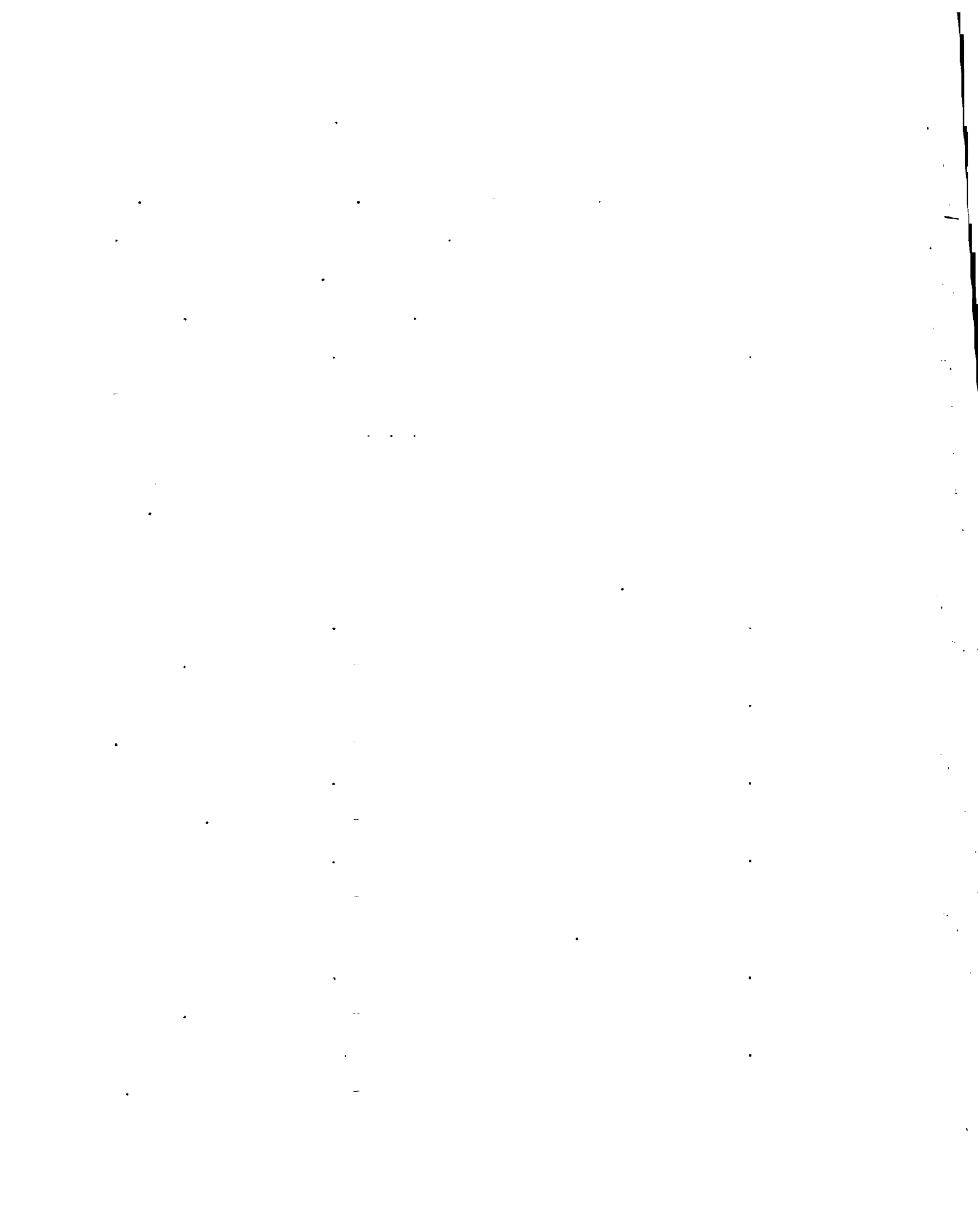
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PREFACE.

This book is dedicated to the millions of farmers and landowners in India whose unending efforts towards increased agricultural production during the past centuries have proved inadequate for the minimum needs of India. It is a maiden attempt intended to bring to the people of India the knowledge of the benefits of mechanical methods and of using electric power on the farm. Besides, it outlines the most suitable methods of promoting the use of electricity on the farms in India.

The objects, need and the scope of this work are clarified in the introduction. Before writing this book, the author has had an occasion to travel in more than twenty States of the Union. Observations made during the tours are included in this work. Wherever possible, photographs have been included to give clear and picturesque impressions to the readers.

The text of this book deals with the development aspect of rural electrification in the U.S.A. in an attempt to bring out as clearly as possible the fundamental principles of a successful effort in extending electricity to the rural areas. These fundamentals are arrived at by studying the various stages of the development of rural electrification and the methods developed as a result of the experiences gained in the United States. An attempt is made at applying these fundamental principles to the existing agricultural conditions in India.

The subject matter has been divided into seventeen chapters. The first three chapters describe the progress of rural electrification and its importance in the social and economic development in the United States. The obstacles in the way of extending electricity to the million of American farms and the measures taken in counteracting those obstacles are discussed in these chapters.

Chapters IV to XI describe the various methods of using electricity as observed on the American farms. In Chapter XII the most common uses of electricity on average American farms are indicated in preferential order. Approximate cost of the appliances and the equipment necessary for the household purposes is calculated showing electrical energy required for their operation.

Probable obstacles in the way of electrification of rural India are outlined. Factors essential for the extension of electricity to the millions of Indian farms are determined. The possible methods of reducing the cost of supplying electrical energy to the rural areas in India are indicated. Finally the future of rural electrification in India is indicated in the concluding chapter.

A short summary of this work is given after the concluding chapter.

The numerical figures appearing against certain words and phrases in the text refer to the footnotes which follow the summary. Quotations have been marked with alphabetical letters and their source stated against the respective

letters in the literature cited following the footnotes. Finally a short bibliography is given for the assistance of those who may carry on further study of the subject.

It is hoped that the contents of this book will find their way through the various channels to the millions of farmers and land-owners in India who will in the course of time adopt the mechanical methods of farming and production and for whose benefit this work is undertaken.

East Lansing, Michigan.

U.S.A. - November, 1946

G. K. Chugani

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East Lansing, Michigan.

U.S.A. - November, 1946

G. K. Chugani

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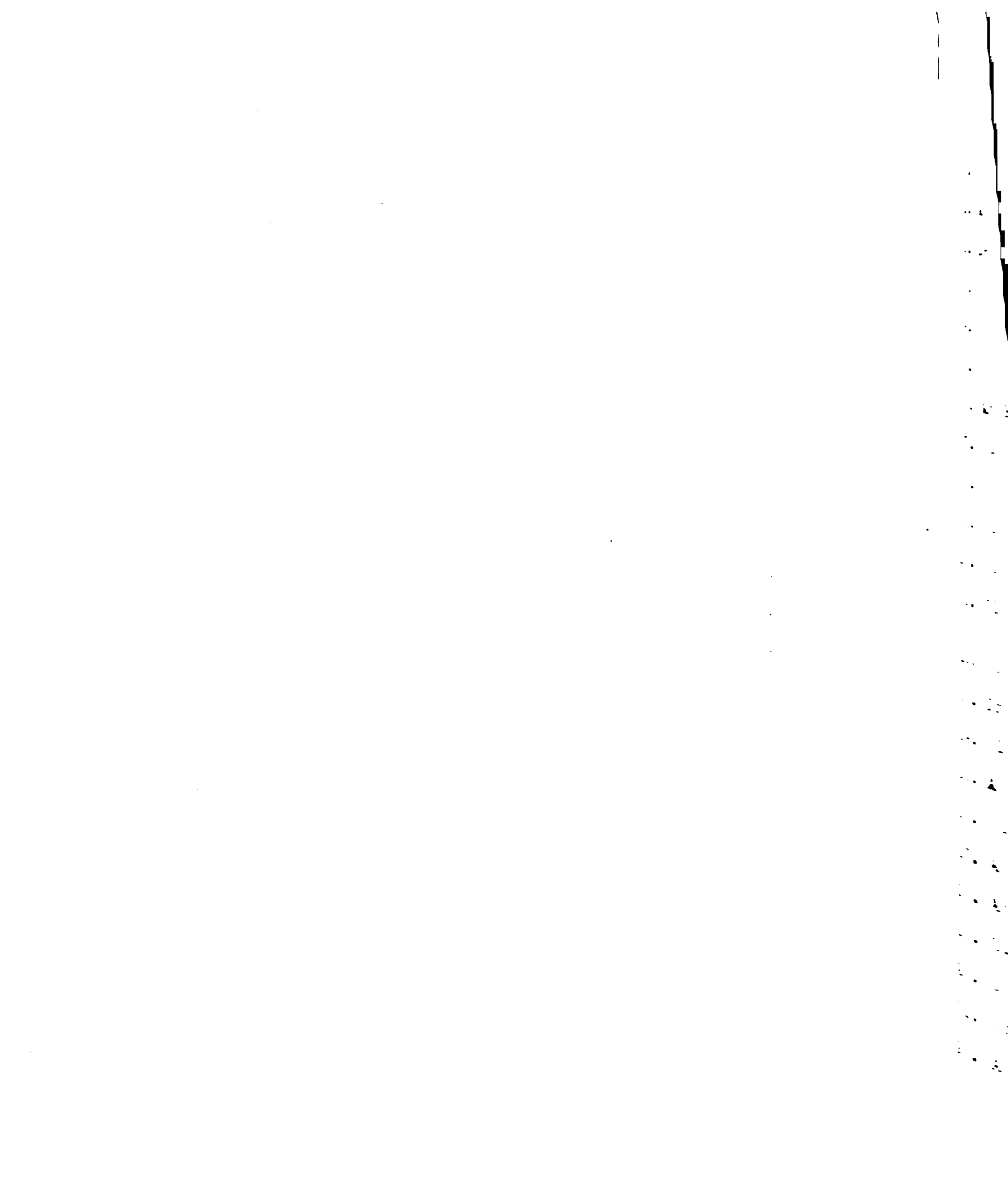
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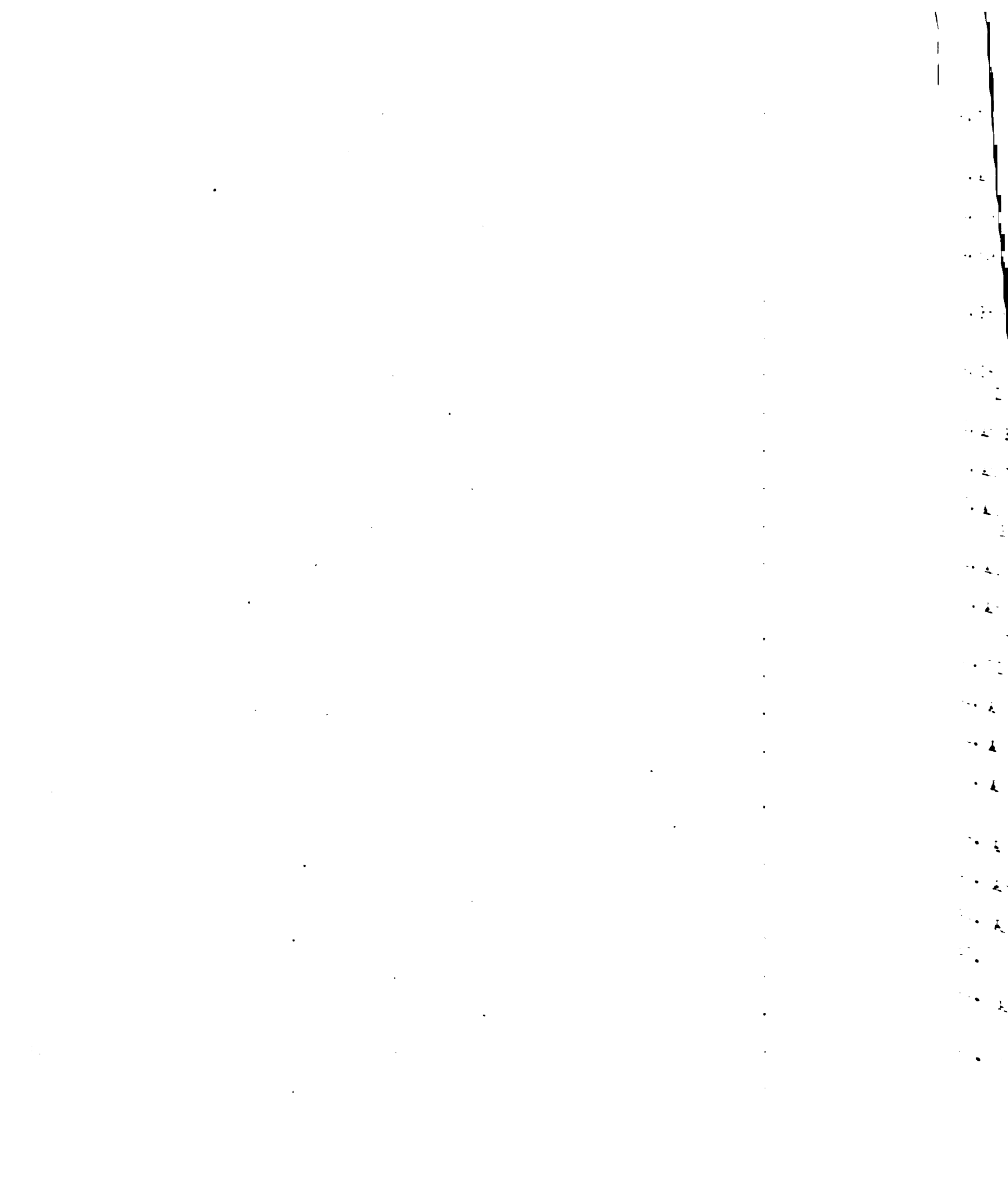
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INTRODUCTION.

General Conditions of Food and Agriculture in India:

India has been known for centuries as an agricultural country. Due to the almost unlimited variety of soils, climate and rainfall, it is possible to grow almost any crop known to agriculture on the Indian soils. Yet India has had to face famines from time to time and pay a heavy toll in the form of millions of human lives and cattle. This state of affairs has not been fully explained. Attempts have been made to plan adequate production. Numerous commissions have been appointed to investigate the causes of famines and suggest remedies. Experts have been invited from European countries to suggest improvements in the methods of agricultural production. Research institutions have been set up. In spite of all these efforts, the agricultural conditions in India have not materially changed from what they were sixty years ago.

Early Efforts of the Government to Relieve Famines:

The Government Department of Agriculture was first started in India in 1771, after the severe famine in the Province of Orissa¹ in the year 1766-67. The failure of this department is evident from the great South Indian famine of 1876-78 in which 5,250,000 lives were lost in British India alone. The Department of Agriculture was therefore closed down in 1878 and a Famine Commission

appointed. As a result of the report of the Commission in 1880, the Department of Agriculture was reopened in 1881. Famines continued to occur, the most important being the great famines of 1896-97, 1899-1900 and the most recent famines of 1943-46.

After extensive tours of India, in his report submitted in 1893, Dr. Voelcker, an expert chemist, described the differences among the agricultural practices existing in various parts of the country as follows:^a

1. Those inherent in the people as 'cultivators',² viz. distinctions of races and castes.
2. Those due to external surroundings, viz, climate, soil, rainfall, irrigation facilities, availability of manure, grazing and fuel wood facilities, etc.
3. Those due to want of knowledge and education, viz. diversity of agricultural practices.

Dr. Voelcker stressed the need for high class agricultural education facilities in India. He suggested establishment of agricultural colleges, research institutions, experimental and demonstration farms and provision of "Fuel and Fodder Reserves."³ He indicated that the racial and caste distinctions would vanish with agricultural improvement. Raising of the standard of living of the peasant population appeared to him essential for the industrial development of the country. Besides, Dr. Voelcker suggested intensive and extensive farming, improvement in land tenure, manuring and fertilizer practices, land drainage and irrigation facilities, cattle breeding, quality of food crops, crop disease and pest control measures, rotation and

and distribution, methods of inquiry and statistics.

Need for This Work:

Strangely enough, the conditions in India today are little better than in the latter part of the nineteenth century described in Dr. Voelcker's report. The Famine Commission appointed after the famine of 1943 under the leadership of Sir John Woodhead made recommendations on the lines similar to those suggested by Dr. Voelcker in 1893, stressing among other things, the need for agricultural education, irrigation, statistics, intensive farming, extensive farming, crop disease and pest control, and improvement in manuring and other production practices. An extract from the report of the Famine Enquiry Commission published in 1945, follows:^b

"The food position in relation to population appears to be in certain respects less favorable than in 1880. There is, however, no fully satisfactory evidence that the standards of nutrition have declined since that date. India, in relation to the existing stage of her industrial and economic development, is overpopulated, increasing pressure of population manifesting itself in various ways. On the other hand, the advance of science has opened up possibilities of increasing food production which did not exist sixty years ago."

In the concluding chapter of the Famine Commission's report, Sir John Woodhead states:^c

"In our report we have insisted that India does not lack the material resources necessary for advancement and prosperity, but these can be developed only by the efforts of human beings - by the governments and people of India - and success depends on the spirit which sustains the country in the tremendous task with which it is faced."

As a result of public agitation in India and realization by the government during the World War II that the

delay in development of industry and agriculture in India was neither desirable nor possible, an all out program of development was adopted by the government. A separate Department of Planning and Development was created and suggestions have been made to continue the existence of the Food Department temporarily created during the war. The proposed activities of the Department of Planning and Development include a variety of long and short term programs for the development of industry, communications, highways, various branches of agriculture engineering, and in numerous other departments.

An acute shortage of agricultural labor was experienced in certain parts of India during World War II due mainly to the development of industries, enlistment in the war services and prevailing diseases and illness in the rural areas. Need for mechanized cultivation was therefore keenly felt. The agricultural production statistics of 1945 and 1946 indicate a shortage of food grains in India to the extent of approximately four million tons. Based on the results of the famine in 1943, the lives of 12 to 15 million people are in danger unless assistance is given from other countries, primarily the United States, which is the only country at present producing appreciably more than its local requirements. Need for mechanized cultivation and the use of electrical power on the farms in India therefore cannot be overemphasized.

Objects of This Work:

The objects of this work may be summarized as follows:

1. To review the history of rural electrification in the United States.
2. To review the difficulties that arose in the way of extending electricity to the farms in the U.S.A.
3. To study the methods employed by the Government and private agencies in the extension of electricity to the American farms.
4. To review the social and economic importance of rural electrification in the United States.
5. To study the various possible uses of electricity on the farms in the U.S.A.
6. To study the present status and the cost of ownership and operation of the electrical appliances and equipment most commonly used on American farms.
7. To study the future program of the development of rural electrification in the U.S.A.
8. To study the agricultural conditions existing in India.
9. To study the extent of electrical energy consumption in India as compared to other countries.
10. To examine the probable difficulties in the extension of electricity to the farms in India.
11. To determine the factors essential for widespread use of electricity on the farms in India.
12. To draw conclusions regarding the future of rural electrification in India.

CHAPTER I

Early History of Electrification in
the United States:

In the United States, rural electrification is of recent development. The previous generation of farmers saw the benefits of mechanized farming and the advantages of tractor power as compared to the animal power on the farm. The present generation has seen the tremendous advantage of electricity on the American farms and in the farm homes.

Electricity was introduced into the United States in the latter part of the nineteenth century. The first central station service was started in New York in 1882 by Thomas A. Edison through the generating station at Pearl Street, New York, N.Y. Until about 1910, the electrical installations in the country were designed for 2,200 volt transmission. Long distance transmission was almost impossible at such low voltages. High voltage transmission at 110,000 volts and 220,000 volts was used in the 2nd decade of the twentieth century when low voltages were stepped up through transformers and carried over longer distances at high voltages. These high voltages were stepped down before distributions at low voltages. The highest transmission voltage since achieved is 287,000 volts at Boulder Dam supplied by the Bureau of Light and Power in the city of Los Angeles, Cal. over a 270 mile transmission line.

The Committee on Electricity in Rural Districts:

In 1911, the Committee on Electricity in Rural Districts appointed by the National Electric Light Association submitted its formal recommendations as follows:^d

1. That the U.S. Department of Agriculture be urged to get out a bulletin on the use of electricity on the farm.
2. That resolutions like those adopted by the National Natural Gas and Gasoline Engine Trades Association be sent the Secretary of Agriculture.
3. That electric motorizing of farm machinery be investigated.
4. That publicity experts be employed.

In their report, the Committee stressed the need for education of the farmers, publicity and the cooperation of agricultural colleges and the U.S. Department of Agriculture in their propaganda. They recommended the supply of electricity to the farms at the same rates as prevailing in the neighboring towns and cities. Unless the rates were low enough, it was feared that the high cost of electrical energy would prevent its penetration into the farms.

The First Rural Electrification Campaign:

The Committee's recommendations were carried out. A census of electrified farms was made all over the country. Representatives of the utility companies agreed in opinion, to the advantages of farm electrification but were unable to supply electricity to the farms except at prohibitive cost as would be permitted by profitable business enterprise. As the "Thought once expressed never dies", so did



the thought of electrifying American farms once expressed, keep itself alive. The public interest in rural electrification was aroused. This was the beginning of the first rural electrification campaign.

Ineffectiveness of the First Campaign:

As a result of the efforts of this campaign, the Government propaganda and the technical developments in electrical engineering, electricity was extended to a few farms scattered all over the United States. Statistics were compiled. It was found that in 1924, only 2.6 percent of the farms in the United States had central station service. At that time, a very negligible percentage had individual generating plants. The progress in rural electrification fell short of the expectations. The primary cause of the ineffectiveness of the campaign was the lack of knowledge and education among the farmers regarding the miraculous benefits of electrical energy. Detailed description of the causes of the failure of this first effort are discussed in the next chapter.

The Committee on the Relations of Electricity to Agriculture:

Soon after the widespread agricultural depression in the years following the First World War, the need for increased agricultural production and falling prices, gave impetus to the use of electricity on the American farms. In 1923, a Committee on the Relations of Electricity to Agriculture (CREA) was appointed from among the members of National Electric Light Association and the American Farm

Bureau Federation. This Committee was primarily a fact-finding Committee with headquarters at Chicago. Later, the CREA consisted of the representatives of manufacturers, U.S. Departments of Agriculture, Commerce and Interior, American Societies of Electrical and Agricultural Engineers; Power companies; American Farm Bureau Federation; American Home Economics Association; General Federation of Women's Clubs; National Association of Farm Equipment Manufacturers and individual manufacturers.

The Second Rural Electrification Campaign:

The formation of the CREA earmarked the second all out attempt to examine the possibility of electrification of the farms in the United States. The general trend of thought of the members of the CREA was towards private ownership of public utilities rather than Federal or State Control. They firmly believed that government control would be ineffective in economic problems. The CREA therefore embarked on a farmers' educational program. Various methods of education were adopted such as extension bulletins, new letters, technical bulletins, trade journals, press articles, annual reports, etc. Agricultural Experimental Stations were established at the Agricultural Colleges in most parts of the country and the results of their researches disseminated among the farmers through the United States, Extension Service⁴ and other channels. The research at the experiment stations was carried on by the experiment station staff with the cooperation of the teaching staff of

agricultural colleges which were already established.

Twenty-seven different states appointed such committees (CREA) for similar activities in the respective states.

The First Experimental Rural Electrical Line:

The first experimental rural electrification line was installed in the State of Minnesota under the Red Wing Project in 1923. It was 6.3 miles long and cost \$1770 per mile. Results indicated that the energy consumption cost varied from nearly 40¢ per K.W. hr. if the monthly power consumption did not exceed 20 K.W. hr. to 5.0¢ per K.W. hr. approximately if the monthly power consumption exceeded 300 K.W. hr. For the year 1924, the average electrical consumption for each family supplied from the Red Wing Project was 151 K.W. hr. per month at an average cost of 10.28¢ per K.W. hr. delivered to the customer.^e In 1927, the average monthly consumption per customer for the same experimental line was 265 K.W. hr. at an average cost of 6.46¢ per K.W. hr. These costs were however still too high for the farmer.

Extinction of the CREA:

After a ten year struggle with the question of rural electrification with the support of the utilities, the CREA began to dwindle, not because it had failed but because its job had been done. It had pioneered the electrification of rural America. The public interest was aroused by the preliminary findings of the CREA indicating vast

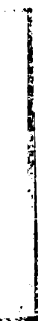
scope for rural electrification in the United States. By 1939, the Rural Electrification Administration had come into existence. It had begun the wide-spread of promoting the use of electricity on the farms all over the country. The continuance of the CREA had therefore little use. It was therefore that the CREA was formally closed down in 1939. The experimental work was however continued at the agricultural colleges.

Two Schools of Thought:

The economic condition of the American farmers in the thirties was depressing. The authorities widely declared that for the economic and social rehabilitation, rural electrification was the first essential. The utility companies could not relieve the situation on profitable business basis. At this stage there were two schools of thought. The utilities suggested a raise in the national level of farm income to a point where electricity could be supplied to farms on profitable business terms. The agricultural authorities vehemently believed that the cost of electrical service must be lowered to a point where the farmers could pay for it at the existing level of incomes and thus increase their incomes. President Franklin D. Roosevelt was inclined towards the latter school of thought.

The Turning Point in the Government Efforts:

Subsequent efforts at rural electrification with the President's support were on a nation-wide scale. Federal



funds were sought and granted. This change in the financial aspect marked the turning point in the Government efforts and rejuvenated the progress of rural electrification in the United States.

Need for Federal Aid:

By 1935, the sponsors of rural electrification having tried for over 20 years, the various methods of extending electricity to the farms, had come to believe that federal aid was essential before the farmers could enjoy the benefits of cheap electrical power. The repeated attempts for the electrification of American farms before 1935, had served one important purpose; that is they created a nationwide interest in rural electrification and convinced the Power Supply Companies as well as the consumers that the presence of electric power on the farm will be of tremendous advantage in national economy. This was indeed a great accomplishment and formed the basis of later developments in rural electrification.

Creation of the Rural Electrification Administration (REA):

Due to pressure from popular national organizations such as; American Farm Bureau Federation, National Grange, etc. and the national need for rural electrification, President Roosevelt solicited allotment of funds from Congress for rural electrification as an emergency relief project to relieve unemployment and to promote private and public business enterprise. In the Emergency Relief Appropriation Act of April 8, 1935, the Congress approved \$100,000,000



FIG. 1. A farmers' Cooperative in Michigan. (Courtesy: Michigan State College)

for rural electrification. On May 11, 1935, the Rural Electrification Administration was created to promote the generation, transmission and distribution of electrical energy in rural areas.

Progress of Rural Electrification Under the REA:

At this stage, rural electrification in other countries such as; Holland, Belgium, Norway, Sweden, Denmark, France, Germany, the Netherlands, Australia and New Zealand had greatly advanced ranging from 50 to over 100 percent of the total farms as compared to about 11 percent in the United States. In the vicinity of Ontario, Canada, the percentage of electrified farms was in the neighborhood of 15%.

The Rural Electrification Cooperatives:

In the United States, the state of Washington had the lead in rural electrification. Several non-profit electric cooperative companies were established. These companies purchased power from the central municipal generating plants and distributed it among themselves at comparatively low costs. In the state of Washington these cooperative companies purchased power at about 7 mills (i.e. 7/10¢) per K.W. hr. and were able to distribute at 3¢ a K.W. hr.^f Farther East of Washington state, the retail costs of electrical energy were a little higher ranging from 3¢ to 5¢ a K.W. hr. By the end of 1935, thirteen states experienced the birth of rural electrification cooperatives. In all, 46 such cooperatives were established on non-profit-

able basis.

The Rural Electrification Act of 1936:

On May 20, 1936, the Congress passed the Norris-Rayburn Act extending the life of REA by 10 years. The bill was introduced in the Senate by Senator George W. Norris, of Nebraska, and in the House by Representative Sam Rayburn, of Texas; hence the name. Under the Act, the REA was made a confirmed lending agency of the Federal Government under an Administrator appointed for a period of 10 years at an annual salary of \$10,000.

The Functions of the REA:

The REA was authorized to make loans to persons, corporations, States, Territories of the United States, municipalities, cooperatives, non-profit organizations, peoples' utility districts and associations or companies organized on limited-dividend basis, up to a maximum of \$40,000,000 apportioned among the States. Loans were to be made against adequate securities for financing construction and operation of generating plants, transmission lines and distribution lines for supplying electricity to persons in rural areas who were not receiving central station service.

The REA was also empowered to make loans for wiring the premises and the purchase and installation of electrical and plumbing equipment. Preference was to be given to the needs of public and non-profit organizations, companies or bodies. The loans were to be amortized within a period of 25 years. This period has been extended to 35 years

under the Department of Agriculture Organic Act of 1944.^g

Under the provisions of the Act of 1936, the REA was to make loans at low rates of interest. In 1936, these loans were made at 3 percent interest. The rate of interest has steadily been reduced. Under the Act of 1944, the rate of interest has been lowered to 2 percent.^g

The Administrators of the REA:

Mr. Morris L. Cooke was the first Administrator of the REA. Under his able administratorship, strong foundations of the REA were laid. After the resignation of Mr. Cooke in 1937, Mr. John M. Carmody became the Administrator. In 1939, when Mr. Carmody was appointed the head of the Federal Works Agency, Mr. Harry Slattery took charge of the administration of the REA. During his tenure of office, due to the impetus given by war, the REA programs and projects made considerable progress. Since 1945, Mr. Claude R. Wickard the former Secretary of Agriculture has been the Administrator of the REA.

The Basis of the REA Programs:

The basis of the REA programs was the safety of electric installations and simplified rate schedules providing low rates for higher power consumption. The policies of the REA had to be modified from time to time due to opposition from the industry, utilities and certain public organization. Why this opposition and what measures were taken to overcome it, are dealt with in Chapter XIII.

Under the Reorganization Act of 1939^h, the REA was

brought under the Department of Agriculture. Henry A. Wallace was the Secretary of Agriculture then. The staff of the REA was increased. Experimental work was planned on the basis of Regional Electric Service which comprised regions of 100 to 2,500 route-miles of rural lines. These regions covered from one to five counties.

The Task of the REA:

The main task of the REA was to keep the rates low enough to be within the reach of farmers if the REA experiments were to be successful. To the industry this task seemed impossible. But the REA did not give up. The creation of the REA was based on the assumption that rural electrification was possible. And why not? It had succeeded in several other countries such as; Norway, Sweden and Germany. An English poet once wrote:

"He, poor fool!
He didn't know
It couldn't be done; so
He went ahead - and did it!"

So the REA went ahead with their work of rural electrification and did it.

CHAPTER II

The Main Obstacles in the Development of Rural electrification in the U.S.A.

In handling the job of rural electrification, the Government efforts met with numerous obstacles in the form of individual, public and State opposition, the inadequacy of technical developments in production, transmission and distribution, etc. In its report in 1934, the Mississippi Valley Committee explained the causes of slow growth of rural electrification as "the lack of interest by operating companies in rural electrification, high cost of line construction because of the unnecessarily expensive line used, onerous restrictions covering rural line extensions, and high rates".¹

Lack of Engineering Skill:

The primary obstacle was the lack of engineering skill in transmission and distribution of the normal transmission voltages of 2200 volts over long distances. This was overcome when high voltage transmission was perfected. Low voltages were "stepped up" as high as 110,000 volts to 220,000 volts for transmission purposes. These voltages could be easily transmitted over longer distances before being "stepped down" for distribution purposes. Further engineering developments made it possible to build up a network of transmission and distribution lines extending thousands of miles in length.

Lack of Education Among the Farmers:

Second obstacle in the way of rural electrification was the ignorance of the common farmer as to the usefulness of electricity on the farm. He had to be convinced that electrification of his farm would enable him to accomplish heavier jobs in less time with safety and ease in operation. Till the thirties, due to the fact that rural electrification was only a private enterprise and more or less a localized effort by individuals, organizations and power companies involving high costs of installation and power consumption, the common farmer did not believe that electrification was economically possible on the farm.

This lack of knowledge among the farmers was overcome by education of the rural population through the medium of Extension Service⁴, advertisement, propaganda and the press. More experimental stations were established. Demonstrations and fairs were held in the States and counties to demonstrate the use of electrical equipment and appliances. The public was kept informed of the new developments by issuing news letters, broadcasting programs, extension bulletins, technical publications, etc. Experimental rural electrical lines were built to prove by demonstration to the farmer that rural electrification was actually economic under normal conditions. It was proved to the farmer that the presence of electricity on the farm was an asset in the form of safety, ease of operation and in handling heavier jobs in less time.

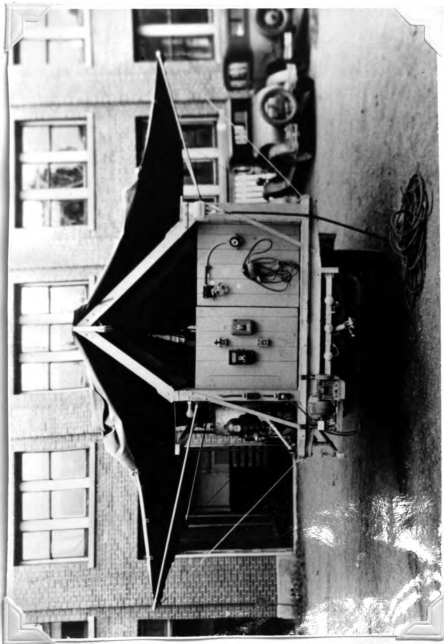


FIG. 2. Demonstrating the use of the farm electrical equipment. This truck mounted with an electrical water pump, was used in a travelling caravan held in Michigan. (Courtesy of Michigan State College)

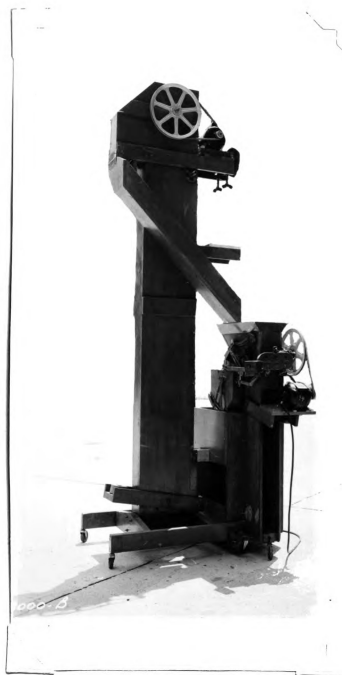


Fig. 3. An experimental model of a vertical cup type elevator. The motor-driven equipment on the right is a capacity measuring device. (Courtesy of Michigan State College)

Omission of Cost Factor in the Early Efforts:

Inspite of the confirmed demand, rural electrification made little headway until the late thirties. One of the main causes of this early failure was that in almost all their early efforts, the cost factor was omitted. In several cases, the farmers were to pay for the installation of the transmission lines and distribution leads, for the wiring and equipment etc. The farmers did not use enough electricity to justify the expenditure involved in the installation of electrical service on individual farms. Added to this was the high cost of power consumed as discussed in the previous chapter. The power companies lowered the rates of electrical energy as far as their business enterprise permitted. Still however, the rates were higher than the farmer's pocket. To bring the initial and operation costs of electrical service on the farms within the financial reach of the farmers, private enterprise was not enough. Large scale effort was necessary. When the program of rural electrification was nationalized and the REA created in the later years, the farmers began to consume more electrical power on their farms which made it possible for both the power companies and the farmers to install electrical service on the farms.

Failure of the effort by Private Companies and farm Organizations:

The attitude of the industry had never been opposed to rural electrification. The utilities were however, un-

able to cooperate unless the returns were at least to pay the cost of supplying electricity to the rural areas. They cooperated with the farm organizations and the CREA in solving the problem. As might have been expected, their efforts achieved only a limited degree of success. Unless the cause was supported by public funds, extensive rural electrification could not be expected.

Ultimately the Federal funds were made available. An Emergency Relief Appropriation Act was passed in 1935 making an allotment of \$100,000,000 for the creation of the Rural Electrification Administration (REA). The aims, objects, functions and powers of the REA have been dealt with in the previous chapter. Further appropriations have been made from time to time for the functioning of the REA and its numerous projects. Until June 30, 1945, the total appropriations amounted to \$564,968,134 including those for the fiscal year 1946 ending June 30, 1946.^j

Opposition from the Utilities and the States:

Under the Emergency Relief Appropriation Act of 1935, the Rural Electrification Administration was an emergency organization for unemployment relief. In bringing about quick relief, the cooperation of the industry, States and the public farm organizations was essential. The States gave a hearty welcome to the REA at the time of its birth. But later, at the instance of the utilities, they did not agree with the Administrator's plan of action. Several States declined to cooperate. Instead they opposed and

created barriers in the way of REA programs.

Undefined Laws Existing in the Various States:

Some States gave the rural electrical cooperatives the same consideration as they gave the public utilities. Thus they claimed regulatory powers over the REA cooperatives. Others claimed no regulatory powers over them since the general statutes of the States authorized non-profit organizations of various kinds. Some States authorized the rural electrical cooperatives by special statute while others declared such cooperatives unlawful. Thus while the installations of transmission and distribution lines by privately owned utilities had the State facilities in the form of the right of eminent domain, the REA program was hampered by varying laws in different States. This confusion was because the nation had the development of rural electrification with unexpected speed. The States were not prepared for the proposed revolutionary changes of rural electrification and the REA programs.

The power companies tended to establish monopoly over power supply. To a certain extent, they had control over the private or municipal competition. As such in the earlier stages they succeeded in preventing the entry of REA in certain States e.g. New York, Rhode Island, Connecticut and Massachusetts. In cases brought before the courts in various States, the judgments were inclined to favor the cause of rural electrical cooperatives and excuse them from the State Supervision because of the futility of

supervision over such non-profit organizations.

Recently as a result of prolonged conflict over the question of the control of Public Utility Commission over the rural electric cooperatives in New York State, Rural Electric Cooperative Act was passed in 1942 to exempt the rural electric cooperatives from the Commission's control.

The utilities feared that the competition with the REA would be detrimental to their business interests. It was explained that there was no conflict of interests between the utilities and the REA since the rural electrical cooperatives were mainly consumers of electricity and it was for the industry to supply electricity to the cooperatives at the rates which the farmers could pay. Despite the utilities continued to oppose the efforts of the REA in the electrification of American farms.

"Spite Lines" Construction by Power Companies:

In the earlier stages, due to its right of eminent domain and priority of interests with the State officials and highway commissions, the industry blocked the way for the REA sponsored rural lines. In several cases the power companies installed short distances of new lines - more expressively called "Spite Lines," - to obstruct the proposed REA lines.

The Right of Way Problems:

Some States refused the right of way for the construction of rural lines on the grounds that they were ugly defacements along the highways which were already overcrowded

with the telegraph and telephone lines. In such cases of State opposition, the farmers cooperated and passed the lines through their farms.

The Ultimate Victory in Overcoming Opposition:

In the continued struggle with the industry, the ultimate victory was won by the REA. Almost all the legal proceedings were decided in favor of the electrical cooperatives. This enabled the REA to work its way into more States every year.

Uniform Laws for Rural Electrical Cooperatives:

The time factor being of essence in the unemployment relief work of the REA programs, it was considered necessary to have uniform laws all over the United States with regard to the REA cooperatives. The idea of uniformity of laws was not entirely new. The Public Works Administration had succeeded in getting uniform laws passed in several States to facilitate PWA projects. Two of these projects provided for the creation of 'farm electrification cooperatives' and 'public power districts'.

The REA therefore proposed and succeeded in getting approved the Rural Electrification Act in 1939. The act exempted the rural electric cooperatives from regulation by the State Commissions, and gave them wide powers including the right of eminent domain. It has since been adopted in most of the States of the Union. At present there are only three out of 48 states which have no rural electric cooperatives, viz; Connecticut, Rhode Island

and Massachusetts.

Fighting the Problem of Interference
With the Telephone System:

A problem of engineering nature was experienced in the extension of rural electric lines to the farms. This was the interference with the telephone system. Where the rural electric lines ran parallel to the telephone wires, the latter picked up induced voltages from the former and created a hum, buzz or other noises in the telephone conversations. This was overcome later in the one-wire installations of the telephone system using the ground as return wire.

In the modern design of telephone lines this interference is eliminated. Some old telephone companies demanded electric cooperatives to pay for modernization of telephone lines to prevent interference with their system. They had the support of the power companies interested in the elimination of electric cooperatives. The REA legal staff fought and won against all this opposition which resulted in its penetration into almost all the states of the Union.

Reduction of Costs:

Before the birth of the REA cooperatives, the customers had to pay for the initial cost of the installation and distribution leads to their farms. This cost was in the neighborhood of \$2,000 to \$2,500 per mile of electrical line. Besides the customer had to pay for the maintenance of the installation. The companies charged the maintenance

cost amounting to about 8 percent of the initial cost of the entire installation annually. Taking for example an average of three customers to a mile⁵ of the electric line which cost an average of \$24,000 per mile, each farmer invested \$300. of his valuable capital. His annual expenses for maintenance were:

Interest at customary rate of 6 percent on \$300.	\$48.00
Maintenance charge by the power companies at per- cent on the initial in- vestment viz. \$300.	\$64.00
	<u>\$112.00</u>

The cost of electrical energy for a low - marginal consumer (i.e. a customer using 100 K.W. hr. per month)⁵ was about 12¢ per K.W. hr., that is \$144.00 a year. Thus a low-marginal consumer had to pay \$256.00 for 1200 K.W. hr. energy consumed annually or 21.33¢ per K.W. hr.

For a well electrified farm, the monthly consumption of electrical energy averages around 500 K.W. hr. For such increased consumption, the energy cost was about 6.00¢ per K.W. hr. In the example above, the cost of electrical energy for a 500 K.W. hr-a-month consumer would be \$360.00 for 6000 K.W. hr. energy consumed annually or 7.87¢ per K.W. hr. nearly including maintenance expenses.⁶

The main task of the REA was to lower this enormous cost of electrical energy. The only method to gain the farmers' favor was for the REA to supply electrical power within the economic reach of an average farmer. The task

was bodily approached with the result that the REA cooperatives were supplying energy @ 4½¢ per K.W. hr. Even prior to the creation of the REA the TVA started in 1933 was charging a maximum rate of 3¢ per K.W. hr. for domestic purposes. These rates have progressively decreased. In some cases they have been reduced to less than 2¢ per K.W. hr. How the REA was able to achieve these low rates sounds mysterious. The remaining part of this chapter will throw some lights on that mystery.

The Development of Engineering Skill:

A factor of prime importance in lowering the costs was the development of engineering skill. The engineers of the Tennessee Valley Authority (TVA) succeeded in erecting transmission lines with widely spaced poles viz. 400 feet apart instead of 200 or 250 feet spacing in practice before. Conductor wires were redesigned to last for 25 years and resist varying weather conditions, winds, rains and snow. The conductors had to be strong enough to support their own weight in all weather conditions. The use of creosoted pine poles instead of the cedar poles and introduction of steel reinforced conductors lowered the costs appreciably.

For the small farmer, the cost of the transformer²⁹ and meter had to be lowered. 600 watt transformers were therefore introduced instead of the 1500 watt transformers in use before. Smaller meters were invented by the rural electrification engineers. Large orders for the transformers and meters were placed by groups of cooperatives thereby

saving in cost. The new meters had a small test light. In case of trouble, if this test light was still in order, probably only the local fuse had blown out which could be replaced without expert service. This saved service expenses to the farmer. The introduction of cyclometer meters further lowered the meter costs. The farmers could read their own meters and keep records on a card. Only periodical checking was necessary. This saved expenses in employing meter readers.

Standardized Distribution voltages for
REA projects:

The rural electrical cooperatives purchased electricity from the power companies which often have varying transmission voltages. This requires different design for all installation equipment including transformers, fuses, meters, insulators, lightening arrestors, etc. for various cooperatives. The REA standardized the distribution voltages at 7200 for all REA cooperatives. This enabled the REA cooperatives to place large orders in groups for their requirements. The manufacturers could foresee the needs of the various cooperatives and reduce costs by way of mass production of the installation.

Loans at Low Rates of Interest:

The terms of the creation of the REA were based on low rates of interest to be charged on the loans made for all rural electrical projects. The loans were made to the cooperatives who in turn made loans to their members. The rates of interest at present charged on such loans is 2%

as against 6½ on customary loans. This in itself results in an annual savings of nearly \$20,000,000 to the rural electrical users.

Reductions in the Rates of Insurance:

Under the Federal Government laws, Workmen's Compensation policies are to be taken out by contractors during the installation of the rural electric lines. These policies are to be taken over by the cooperatives when the installation work is complete. By new laws, REA cooperatives were granted special insurance classification which reduced not only the premiums against the Workmen's Compensation policies but also those against contractor's performance bonds, public liability and property damage, and fidelity bonds from 25 to 50 percent annually.

The quality of installations was improved so as to be more safe and long lasting. National electric safety codes were strictly adhered to. This induced the insurance companies to reduce fire insurance premiums. This saving in insurance premiums alone amounts to several million dollars annually which ultimately reduces the cost of electrical energy.

Partial Exemption in Taxation:

In most of the States, the rural electrification cooperatives were subject to the usual taxation as was imposed upon the power companies. Some States like Mississippi and Kentucky excused electrical cooperatives from taxation entirely. Other states granted them partial relief from

taxes, e.g. Wyoming, Louisiana, Iowa and Colorado. The REA urged only partial relief from taxation and recommended that the electrical cooperatives be taxed according to their ability to pay. The reduction in taxes was another branch chopped off the tree.

Reduction in the Actual Cost of Construction:

The next main item of cost reduction is the cost of actual construction work. New construction techniques were devised. The 'moving belt principle' of construction which has been so well developed in the automobile and other industry in the United States and European countries was adopted. The only difference was that instead of a moving belt or chain passing along a line of workmen, a series of crews of workmen moved along the road. Under this principle the entire labor is divided into small crews of specialized groups. Each group is sent out along the line of construction in waves. For example the staking or laying out of the line starts first. When the staking crew has had enough lead, hole digging crew follows. Then follows a batch of workers distributing the proper size of poles along the line of stakes or holes. Another batch attaches accessories such as; insulators, bolts and nuts, brackets, etc. to the poles. Then follow the crews for setting poles, stretching wire, attaching transformers, connecting branch lines, etc.

This method of construction is also referred to as 'Streamlined Construction'. It gives better turnout of

work and increases efficiency by nearly 60 percent.

The Grouping Plans of Cooperatives:

The cost of wiring, plumbing and the purchase of appliances had to be brought down next. The reduction in these items was possible only to a certain extent by the grouping plans such as; 'group wiring plan', 'group plumbing plan', 'group purchasing plan', etc. The distribution voltages were standardized. This made the design of appliances more uniform and made bulk manufacture of electrical appliances possible. Both these factors coupled with 'group purchasing plan' reduced the cost of the appliances to a certain extent.

Aids to the Consumers:

Aside from these efforts of the Government directly aimed at reducing the costs of electrical energy, aids were given to farm consumers of electricity. These aids were in the form of direct financial help, relieving their personal real estate property from liabilities of the cooperatives of which they were members and in several other forms. Some of these aids to the consumer are described in this chapter.

The rural electrical cooperatives aim at helping those farmers who are willing to help themselves. REA was formed not to give in charity or donations but to make secured loans for rural electrification. Loans were therefore given to the cooperatives only against mortgages on the electrical lines. The mortgages were not on the personal or real estate



FIG. 4. Cooperative method of business is economic for the farmers. This photograph shows a gas station owned by a cooperative in Michigan. (Courtesy: Extension Service, Michigan State College)

property of the members of the cooperatives receiving the loans.

In the case of cooperatives whose securities were not enough for the loans sought according to the requirements of the REA provisions, the REA staff devised self-help cooperatives. The object of these self-help cooperatives was to reduce the cost of installation and wiring thus reducing the amounts of loans necessary from the REA. The reduction was brought about by employing the cooperative members for labor work, cutting poles, etc., and placing wiring contracts with one engineering firm by grouping system. The costs having been reduced, more of the neighboring farmers were likely to cooperate thus raising the membership of the cooperative which thereby would have been recognition.

This type of cooperatives are still popular with the less prosperous communities. They are unique in their working and are less likely to be found in the more prosperous communities.

Training the Farmers:

The farmers and the managers of cooperatives had to be trained in the proper use of the electrical equipment, safety codes, first aid, etc. This was done by holding training classes, short courses and conferences with the help of the educational institutions, the American Red Cross, etc. Farm Equipment Tours and Travelling Caravans demonstrating the safe and efficient way of operating

electrical equipment were organized at convenient centers for the farmers. Exhibits were displayed at the county fairs and State fairs and the use and operation of the electrical appliances and equipment explained to the visitors.

Financial Assistance to the Farmers:

As regards the financial aids to the consumers, the Electric Home and Farm Authority (EHFA) financed the private purchases of the more expensive electrical appliances and equipment. The EHFA pays for the initial cost of purchase of the customer's equipment and recovers from him the full amount with interest in installments. The customers pay the monthly installments along with the monthly electric bills to the cooperative or the utility as the case may be. The cooperative or the utility credits the amount of the monthly installments in the accounts of the EHFA until the amount is fully paid by the customer. The EHFA borrows its money from the banks at customary rates of interest and is a self supporting organization without Federal appropriations.

Research in the Economic Design of Electrical Equipment:

The manufacturers and the American Society of Agricultural Engineers collaborated in the design of electrical equipment and appliances suited for the farmers' needs. The manufacturers cooperated with the Government and employed experts for research in such design work. Criticism has been levelled against research work by the manufacturers

on the grounds that they know little about the farmers' needs and are more interested in their selling campaigns. At present therefore, the farmers' representatives are called to cooperate with the manufacturers, American Society of Agricultural Engineers and the Government representatives in planning the development programs. Several new pieces of farm electrical equipment such as; grain elevators, milk coolers, refrigerators, chick brooders and what not have been designed keeping in mind the items of initial cost, energy consumption and the farmers' needs. Improvement work in the design is in progress by the various manufacturers and the Government experimental stations.

In several instances, wherever possible within limits of safety, the farmers are advised to use home made equipment such as; water heaters, water tanks, pig brooders, portable motors, etc. Instructions regarding construction of such home made equipment are issued through extension bulletins and exhibition of models at the state and county fairs, in caravans, etc.

In case of inventions made by the REA staff, the Government secures the patent for the inventor in his name. The Government departments are entitled to using the invention without paying royalties. In case however, private companies use the invention, they pay royalties to the inventor in whose name, the invention is patented. Thus the REA electric cooperative members receive the benefit of the inventions free of cost.



FIG. 5. A homemade pig brooder. This simple device keeps new born pigs from chilling in cold weather and keeps the pigs from being injured by the sire. (Courtesy of Michigan State College)

The research work started by the CREA is still in progress at the colleges and the universities. As a result of these researches several pieces of new electrical equipment have been designed. More staff is being employed every year. Besides the colleges, the administrator of the REA appoints Student Engineers who are qualified graduates from universities and colleges for research work. By this method research work has been speeded up in various problems of rural electrification.

The United States Extension Service:

All these measures are in progress even today in various parts of the United States not only in the development of rural electrification but also in several other fields of development such as; engineering, agriculture, home economics, etc. A well organized Extension Service is in charge of this educational work. The United States Extension Service is a part of the Federal Department of Agriculture and operates on a network system controlled by the Federal Director of Extension at Washington, D.C. It works in cooperation with the land grant colleges established in almost all the states of the Union.

The United States Extension System employs various means of educating the farmers in agriculture and home economics developed through years of experience. Extension bulletins, technical bulletins, press articles, short courses, conferences, lectures, 4-H Club projects for boys and girls, caravans and radio programs, employment of State

and County leaders, home demonstration agents, extension specialists, etc. are some of the methods employed in the United States Extension work.

On account of the well organized Extension System, excellent highways and a well developed communication system as existing in the United States, it is possible for the national leaders to reach the most distant rural population just within a few hours. Whatever men and materials the nation may need in time of any emergency such as war, epidemic, drought, famine or floods, the cooperation of the entire nation could be obtained almost at once through the Extension Service.

Uniformity of Administration and Accounting:

A very important factor in the successful reduction of costs was the uniformity of administration. A scheduled management was planned for the REA cooperatives. A uniform system of accounting as worked out by the Federal Power Commission and the General Accounting Office was introduced. The forms for contracts, budgets and auditing were standardized. This standardization saved much time in the comparison of projects, preparation of consolidated statements, etc. Contract work was simplified and projects accomplished with more speed.

This uniformity of administration was possible primarily because rural electrification was one huge project spread all over the country with a central administrative staff. The success in reducing costs was to a great measure due to the well organized and capable administration.

CHAPTER III

The National Importance of Rural Electrification:

The vast country of the United States has been in a constant state of development and progress. The rural, agricultural and industrial enterprise has developed by leaps and bounds on account of the tremendous natural resources and a United effort by the people. The method of government of the country has greatly accelerated the Nation's progress on the whole. The inevitable opposition from the utilities has not stood in the way of rural progress of the country mainly because the development programs are too far overwhelming in magnitude. Nation-wide scale of programs and unified effort are the two fundamental secrets of success of the development programs.

Rural electrification has been a nation-wide enterprise, the social and economic importance of which was foreseen by the national leaders. The aims of this enterprise has been to bring comfort and happiness to the farmers' homes all over the country. The farmers' welfare being the backbone of a nation, the spread of rural electrification could not be prevented.

Social Significance of Rural Electrification:

The presence of electricity on the farm has an important social significance. It links up the rural areas and facilitates the general uplift and development of the country. It promotes the social and cultural contacts

among the people of the rural areas on the one hand and those of the rural and city areas on the other. By the use of electricity the extension work and the education of the farmers made easy and more complete. The presence of adequate telephone, telegraph and radio communications in the rural areas is a definite asset to the extension workers in reaching the rural communities and in establishing a link between the farmers and the outside world.

The work performed by electricity, being safer, quicker and less exhausting, the rural communities and farm families get more leisure hours for social and cultural contacts among the rural neighborhoods. This makes life on the farms and in the villages as delightful and comfortable as in the towns and cities thereby eliminating to a certain extent the rival feelings among the city residents and the country folks.

The presence of electricity helps in improving the health of the people. The electric lights, hot and cold running water and good drainage and sanitation, are but a few essentials of health brought within the reach of an average farmer by rural electrification. In case of disease or epidemics and in hospitals, there is no handier combating tool than electrical power. For example in the sterilization of apparatus, x-rays, surgery, excavating and in numerous other processes, electricity finds important uses. Without electrical power, effective control of epidemics and disease would be almost impossible. Thus

rural electrification adds considerably to the longevity of the rural population.

Economic Significance of Rural Electrification:

In the field of national economics, rural electrification has proved useful in more than one way. With the increased education through extension service, knowledge about improved methods of farming and weather forecasts given to him over the radio, through the press or news letters, etc., an American farmer has been found to make better use of his finances, labor and the services offered him by the utilities. This adds to the wealth of the American farmers thereby adding to the wealth of the nation as a whole.

The trends of the industry in the United States as in almost all other countries where industrial developments took place, have been towards centralization, which has resulted in overpopulation of the industrial centers and formation of slum districts in the hearts of the cities. The modern thinkers on industrial and economic matters have therefore recommended decentralization of the industry all over the country. Rural electrification has played and will play its part in this industrial re-shuffle. A survey of the farm users of electricity shows that the development in rural industries is already afoot in preparation to relieve the centralized industry.

The use of electricity in Rural Industries:

Among the farm industries, electricity is used for seed

cleaning, seed processing, cotton ginning, cold storage, sheep farming, fruit and vegetable grading, and for numerous other purposes. In the forests, it is used for wood-cutting and sawing, planing, etc.

In food industry, it is used for canning, dehydration, fruit-packing, meat-packing, slaughter houses, flour mills, sugarcane mills, etc.

For mining purposes, rural electrical lines supply coal, phosphate and graphite mines, oil pumps, refineries, roller mills, asphalt plants, etc.

Among other rural industries, electricity is used in the manufacture of brick, tile, cement and glass including digging shale, stone and other minerals. In chemical industry, electricity finds an important place in the manufacture of fertilizers, paints, varnishes, pigments and other chemical products. In textile industry, it is used in the manufacture of hosiery, clothing, silk, knitted wear, mercerized cloth, rayon and other types of cloth.

Besides rural industries, electricity finds a number of commercial uses such as in theaters, amusement parks, gas stations, farm workshop, machine shops, advertising and other commercial purposes.

The Importance of Rural Electrification in National Advancement:

Towards the end of the nineteenth century and early in the twentieth century, the introduction of mechanical power on the farm relieved agricultural labor from the farms for industrial purposes - a feature essential for the social

and economic advancement of a nation. When electricity was introduced on the farm, more agricultural labor was released for industrial use. When REA took over the development of rural electrification, hundreds of thousands of farm laborers took to industrial enterprises thus reducing the total percentage of population engaged on the farms for agricultural production.

Rural Electrification and National Defense:

Incidentally this labor released from the farm was utilized in the last World War. It was not only the men released by rural electrification but also the electrical power extended all over the country that was invaluable in the unequalled war effort put forth by the nation as a whole. In the production of materials and the maintenance of the health of the people, in the Army and Naval camps, training schools and hospitals, in the airways radio system, beacon lighting, telephone and telegraph lines, military radio system and such other institutions of the war effort, electrical power was an invaluable asset.

Thus rural electrification has proved to be of definite importance in National Defense.

CHAPTER IV

Uses of electricity on the farm:
In the home-making:

When the national importance of rural electrification was realized, the idea that the use of electricity was safe, economic and time-saving was conveyed to the farmers through all the possible channels of education as explained in the preceding chapters. The farmer was convinced that electricity would bring to him the speed of work and simplicity of operation thereby enable him and his family to snatch a few moments everyday for recreation and social contacts. Above all he was made to realize that electricity would bring health to his family. This done, it was but natural to expect a rapidly increasing demand for electricity from the farmers.

The purposes for which electricity has been used on the farms in the United States vary from place to place according to the individual needs of the farmers. This chapter and the next few chapters are devoted to the description of how electricity is used for the various purposes on the American farms.

The object of all human efforts by any nation is to have happy homes for its people. Lack of adequate home comforts in a nation is one of the root causes of international unrest. American economy aims at providing a better standard of living for all classes of workers, at providing them with increased education and all the conven-

iences and comforts of home life. With increased education and guidance through United States Extension System and other channels, an American farmer is able to get better returns from his investments and enterprises. He is taught to realize the importance of the health of his family, the sanitation of his house, the education of his children and of the social and cultural contacts with his neighborhood. For each of these purposes electricity has been invaluable to the farmer.

Lighting:

The need for lighting in a farm home can hardly be over-emphasized. Adequate lighting of the house is essential for preserving eyesight and the health of the family. Inadequate lighting slows down the work besides being detrimental to health. Electric lighting is safe, simple to operate and economically cheap in the long run. Electric lighting in the rural areas has become very common in the United States; so much so that in some states a house is considered incomplete without electric lighting. The farmers often start the electrification of their farms with the idea of "Let us have electric lights."

Defective lighting is exhibited in shadows or glare in the eyes obstructing work. Poor lighting results in near sightedness, a common defect in children. Passing from a brightly lit room to a poorly lit room affects eyes.

For adequate lighting, a lamp in the center of the room with additional floor lamps and wall brackets located

at suitable places for different purposes avoiding glare from the mirrors, window panes, etc. is essential. Glare from unshaded lamps has noticeable effect on the eyes. With proper lighting, work is made more convenient and the house appears more presentable.

Either gas filled or vacuum lamps are used. The former are better for the eyesight.

There are three ways of receiving light from an electrical source:

1. Direct method: In this case, the light from the source of illumination is thrown directly on to the objects.
2. Indirect method: In this case opaque reflectors throw the light from the source to the ceiling whence it is reflected to illuminate the entire room.
3. Semi-direct method: In this case the light from the source is diffused through the lamp shades to prevent glare and shadows.

Proper wiring of the house is essential for safety against electric shocks and fire hazards. While wiring the house, providing a sufficient number of convenience outlets at suitable locations, e.g. underneath the breakfast table, in the kitchen and in all the rooms of the house, adds to the convenience of operation of the movable electrical equipment. A proper control of lights using two-way and three-way switches for more than one control for a light or series



Fig. 6. An electrified kitchen fitted with adequate lighting, hot and cold water and other electrical kitchen appliances. (Courtesy: "Northern Illinois Farm Life" magazine)



Fig. 7. Adequate lighting is necessary in the house, for the health of the family. Lamps should be cleaned regularly. Mrs. Earl of Illinois cleans her fluorescent lamp unit in her modern farm home. (Courtesy: Northern Life)

of lights, wherever necessary. Lighting of closets, passage-ways, staircase, open yards, porches, cellars, garages, and store rooms should not be neglected. These places need as much attention in planned lighting as any of the offices, study, living or bedrooms.

Water supply:

If a city dweller is not conscious of the advantages of having a running water supply in a farm home, just turn off the water mains in his area and he will know. All the home jobs requiring use of water, such as cooking, washing, laundry, home cleaning, and care of the family are simplified and speeded up by having running water in the house.

Electrically operated water systems save time and labor and improves sanitation. An electric pump with an automatic switch control does the job of filling up the water tank with no attention or care. An electric ozonator could be added for purification of water for drinking purposes. Larger tanks are desirable for a farm house to provide for sufficient water supply for fire protection. A gravity water supply system is fairly satisfactory for daily needs.

The job of home-making is undoubtedly a tedious one. No one would therefore appreciate relief in one's work as much as a house-wife would. Much of the domestic work such as house cleaning, washing, and cooking if accomplished by electrical methods saves time, gives more hours of leisure and thereby adds to the comfort and happiness of the family. Besides, it saves time and thus gives more turn-over of work



Fig. 8. A water pump provided with automatic switch controls is a great convenience to the farm family. (Courtesy: "Northern Illinois Farm Life" magazine)

on the farm thereby assisting the family in economic farm management. Proper lighting, availability of hot water and refrigerator service safeguard health and give longevity to the farmer and his family.

In the United States, the farm women have a full time job on the farm and in the farm home. Prior to rural electrification, the surveys indicated that on an average, the farm women work nearly 64 hours a week with the work distributed as follows:^k

	Hours
Home-making	52
Farm work	11
Other work	1

Out of the 52 hours of homemaking, 37 hours are devoted to the routine work such as preparing meals, house cleaning, looking after fires, laundry and mending. The farm work on which most women were engaged comprised dairy, poultry and raising of fruits and vegetables.

The percentages of the time devoted to the various items of farm women's weekly work of 64 hours follows:^l

	Percentage of total work	
Food		
preparing meals	25.3	
clearing away meals	13.3	
food preservation	1.3	
other food work	<u>0.4</u>	
Total for food		40.3
House		
cleaning and straighten- ing the house	12.9	
care of fires, lights, water supply, repair of		

furnishings and care of house surroundings	<u>3.5</u>	
total for house		16.4
Laundry		3.3
Clothing		
Sewing	6.5	
mending clothes	2.7	
other care of clothing	<u>0.3</u>	9.5
Total for clothing		
Care of children and other members of the family		3.8
Purchasing, planning and home management		2.8
Miscellaneous		<u>1.4</u>
Total in the homemaking		32.5
Outside farm work viz. Dairy, poultry, gardening, etc.		<u>17.5</u>
		100.0

Experiences of the farming families in home-maintenance with the electrical methods of work indicate an improvement in the quality of work in less time. The savings in time makes possible attending to the more profitable work such as dairy, poultry and gardening, thereby adding to the family's income and making possible better standards of living.

A comparison of 5 Illinois farm families during typical weeks before and after electrification of the farm is represented graphically on the next page. These graphs indicate that after electrification, the savings in time from the routine work coupled with a little curtailment in leisure hours is utilized in more productive occupations.

Cooking:

The major job of the home maintenance is cooking. Studies made by the United States Department of Agriculture indicate that farm women spend about 16 hours a week on cooking. An electric range used for cooking not only reduces the weekly hours of work but also adds to the quality of the cooked food.

The advantages of using electricity for cooking purposes maybe summarized as follows:

1. Temperature control is far more accurate with an electrical range than with any other cooking device. With the use of time switches, it is possible to place food in the oven, set the thermostatic controls and switches, set the time, and without further attention the cooking will be started at the set time and the switch turned off when the food is ready. Thus the housewife can attend to several items of work at one time, go outdoors if she pleases and on return find a hot meal ready for her and the family.
2. Cleanliness and hygiene during and after cooking until the food is served is an outstanding advantage of an electrical range. The latter produces neither soot nor smoke. No ashes have to be cleaned. The kitchen is maintained cleaner. Less attention is necessary for cleaning the

stoves and the kitchen.

3. Electric ranges properly designed confine the heat where needed. Less heat is given off to the atmosphere in the kitchen or the room where the range is placed. This provides better comfort to the attendant. In hotter regions or in the summer months therefore an electric range is ideal for cooking purposes.
4. Cooking by electrical methods is more efficient. Tests carried out at Purdue indicate that electric cooking on surface burners is 15 times as efficient as coal and more than twice as efficient as kerosene. This leakage of heat from stoves using coal or kerosene makes the room very uncomfortable and makes cooking an unpleasant task. In places where coal, wood or other fuel is cheaply available, combination furnaces making use of the fuel and electricity can be used with advantage. In a combination range, as the cook gets used to the convenience, reliability and economy of the electrical cooking, the coal range is very little used.
5. In cooking with electrical ranges properly installed by authorized persons, one does not handle open flames or exposed electrical connections. No waste gases are given off unlike the combustion of any kind of fuels. This ensures safety of



Fig. 9. An electric range with automatic time controls and an electric coffee percolator are a convenience the farm family enjoys. (Courtesy: "Northern Illinois Farm Life" magazine.)

health and property and provides neat and healthful surroundings to work in.

6. Electrical ranges last longer than other ranges with the exception of heating elements which might require occasional replacement. The initial cost though higher than other ranges is well returned to the owner in the form of cheap operation cost even at a three cent rate. Adding to this the saving in time in cleaning the stove and the saving in time in cleaning the stove and the surroundings, the electric ranges will be found to be more economical than any other cooking device.

Two power companies in Wisconsin have found it sufficiently accurate to assume a consumption of one K.W. hr per person per day for rural families of 4 to 7 members where all the cooking is done electrically. Careful use of an electric range reduces the electrical power consumption. Increasing experience of the cook adds to economy in power consumption thereby making the ownership of a range more economical.

A pressure cooker can be used for cooking a variety of foods at one time. Using a coffee percolator reduces the time taken in making coffee to less than one half of the time required on an electrical range. The use of a toaster provided with automatic heat control, makes possible the hot toast served at the table with less effort and attention. It saves the annoying trips to the kitchen by the hostess.

Sandwich toasters make it possible to serve two or more hot sandwiches at the table. Waffle irons can be used for home cooking of cakes, gingerbread, etc.

Electric cookers can conveniently cook small dinners and are ideal for small parties and picnics. Electric grills and chafing dishes can be used for various purposes such as toasting, frying, broiling, etc.

In an electric egg cooker, eggs can be boiled with a few teaspoonfuls of water heated to the required degree. Two, three and five teaspoonfuls of water poured in the egg cup determine the degree of boiling as soft, medium and hard respectively. The principle is that the water completing the electric circuit evaporates as steam and the greater the quantity of water, the longer is the time of boiling.

Hot plates are a fair substitute for electric ranges for minor cooking purposes. They are also called table stoves and often supplement coal ranges. When the electric ranges are installed, there is little use for the hot plates.

A small electric oven is another substitute for an electric range. It is a miniature electric range on a plug and socket arrangement adapted for lighter cooking work. It is more handy to operate.

There are several kinds of electrical appliances specially designed for various items of cooking. For instance, a teakettle, an immersion water heater, a water heating jar, etc. They are all very handy inexpensive cooking



Fig. 10. An electric toaster at the breakfast table saves the annoying trips of the hostess to and from the kitchen. (Picture taken in a farm home in Michigan)

appliances. A farming family may well own these according to their means and finances.

Several makes and sizes of the various cooking appliances are available in the market. "General Electric", "Edison Electric", and "Westinghouse"³ are some of the well-known American makes. The choice of sizes and makes depends upon the family requirements and individual preference.

House-cleaning:

In a modern home, the job of cleaning the floors, rugs, draperies, furniture, walls, etc. is one of the tedious tasks of a homemaker. The number of children and the size of the house determine the amount of work necessary to keep the house clean and tidy. A vacuum cleaner operated by a small motor facilitates and speeds up this job. It can be used while standing erect or bending slightly while reaching underneath the furniture. Apart from the simplicity of operation, it does a more thorough job of cleaning than otherwise. Much of the dust that is usually stirred up in the room and resettles soon after hand dusting is drawn into the vacuum cleaner and taken out of the room. Small insects, fine feathers from incubators, fine spider webs, etc. could be completely eliminated from the house by use of an electric vacuum cleaner.

Electrically operated equipment is available for sanding, scrubbing and waxing of floors that is necessary in a house occasionally. Such equipment is rarely owned by families.



Fig. 11. House cleaning with a vacuum cleaner.
(Courtesy: "Northern Illinois Farm
Life" magazine.)

They can however be conveniently rented in most of the towns cheaply. A better job of sanding, scrubbing and waxing is possible with electric equipment. The latter could easily be handled by children and is operated while standing.

An attachment that can be used on a vacuum cleaner with advantage is a spray painter for minor painting jobs like wire screen and furniture painting. Much time and labor could be saved. The initial cost of a spray painter attachment is rather excessive and may or may not justify its ownership by a family for domestic purposes.

Laundry work:

The most disagreeable part of the farm house keeping is washing the linens and the entire family's clothes. An electric washing machine saves a great deal of toil. The soiled clothes are placed in the machine. Required quantities of soap and water are poured in and the switch closed. Washing is done by the action of an agitator provided in the machine. The time required for washing varies according to the make of the washer. After washing, the clothes are placed for drying.

With the modern machines such as; "Bendix" washing machines,⁸ it is possible to feed soiled clothes into the machine at one end and get clean and almost dry clothes at the other end. The clothes are then ready for pressing.

Pressing is done either by ironing machines or by hand ironers. For lighter work, electric hand irons are



Fig. 12. A farm woman in Michigan attends to some of the minor pressing work for the family with an electric hand iron provided with a temperature control switch.



Fig. 13. Pressing of sheets, table covers, napkins and household linen requiring flat pressing is easily handled by an ironing machine.
(Courtesy: Northern Life)

used. The ironing machines occupy small space and are simple to operate. They are economic to maintain in the long run. Several types and sizes of washing and ironing machines are on the market. Almost every middle class American home is equipped with a washing machine. It is considered to be one of the most useful pieces of equipment in a farm home.

Refrigerators:

Researches by various scientists and the Government departments have indicated that temperatures below 50° F materially check the growth of bacteria and fungus. Large quantities of cooked foods, vegetables and milk are wasted daily due to spoilage on account of the bacterial and fungus activity. This wastage can be considerably reduced by keeping foods in the refrigerators, wherein lower temperatures inhibit the bacterial and fungal activity. Thus the foods are kept in edible condition for longer periods. Possession of a refrigerator in a farm home eliminates frequent visits to adjoining towns for obtaining fresh food supplies. A refrigerator provides a wider variety and better and better quality of food and fruit for the family at all times resulting in better health of the family. Electric refrigerators maintain a constant temperature unlike ice boxes which maintain different temperatures at different times depending upon the quantity of ice in them. The dirt particles contained in ice are eliminated in an electric refrigerator. Thus electric refrigeration is better



Fig. 14. An electric refrigerator makes it convenient for the family to preserve milk, eggs, meat, fruits and other foods for several days.
(Courtesy: Northern Life)

than ice refrigeration.

The results in bulletin No. 28 of the Iowa Engineering Experimental Station indicate that approximately 1 to 1.5 cu. ft. size of refrigerator per person in a farm family is adequate. If several days' rations are to be stored in the refrigerator, the size should be greater. Considering the cost of ice and the family labor required to maintain an ice box, a mechanical refrigerator is more economic to maintain in a farm home.

In the United States several makes of refrigerators are on the market such as "General Electric", "Westinghouse", "Kelvinator", and "Frigidare". For the farmers' use, general purpose refrigerators have been designed. These refrigerators are compact in size, consume less energy and have other conveniences such as; automatic lighting of the inside when open, design of shelves according to the family requirements, etc.

Freezers:

Some of the modern American homes are equipped with small freezing units. The size of these home units varies according to the size of the family. The purpose of a home freezer is to preserve foods over a period of several months. It does not replace a refrigerator, since the temperatures maintained in a freezer are very low. The refrigerator temperature is generally higher and varies in the neighborhood of 45° F. The purpose of a refrigerator is to keep the the temperature low for short duration preservation.



Fig. 15. A frozen food unit for a farm home. The motor driver compressor is shown at the right. (Courtesy: Michigan State College)

The practice of freezing of foods has become very common in the United States. It saves the national waste of food. A small freezing unit owned by a family is a great convenience. It saves expenses as well as the trouble of making trips to the locker freezer plants where the family might otherwise rent a freezing box.

Almost all makes of refrigerators have a small compartment for freezing ice cubes. Often times this compartment is not used. Some housewives use this compartment for freezing small quantities of foods like meat and fruits. This method could however, be used for preserving only small quantities of foods, because of the size of the compartment.

The modern freezers are rust proof and prevent contamination of food, during the period of preservation. One such freezer called "Eskimo Freeze" has been perfected recently by Reynolds Metal Company, Louisville, Kentucky. It has a food storage space of six cubic feet and is equipped with 1/5 H.P. motor. The inside is lined with aluminum to make it rust proof and easy to clean. It does not absorb any food odors and weighs only 135 pounds. The high conductivity of aluminum liner inside increases the rate of cooling and therefore the rate of freezing.^m

Water heating:

Those of us who are always used to having hot running water in the kitchen and bath have only to imagine ourselves taking a shower with freezing cold water or sitting in a bath tub of cold water while it is below freezing temperatures

out in the open. The usefulness of hot water in maintaining the health of the family, for washing clothes and dishes, in showers, can hardly be emphasized enough specially during the winter season.

Heating water on an electric range or a coal range, is not convenient even though it is somewhat economical in cost. At the modern rates of electrical energy, heating water by immersion water heaters is convenient and inexpensive. If the house is fitted with an electric range as well as a hot water tank, the switch arrangements are so made that only one of the two operates at a time, thus preventing the overload on the installation. Thus the wiring can be made less expensive by designing it for lower loads. In modern installation, the time clock switches are used which operate automatically at the set intervals of time.

The most satisfactory electric water heater for a family of five persons is about 60 gallon capacity. It has two heating elements. The one at the top takes about 1500 watts and the one at the bottom takes about 500 watts or 750 watts. Both the elements are thermostatically controlled. There are however various types and capacities of water heaters on the market and the choice depends upon the individual needs and the size of the family.

In the areas where the sun's rays are available in plenty, a combined solar or electric water heater is far more efficient than either solar or electric heater alone.



Fig. 16. An electric water heater in the basement provides a constant supply of hot water in the house. Automatic time switches are generally provided in electric water heaters. (Courtesy: Detroit Edison Company)

These combined water heaters are used in some instances in California, Texas, and other warmer states.

For water heating purposes by any method, good insulation is necessary to reduce the radiation losses to a minimum. The tank as well as the pipes carrying hot water should be well insulated. For efficient hot water supply system in the house, a well insulated tank, a make and break type thermostat and 15 to 20 gallon tank capacity per member of the family are the essential requirements. Easily replaced heating elements economize the cost of operation by reducing the cost of repairs when the heating elements go out of order.

Dish washing:

If you are a housewife, you will bless the inventor of the electric dish washer. In many American homes an electric dish washer has come to be recognized as a piece of regular kitchen equipment. Dishes collected from the table have just to be placed in a wire basket inside the dish washing machine. In a few minutes they are washed and cleaned automatically. No scrubbing or wiping is necessary. By this method, a better job is done. Use of hot water at higher temperatures is possible since no hands need be used during the process. Use of unclean kitchen cloths or dish cloths is entirely eliminated thus making the job more sanitary. A dish washing machine gives far greater speed of work than is possible by hand method.

One of the objections to a dish washing machine is that



Fig. 17. An electric dishwasher does a thorough job of washing chinaware, glassware and enamelware. (Courtesy: "Northern Illinois Farm Life" magazine)

more hot water is required in a machine than by hand washing, but this objection is over-ruled in view of the advantage of a dish washer. In case of scarcity of water however, an electric dish washer will have no use. Another objection is that all kinds and sizes of dishes and table equipment cannot be washed in a dish washer. Odd sized dishes that do not fit into the dish washer have to be washed by hand.

Electric fans:

Comfort is a desirable feature in a home. In the summer months, specially in hot regions, heat of the day often becomes oppressive and a source of great discomfort. Electric fans increase the circulation of air in the room and the discomfort. If the breeze of the fan is passed over cold water or some wet cloth, a pleasant cooling effect is produced in the room.

In the winter time ordinary electric fans are useful in having equal heat distribution in the rooms. The uneven heating of rooms due to improper air circulation can be corrected by providing a fan in the cold air duct of the heating furnace. An oscillating fan used alongside a hot water radiator helps maintain even temperature in all parts of the room.

Electric fans may well be used to exhaust gases and odors from the kitchen or smoke from the living room. Ventilating fans also help to draw fresh air into the rooms and keep them well ventilated. In the winter months, their



Fig. 13. An exhaust fan removes odors and provides ventilation in the house in warm days.
(Courtesy: Northern Life)

usefulness is even more important since they provide exhaust of burnt gases, smoke, steam, etc. from the house while the doors and windows have to be kept closed due to the cold weather. Several types of ventilating fans are on the market. They are not expensive and are cheap to maintain.

Fly control:

Electric fly traps control flies effectively inside buildings as well as outside. The traps comprise an electrically charged screen energized from the electrical mains through a low capacity transformer. The screens are provided with guards to prevent accidental contact. The flies attempting to pass through the screens to enter the building or come out of it come in contact with the charged screens and die instantaneously. The operating voltages are as high as 4000 volts. The capacity of the transformer in the circuit being low, the fly trap is quite safe in case of accidental contact by human beings.

Electric buzzer:

An electric buzzer or bell is a common family requirement for the convenience of visitors, calling folks to meals, etc. It saves both the visitor and the host the annoyance of door knocking.

Electric clock:

An electric clock requires no winding, regulating or oiling. It keeps more accurate time. The annoying tick of clock is avoided in a noiseless electric clock. It costs



Fig. 19. An electric fly trap helps to keep down the fly population inside or outside the farm buildings. (Courtesy: Michigan State College)

only a few cents per month to maintain. Recent development in electric clocks provides alarm devices. Some electric clocks are coupled with a radio set, which provides the automatic turning on of a radio program at the desired time followed by a buzz at the set time. Thus the strain of a sudden alarm on the human nervous system is avoided. The electric clock is certainly a very handy and economic time piece for a farm home.

Radio:

The use of a radio is known to every American. Its utility in keeping the farmer informed about the weather conditions, commodity prices in the markets and the news of the day can hardly be overestimated. In the United States several educational programs are broadcasted by the United States Extension Service and the utilities over the radio system for the benefit of the farmer.

For recreation to the farmer and his family, a radio is a boon. It brings to them the music and entertainment across the hundreds of miles. They can listen to the master minds or to the politicians while sitting in their very homes as well as any city dweller does. To own a radio therefore is certainly of educational as well as recreational importance to the farming family.

A modern home is considered incomplete without a radio. A variety of sizes and makes is available on the market. The range and selectivity of the radio varies with the make and its cost.

Electric shavers:

The daily routine of shaving is simplified by an electric shaver. Use of blades, soap and water is all eliminated. An electric shaver is a handy piece of equipment for all men and women. It saves time and the maintenance cost is negligible. Electric shavers are commonly available on the market in double-head and triple-head types. There are also single-head and twin-dual types of shavers in the market. The triple-head and twin-dual (or four-head) types are more efficient in performance.

Curling irons:

For the women in a farm home, maintenance of a curling iron for the hair is an asset to beauty. A curling iron takes a load only of about 25 watts and is useful in varying hair styles. It is a simple handy appliance for women who desire to look beautiful.

Sewing machine:

A woman who has worked at a sewing machine operated either by hand or foot power, sewing machine can readily appreciate the utility of an electric sewing machine. The latter turns out a better job in less time with easier operation. The energy consumption of an electric sewing machine is almost negligible.

Meat grinding:

Mincing and grinding meat can be accomplished by a small electrical meat grinder. This little device comprises a small motor connected to the meat grinder by means of a



Fig. 20. An electric shaver is a great convenience to the family. It eliminates the use of soap, water and razor blades. (Courtesy: Northern Life)



Fig. 21. An electric meat grinder simplifies the job of mincing meat. (Courtesy: Northern Illinois "Farm Life" magazine)

V-belt. It consumes less than $\frac{1}{2}$ K.W. hr. per 100 lbs. of meat ground and saves much of the hard work done and the time spent in butchering.

Electric radiators:

On a cool day, an electric radiant heater helps to warm up the room, especially when it is not cold enough to start the furnace or light the stove. For shorter durations, electric heaters are convenient to operate. They are usually used for supplementary or occasional heating e.g. in bathrooms, children's playrooms, etc.

Automobile engine heaters:

If you have tried to start your car early in the morning after leaving it in an open garage on a cold night, you will easily realize the usefulness of an automobile heater. An electric automobile heater is a simple piece of equipment and saves much time and worry. On a cold morning, just plug it in for a few hours just before starting the engine. On extremely cold nights, keep the heater on all night long.

Few people realize the utility of heated automobile garages. If only we knew the dangers of parking cars in unheated garages, we would lose no time in installing our garages with heaters or radiators. Automobile gasoline contains small quantities of sulphur. This sulphur is always present in exhaust gases to a certain extent. It forms oxides of sulphur with the exhaust gases. In cold weather these oxides of sulphur settle down in the garage

and form sulphurous acid and monoxides of sulphur. Even the traces of these are dangerous to human beings. Heated garages prevent the formation of these harmful gases. In absence of heated garages, it is necessary that the doors of an automobile garage be kept open for some time before entering.

Household motors:

A portable motor is a very convenient piece of equipment in a farm home. It can be used to operate a small churn, grinder, mixer, ice cream freezer, etc. For example a "kitchen aid" now on the market has several attachments to adapt its use for mixing, pastry cutting, food chopping, meat grinding, egg beating, heating small quantities of water, slicing and washing potatoes and whipping cream. It is equipped with a 1/10 H.P. motor which consumes 1/6 K.W. hr. per hour of operation.

Artificial sunshine:

Natural sunshine is found to contain ultra violet radiation rays which give health and vitamin energy to human beings and animals. Artificial lighting however much developed and well designed it may be is a poor substitute for sunlight. As nature would have it, sunlight is not available for human use for most part of the year and when it is needed the most. in the winter months. Tungsten filament lamps, carbon arcs, mercury or combinations of mercury and tungsten have been found to produce artificial light rays closely resembling sunlight.



Fig. 22. A portable fractional H.P. motor for a farm home is useful for miscellaneous purposes. (Courtesy: Michigan State College)

Heating pads:

Elderly people and babies in the family occasionally need sudden warming up due to illness or effects of cold. Heating water for a hot water bottle takes time and is inconvenient. Hot electric pads can be used almost instantaneously whenever needed. They are cheap to maintain in operation. With an automatic time switch and thermostatic control, these pads can be turned on before going to bed so that they will be automatically turned off at the set time.

House heating:

From the point of view of comfort, health, cleanliness and convenience, electric house heating is desirable. The initial cost and the operation cost is however not as yet within the reach of an average farmer. Researches are being made in this direction and it may not be far to expect that benefits of electrical house heating may be brought within the financial reach of the farming families.

Other uses in homemaking:

Besides the above electrical appliances for the efficient home maintenance, the following electrical devices could well be used at home with advantage, viz:

- Ornamental and decorative lights,
- Baby's bottle warmers,
- Juice extractors,
- Mixing and stirring appliances for
the kitchen,
- Phonograph and piano motors,
- Hair driers,
- Hot air towels,



Fig. 23. An electrically driven lawn mower used by a farm family in Illinois. (Courtesy: Northern Life)

Humidifiers,
Inhalers (for colds, bronchitis,
etc.)
Cigarette lighters,
Drink mixers,
Patters for skin treatment,
Toys and toy ranges,
Pant pressers,
Tie pressers,
Exercisers,
Garden lawn mowers,
and numerous other home appliances.

In most cases these devices are inexpensive and economic to maintain.

CHAPTER V

Uses of electricity on the farm:
In Animal husbandry:

The value of electricity in the barn has been recognized by most American farmers. Lighting of the barn facilitates feeding, watering, and milking the animals. Experiments have proved that the capacity of one lamb feeder could be increased by about 20 percent by installing electric lights.

The electric lights may be gas-filled or vacuum lamps. In dusty places, gas-filled lights are not desirable since due to high operating temperature of gas-filled lamps, the heat transmitted to the dust particles surrounding the lamps may start fire hazards. Vacuum lamps are therefore recommended for all dusty locations.

Lighting is equally necessary in sheep, hog and cattle barns, haymows, silo chutes, feed storage rooms, granaries, poultry houses, incubator houses, brooding houses, etc. They add to the convenience and speed of the work.

Water supply:

Adequate drinking water supply and water for washing the animals is essential for the health of the cattle and for better production ultimately. A running water supply line from the home water supply tank satisfactorily provides running water at all times for the animals. A star-line water bowl system or other suitable water bowl system may be installed in the barn.

Water heating:

In cold weather, warm water has to be provided in the pipe lines of the water bowl system to prevent freezing and to provide water at suitable temperature for drinking purposes. Besides, hot water will be necessary for washing the animals, cleaning the barns, etc. Hot water supply could be provided at reasonably low cost by installing an electric hot water tank as explained in the previous chapter.

Grooming machines:

Portable knap-sack type grooming machines prevent the contamination of milk from dirt, hair and scurf of the cows. Electric grooming machines require less than two minutes per day for grooming a cow. Thus it is possible to groom all cows on the same day. The operation cost is negligible as compared to the amount of convenience they provide to the farmer or the dairy herd owner.

Ultra violet rays for the cattle:

As explained in the previous chapter, the sun's rays have additional qualities as compared to artificial lighting. With electrical methods, ultra violet rays have been developed which carry within themselves some of the most desirable qualities of the sun's rays. An ultra violet ray lamp provided at a convenient place in the barn helps maintain the animals and attendants in better health. The animals and attendants are exposed to the ultra violet rays occasionally as advised by the veterinarian or doctor.



Fig. 24. A floating type electric water heater keeps water from freezing. Notice the heater on the left side of the tank. (Courtesy: Michigan State College)



Fig. 25. Spraying the cows with insecticides increases the milk yield of the dairy herd. An electric spray is inexpensive and does a better and quicker job of spraying. (Courtesy: Northern Life)

Feed and forage grinding or chopping:

Many types of feeds are ground before feeding. This can be accomplished by installing a small electrically operated grinder. Various makes and sizes of these machines are on the market. They are inexpensive to maintain and save a lot of effort.

Green-feed cutting:

If green feed is given to the animals, chopping of the feed is generally necessary before feeding. Electric green feed cutters or feed choppers of suitable size are cheap and may be provided on the farm for efficiency and convenience.

Hair clipping:

Electric clippers help keep cows, horses and other livestock clean. Cows produce cleaner milk if kept clipped. Electric clippers are simple and inexpensive. Maintenance cost of electric hair clippers is negligible.

Taming of bulls:

Intermittent high voltages may be used to bring bulls under control. Electric shock from a charged wire will scare the bull from approaching the wire again and thus effectively bring it under control.

Care in handling electricity is necessary to prevent electric shock hazards. Horses are specially susceptible to electric shocks. Electricity should therefore not be used where horses are likely to come in contact with exposed electrical wires.

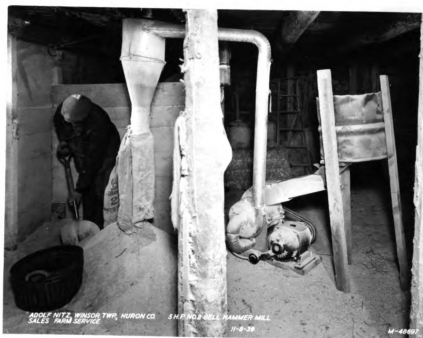


Fig. 28. Feed grinding with an electrically operated hammer mill on a farm in Michigan. (Courtesy: Detroit Edison Company)

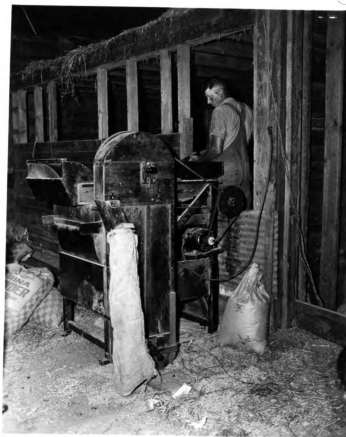


Fig. 27. An electric feed cutter on an Illinois farm. (Courtesy: "Northern Illinois Farm Life" magazine)



Fig. 28. An electric feed mixer on a
Northern Illinois farm.
(Courtesy: "Northern Illinois
Farm Life" magazine)



Fig. 29. Regular hair clipping of the dairy herd helps in producing cleaner milk. Electric hair clippers are inexpensive and cost negligible to maintain. (Courtesy: "Northern Illinois Farm Life" magazine)

Bull exerciser:

Certain electrical devices have been developed to provide movement and exercise for the bull. They keep the bull healthy and strong. The newer devices move the bull forwards and backwards instead of round and round. They use fractional H.P. motors and use little electricity.

Manure pumping:

Cleaning of the barn is greatly simplified by using an electric pump to pump out the liquid manure from the barn sewage pits or cisterns. The sewage pumped out is then taken to the field in tank wagons where it is spread out as manure.

Manure drying:

Some of the owners of large dairies and poultry houses find it economic to dry manure and sell it whenever in excess of their own requirements. An electrically heated drum containing manure rotates at a fixed speed necessary for drying. The dry manure is delivered at the other end. Usually dry manure is ground before being sold. An ordinary hammer mill will do the grinding job satisfactorily.

Other uses in animal husbandry:

Aside from the uses of electricity in animal husbandry as described above, electrical power is required in the veterinary hospital. It is well used for barn and feed storage ventilation, fly control, elevating the wood shavings from the barn by means of an electric blower, feed mixing,

milking the animals, etc. These uses have been dealt with elsewhere in this book.

CHAPTER VI

Uses of electricity on the farm:
In dairying:

The use of electricity in dairy industry has made possible the large scale production of milk and dairy products for the millions of American people. With electrical installation in the dairy barns it is possible to improve the quantity and quality of milk available from the animals.

Milking:

The modern electric milkers have effected considerable savings in the total time required in milking. For herds of 20 to 25 cows, the savings in time has been worked out to average more than 50 percent. In 1930, out of the total cost of milk in the United States, 50 percent approximately was for milking alone. Thus a 25% savings in the cost of milk was brought about merely by the use of electric milking machines.

Rotary combine milkers or "Rotolactors" reduce the cost of milking by nearly 70 percent. The initial high cost of rotolactors however, makes the installation of these machines prohibitive on individual farms.

Electrical washing machines for the electric milkers speed up the work and bring about reduction in the cost of producing milk.

The dairy should be one of the cleanest and the most sanitary places on the farm. Electricity has therefore



Fig. 30. Electric milking is quicker and more hygienic giving less bacterial count in the milk. This photograph shows an Illinois farmer milking a cow with an electric milker. (Courtesy: Northern Illinois Farm Life" magazine)

more uses in the dairy than in any other farm building. In dusting, scrubbing of floors, fly control, bottle washing, etc., electrical power saves expenses and energy. In dairy refrigeration, milk pasteurization, cream-separation, butter making, cheese making, etc., it is invaluable.

Dairy refrigeration:

In most states the quality of milk sold in the market is controlled by law; for example milk must not contain more than 150,000 bacteria per c.c. before pasteurization and not more than 15,000 bacteria per c.c. after pasteurization. Also that no milk containing more than 50,000 bacteria per c.c. is to be sold to any customer. In several states, it is specified that milk should be cooled to below 50° F immediately after milking.

By experience as well as experiment, it has been found that milk cooled immediately to below 50° F, does not increase in bacterial count within about 12 hours or longer. Later the germicidal properties of fresh milk are gradually lost and even with low count milk will sour at ordinary room temperatures.

The keeping quality of cream is preserved by rapid cooling which prevents the bacterial activity. Brine coolers may be used for refrigeration of cream. There are "Dry" and "Wet" types of coolers on the market. They may be box type or concrete tank coolers. Data from Texas state indicates that the cost of electric cooling is approximately half of the cost of ice cooling.



Fig. 31. An electric milk cooling tank
for a dairy farm. (Courtesy:
"Northern Illinois Farm Life"
magazine)

Freezing of dairy products:

When products like butter, cheese and ice cream are to be preserved for longer periods extending over several months, freezing units are very useful. The use of freezing units has already been described in connection with the electrical equipment for a farm home in Chapter VI.

Milk pasteurization:

An effective method of controlling the bacterial activity in milk is to raise the temperature of milk to about 140° F and retain this temperature for about half an hour. This method of pasteurization is called the holding method because the milk is held in large tanks at 140° F for half an hour. Electrically heated and thermostatically controlled tanks are used for this method.

Another method of pasteurization is the flash method wherein the milk is raised to 165° F for about one half of a minute before cooling. This is accomplished by passing the milk over hollow metallic tube through which hot water is circulated. Several makes of pasteurizers are on the market. In the flash pasteurization method, the vitamins are destroyed but it has the advantage of being quicker. Both the methods are in use in the United States.

After pasteurization, the milk is bottled in sterilized bottles. The bottles are then sealed. Electric bottle fillers simplify the entire process.

Milk handled by electrical devices is less apt to be contaminated and hence keeps for longer periods without souring.

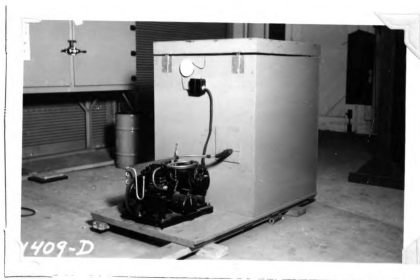


Fig. 32. An electric frozen food unit for freezing small quantities of dairy produce. (Courtesy: Michigan State College)

Milk sterilization:

Recent researches have proved that milk can be kept from souring at room temperatures by raising it to temperatures as high as 280° F for 4 seconds. The treatment involves forcing the milk through small nozzles in the form of a fine spray into chambers heated to 280° F. The fine spray makes even heating of the whole mass of milk possible. The process is however, not yet being used on a commercial scale.

Cream separation:

Electrically operated cream separators require very little in the form of energy consumption. Various sizes are available. Portable motors may be used for operating cream separators. An electric washer facilitates the job of cleaning the separator. Thus by means of electricity the entire job of cream separation and cleaning the separator is accomplished in just a few minutes.

Butter making:

Where butter making is done on the farm, an electric churn saves a lot of the monotonous labor and turns out a better product. A 12-gallon cream capacity churn operated by $\frac{1}{4}$ H.P. motor requires less than 1 k.w. hr. for 100 lb. of butter churned. The electric churn needs no attention once it is started. If enough cream is produced on the farm, butter manufacture in the home will be a paying side industry and will justify ownership of an electric separator and an electric churn.



Fig. 33. An Illinois farm woman uses an electric cream separator.
(Courtesy: "Northern Illinois Farm Life" magazine)

The recent electric churns placed on the market have special arrangements inside for working the butter. Thus in such churns no working of the butter is necessary after it is taken out of the churn.

Cheese making:

Cottage cheese can be made with the help of an electric machine. The entire process is automatic requiring little attention. The ownership and operation cost of the machine may or may not be justified for a farm family depending upon the consumption of cottage cheese by the family or in the neighborhood.

Sterilization of the dairy equipment:

Electric washing machines are invaluable in cleaning the dairy appliances. They provide water under pressure and make it possible to work with water at boiling temperatures. Thus a reasonable degree of sterilization is achieved in everyday cleaning work of the dairy equipment.

For laboratory and experimental work, electricity is used for sterilization. The latter may be electric hot air sterilizers or hot water sterilizers. The former are more desirable since they are easy to control and provide a wider variety of design. The newer sterilizers can be operated at varying pressures and temperatures which is best controlled by electrical methods.

Butter fat testing:

Electrically operated butter fat testing machines operating on the principle of a centrifuge are available on



Fig. 34. Electricity is used in cheese making.
Notice the small motors operating
each of the stirrers. (Courtesy:
"Northern Illinois Farm Life" magazine)



Fig. 35. Electricity is used in testing the percentage of butter fat in milk.
(Courtesy: "Northern Illinois Farm Life" magazine)

the market. With the help of these machines, it is possible for the farmer to keep a watch on the butter fat percentage in the milk from his herd. If he observes a deterioration in the quality, he can take timely precautions by added attention to his cattle or by consulting a specialist.

Bottle washing:

Electric bottle washers perform all the functions of bottle washing i.e. rinsing with hot water, brushing the inside and outside by means of rotary brushes and delivering the bottles in absolutely clean condition with almost no breakage losses. A single brush washer will wash clean the inside of the bottles, the outside being taken care of by hand. Single brush bottle washers will require a $1/3$ H.P. motor. For more brushes e.g. in the case of the two and three brush bottle washers, $1/2$ H.P. motor will be suitable. Four or more brush types of bottle washers are used in larger dairies.

Other uses in dairy work:

In addition to the uses of electricity in dairying described above, electricity is used in lighting the dairy buildings, barns and milk rooms, in cleaning the dairy equipment and in providing hot water service. These uses have been discussed in the preceding chapter.

CHAPTER VII

Uses of electricity on the farm:
In food processing and storage:

Animal feeds and human foodstuffs have often to be processed either for storage or consumption. Electricity simplifies the processes and saves time and labor. It maintains a constant working speed of the machine and is therefore eminently suited for use in threshing of grain, corn husking and shelling, hay baling, grain elevating, etc. It can be used for canning, cold storage and other processing purposes.

Grain threshing:

Grain threshers using two or three electric motors are available for threshing wheat, oats and other grain. These threshing machines have been popular in the past and are still in use in some parts of the United States where combines are not used. In most parts however, the introduction of combines has supplanted to a great extent the use of stationary threshing machines. Various types of harvesting combines are on the market. Some makes are drawn by a tractor and others are self-propelled. For example Massey-Harris self-propelled combine has all the driving mechanism, fuel tank and the operator's seat mounted on the combine. This facilitates the operation and handling of the combine.

Corn husking and shredding:

Husker-shredders effectively destroy corn borers. They



Fig. 36. An Illinois farmer uses electricity in elevating corn cobs. (Courtesy: "Northern Illinois Farm Life" magazine)



Fig. 37. A farmer in Northern Illinois uses a corn sheller on the farm. Courtesy: "Northern Illinois Farm Life" Magazine)

may be operated by electrical or tractor power. Shredded corn is more easily stored and fed. Where roughage feeding is practiced, electricity can be economically employed to operate husker-shredder machine, especially so when the dairy herd owned is not large enough to justify a silo on the farm.

Corn shelling and grading:

Corn shellers operated by hand will be commonly found on every corn growing farm. A $\frac{1}{4}$ H.P. motor will more than double the capacity of a corn sheller. No cranking is necessary for an electrically operated corn sheller. Often times, shelling and grading of corn is done in the same operation. $\frac{1}{2}$ H.P. motor will be enough for capacities up to 1500 to 2000 lbs. of shelled corn per hour.

Grain and seed cleaning and grading:

A fanning will remove weed seed, undersized grain and trash thereby improving the quality of grain or seed. $\frac{1}{4}$ or $\frac{1}{2}$ H.P. motor will effectively operate the fanning mill and save time and labor. Besides it will improve the quality of the grain or seed by operating the mill at a constant speed which is not practicable with hand operation.

In vegetable growing tracts, the use of a fanning mill improves quality of vegetable seeds. A fanning mill with an arrangement for grading and sacking at the delivery end will deliver the grain or seed separated in sacks. Such a mill for triple operation of cleaning, grading and sacking is easily operated by a $\frac{1}{2}$ H.P. motor.

Seed testing:

An electrically heated seed germinator comprises a specially made moisture proof double walled construction with an air layer trapped between the two walls. The inside lining is generally fiber to prevent loss of heat. To test seed for viability or disease elements in the seed, the germination box is kept at 80° F. High percentage of humidity viz. 95 to 98 percent, is maintained to favor quick and vigorous germination. This is done by placing heated pans of water inside the germination box. The high temperature and humidity bring out the manifestation of the disease symptoms on the young plants in about a week's time. This method of testing has been found effective in corn seed testing.

Storage of grain, corn and hay:

Large quantities of grain, corn and feed are usually handled for storage on the farms. A very tedious part of a farmer's job is of transferring grain from the threshing grounds to the place of storage or from the open to the storage shed. Often times it involves raising the grain or feed to 30 or 40 feet heights. Using a grain elevator or an electric blower simplifies the entire job and speeds up work. In the case of grain, no sacking or bagging is necessary. If a grain thresher is used, it is possible to deliver grain directly into grainery bins by means of an elevator or a blower.

In addition to these advantages, greater heights of



FIG. 39. An electrically driven elevator makes it possible to store grain in overhead granaries. (Courtesy: Michigan State College)



FIG. 38. Electricity in the grain storage building. (Courtesy: Detroit Edison Company)



Fig. 40. An elevator operated by a fractional H.P. motor is used in filling the granaries. (Courtesy: Michigan State College)



Fig. 41. An electric elevator for elevating bags of feed. (Courtesy: "Northern Illinois Farm Life" magazine)



Fig. 42. An Illinois farmer loading a wagon with corn by using an electrically operated elevator mounted on wheels. (Courtesy: "Northern Illinois Farm Life" magazine)

storage are possible by the use of electricity. This reduces the total cost of storage. The cost of a grain elevator is thus amply repaid the farmer.

Considerable amount of spoilage of hay can be avoided by proper handling. Timely removal of hay from the field to the mow will prevent losses due to untimely rains. A motor-driven hay hoist hastens the slow process of transferring the hay from the wagon to the mow. Two to five H.P. motor will do the job satisfactory depending upon the capacity of the hay hoist.

Hay drying:

Transport and storage space for green feeds can be greatly reduced by making hay. Use of dry hay reduces the necessary ration of concentrates for dairy animals. This lowers the cost of dairy maintenance.

Hay with less than 20% moisture is considered to be dry and is reasonably proof against fire hazards. Green grass cut in the field has much higher moisture percentage varying from 30 to 70 percent. Drying of green grass in the field will take several days of continuous dry weather. Electric hay drier makes it possible to dry hay artificially. It has been found by experience and experiment that drying hay with more than 35 to 40 percent moisture content is not economic due to the excessive electrical energy required to reduce the moisture percentage below 20%. It is therefore desirable and economic to leave the hay in the field to reduce the moisture percentage to about 35 to 40



Fig. 43. A model of a mow hay drier. Air is forced through the central tunnel by means of a fan. The side tunnels give equal distribution of the air through the mow. (Courtesy: Michigan State College)

before taking it to the mow for artificial drying.

Several types of driers have been designed. Tunnel type drier is more commonly used. One main tunnel runs along the length of the mow and several side tunnels run along the width of the mow at fixed spacing. Air is driven into the mow by means of an electrically operated fan, through the tunnels over which hay is stacked in the usual manner. The period of time for which the fan should be operated is determined by the percentage of moisture in the hay. Details of construction of such hay driers have been worked out by several experimental stations in the various states. These details are supplied to the interested farmers on request.

Before hoisting hay into the barns, baling of hay is sometimes desirable. An electric motor can be adapted for stationary baling of hay. 5 to 7½ H.P. motors will operate hay presses satisfactorily for smaller capacities. For larger bales, up to 25 H.P. may be required. Baled hay is then transferred to the storage barns by means of a hay hoist.

Drying of grain and small seed:

Small seeds like sweet clover and blue grass usually need some artificial drying to keep them viable. Drying of corn and wheat seeds has been considered advisable. The principle of drying either grain or seed is the drawing of hot air by an exhaust fan and forcing it through the entire mass of grain or seed until the moisture percentage

is 20 or less as may be required. Suitable installations working on this principle may be used. Usually the job of design is entrusted to experts or business agencies who employ experts for such design work

Feed processing:

Grinding and mixing the feed for animals is rather an unpleasant job for a dairy herd owner. For livestock feeding, harder grains such as millets, wheat, barley and rye have to be ground. For poultry feeding they are usually cracked. A feed grinder or a hammer mill could be satisfactorily operated with one H.P. to 5 H.P. or a larger motor. A separate small motor may be used to operate the elevator carrying the ground feed.

Feed mixers are usually installed along with feed grinders, but in case ground feed is purchased, separate feed mixers are available. These mixers can be used for mixing any feeds for dairy livestock and poultry. A $\frac{1}{2}$ H.P. motor will satisfactorily operate a feed mixer up to 2 tons per hour capacity. By this method, the feed is thoroughly mixed and screened and a uniform mass produced for better health of the livestock. Bits of iron and steel are removed by a powerful magnet at the delivery end of the mixer.

Ensilage making:

Ensilage is considered to be an excellent feed mixed with green feed for dairy animals, horses, sheep and chickens. It is essential for economic milk production in the Middle West. It improves the health of the livestock



Fig. 44. An Illinois farmer lights his hay mow with electric floodlights. (Courtesy: "Northern Illinois Farm Life" magazine)

and reduces feeding costs. Ensilage cutters and silo fillers can be operated with electricity for economy in cost. 5 to $7\frac{1}{2}$ H.P. motor will satisfactorily handle a 12 inch cutter and deliver the ensilage into the silo.

Other uses in food processing and storage:

Aside from the uses of electricity for feed processing and storage described heretofore in this chapter, electricity is used in drying rice, corn and hops. It is used in the dehydration of foods such as meat, fish, fruits, potatoes and vegetables. These uses have been discussed in Chapter XII.

CHAPTER VIII

Uses of electricity on the farm:
In the field:

Electricity is adopted for use in actual field work for various operations from plowing the land to delivering the produce in the storage barns or graineries. In the United States for field work, electricity is more commonly used for irrigation and land drainage purposes by pumping. In the nurseries and experimental work, it is used for soil sterilization and soil heating. In this chapter the various uses of electricity in actual field work are dealt with.

Plowing:

Early experimental work in electrical plowing was done by a Frenchman towards the end of the nineteenth century. The plowing unit designed by him is shown by a schematic diagram on the next page.ⁿ In other European countries like Switzerland and Holland, experimental work on electrical plowing has been tried in small fields. In the United States, the early experimental work in plowing by electrical power was done in the early thirties. It has received little attention within the past years. A common gasoline tractor is eminently suited for heavy tillage work on the farm. It has succeeded in replacing the animal power in most parts of the United States. It operates more economically than electric plowing or tillage devices for large scale farming.

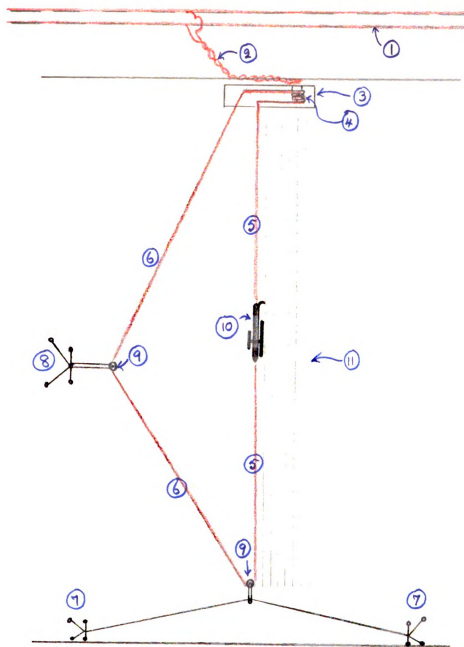


Fig. 45. Schematic diagram of an electric plough:
 1. Overhead electric wires.
 2. lead for the motor. 3. Wagon
 4. Winding drum and return drum for the cable. 5. Hauling cable.
 6. Return cable. 7. Anchors 8. Intermediate anchor. 9. self-adjusting pulleys. 10. the plough
 11. ploughed land.

In electrical plowing, an electric motor is used as the motive power in place of a tractor. The motor is operated by a long flexible extension cable tapping electricity from convenience outlets installed at regular spacing along the sides of the field. The wear of the electric cables becomes an expensive item. Also the handling of a long cable is somewhat inconvenient in field work.

Irrigation:

There are numerous methods of irrigation. The advantages of artificial irrigation are known to every farmer. It is beyond the scope of this work to discuss the subject of irrigation at any length. Suffice it to say that electric pumps are simple and economic devices for various methods of irrigation. Most pumps in use are of the centrifugal type. An automatic switch control can be made to operate the irrigation pump.

The principle of operation of an automatic switch control pump is to operate the switch of the motor by means of a lever connected to a float in the tank. As soon as the level of water in the tank falls below a particular level, the switch is closed and the pump starts working. Thus an electric pump does not require constant attendance.

Land drainage:

The soils of the European and American countries are on the whole "wet".^t The excess of water is harmful to



Fig. 46. Watering the lawn with rotary spray irrigation devices. Water is raised by pumping to suitable heights and used for irrigation purposes in various parts of the United States.

the soils. In extreme cases it causes the formation of swamps or salt lands. In normal cases of moderately "wet" soils, the crop is stunted in growth and gives less yields. The excess water has therefore to be removed from the soil. This could be most efficiently done by installing electric pumps of adequate capacities.

In "dry" soils such as those of the most parts of India,² often times the land has to be drained to remove the excess of irrigation water. At times, seepage from irrigation ditches or irrigation canals results in wet lands along the sides of the ditches or canals. Automatic electric pumps would be best suited to remove the excess of water from such lands. The water so pumped out is generally used for irrigation of the adjoining higher lands, if it is found free from harmful salts. The presence of the latter would make it unsuitable for irrigation purposes.

Land drainage may be done either by installing centrifugal electric pumps to draw out water directly from the lower layers of soil by tube-well system or by drawing out water from the open drainage ditches. In the latter case, a net work of open drains, collects the excess water from the field into the main drain from where it is pumped out into the county drain or used for irrigation if found suitable for irrigation purposes.

Farm fencing:

Hundreds of thousands of dollars are spent annually

by the American farmers in installing elaborate wire fences, walls or hedges round their farms. Barbed wire or woven wire fences are more common than other types of fences. When electricity was introduced to the American farmer, electric fences became very popular as an effective protection against damage by stray animals and trespassers.

In most electric fences, only one energized wire is used. This wire is called the hot wire and is placed about $2\frac{1}{2}$ to $3\frac{1}{2}$ feet above the ground depending upon the size of the animal fenced in or against which protection is desired. For certain types of animals like sheep, more than one wire is necessary. In that case only one wire is energized. The other wire is neutral and is placed not less than 8 inches from the ground. The distance between the neutral wire and the ground generally varies between 9 inches to 2 ft. The distance between the hot wire and the neutral wire generally varies between one to $1\frac{1}{2}$ ft.

For energizing the hot wire an electric fence controller is necessary. Standard fence controllers built on the principle of safe currents for human lives including men, women and children, approved by the Underwriters' Laboratories or other recognized bodies are available on the market. Homemade fence controllers are highly unsafe as they permit nearly 10 times the currents safe for human beings. In wet weather, the homemade

electric fence controller, may turn the farm fence into a death trap.

The standard approved fence controllers are of various types and makes. The main variations in the principle of operation are:⁹

1. Non-interrupted D.C. Type,
2. Non-interrupted A.C. Type,
3. Intermittent A.C. Type,
4. Intermittent D.C. Type, and
5. Single impulse A.C. Type.

Direct current fence controllers are usually safer since the input in a d.c. fence controller is low. Alternating current fence controllers are reasonably safe within the standards approved by Underwriters' Laboratories and other recognized bodies.

The single impulse A.C. type fence controller is of more recent development. The A.C. is first rectified to pulsating D.C. The voltage is then stepped up to reduce the value of current in the circuit. 60 to 80 milliamps D.C. is considered to be a reasonably safe range for human beings. 15 milliamps is usually provided in the line. The negative terminal of the circuit is connected to the hot wire and the positive one is grounded. This gives the advantage of the polarity effect of the human body which is positively charged and therefore receives a stronger shock than otherwise. The strength of the shock is independent of the length of contact with the wire. The maximum intensity of the shock is experienced at the first instant of contact, being rapidly damped as

as soon as the contact with the wire is made.

Soil heating:

With the reduction in cost of electrical power, soil heating has become profitable to the nurseryman, the florist and the market gardener. By heating soil it is possible to promote the growth of the plants and have the produce on the market out of season when the prices are the highest. The germination percentage of the seed is better in electrically heated soil beds. Such beds require less time and labor for preparation for sowing. The cost of manure is saved. All these factors add up to increased profits to the nurseryman.

A hot bed is easily prepared by laying a soil heating cable and a control thermostat at the bottom of the soil bed. The cable is covered by 4 to 6 inch layer of rich soil. This makes it possible to raise seedlings and flowers even in the coldest season of the year or amidst snowy weather. The average electrical power consumption for heating a 3 ft. by 6 ft. soil bed varies from 1 to 1½ K.W. hrs. for every 24 hours of operation. The factors affecting the power consumption are the outside temperature and the temperature setting. The General Electric Company, Schenectady, New York has a ready-to-plug hotbed equipment on the market. It can be obtained in varying sizes from any of the dealers in the United States. Other makes of hotbeds are also available.

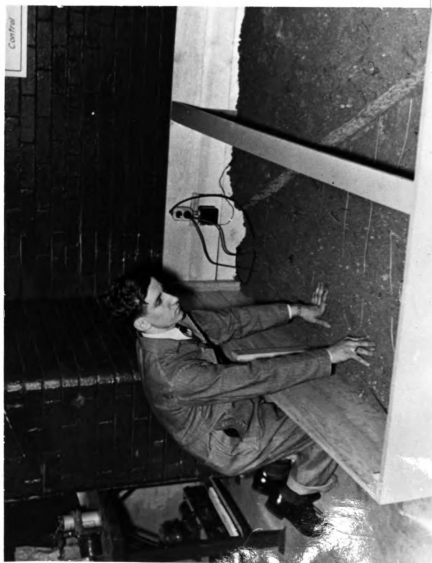


FIG. 47. Soil heating by laying electrical cables underneath a layer of soil provides even heat for the plants automatically and results in early germination and quicker growth of the plants. (Courtesy: Michigan State College)

Soil sterilization:

In experimental work in the laboratories and green houses, at times it becomes necessary to kill soil organisms for the study of micro-organisms causing plant diseases. Electricity is best suited for soil sterilization. The mass of soil is sterilized by placing it at a particular temperature for a specified time. The sterilized hotbeds provide ideal conditions for plant germination and the growth of the particular micro-organisms under study.

Other uses in the field:

Aside from the field work described above, electricity is used for threshing grain, husking corn and other field work described in the earlier chapters. It may be used in an electric truck. The use of electricity in an electric truck is described in Chapter XI.

CHAPTER IX

Uses of electricity on the farm:
In poultry farming:

Poultry farming has made considerable progress in the United States. It has been found to be a very paying side industry to the farmer. Electricity is valuable to the poultry farmer in various ways such as; incubation, brooding, feeding and improving the health of the stock. Besides it is useful in lighting, water supply and general cleaning of the poultry house.

Incubation:

Electric incubators are simple, clean and less susceptible to fire hazards. They save time and labor and give higher percentage of hatching. An electric incubator requires no more attention than occasional inspection of eggs and adjustment of the thermostat if necessary. There is less contamination, better ventilation and better control of temperature and humidity in an electric incubator.

The turning of eggs is essential for higher percentage of hatching. In an electric incubator it is done automatically by operating a lever which moves the trays containing eggs, through an arc of 90 degrees.

To prevent disease among the chicks, scrupulous cleanliness of the incubator and the trays is important. A rotary wire brush cleans the trays thoroughly. The inside of the incubator is cleaned by hand.

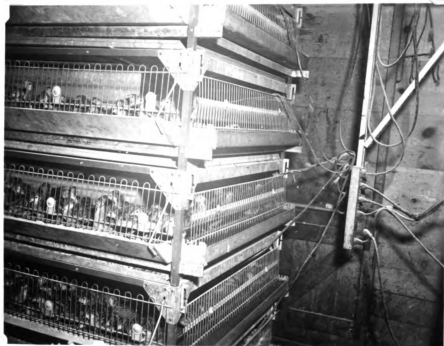


Fig. 40. Battery brooders are conveniently heated by electricity. (Courtesy: "Northern Illinois Farm Life" magazine)



Fig. 49. Cleaning the incubator trays with an electrically driven rotary wire brush. (Courtesy: "Northern Illinois Farm Life" magazine)

The consumption of energy per 1000 eggs hatched varies widely from 25 K.W. hrs. in large incubators to 200 K.W. hrs. in small incubators depending upon the insulation. In well insulated incubators, the energy consumed is less.

Several makes and models of electric incubators are on the market with automatic heat and humidity control. The energy consumption varies very little from one make to another if the capacities and other factors are the same.

Chick brooding:

An electric chick brooder saves time and labor. The operator has no worry about watching the temperatures frequently. This convenience is appreciated specially at night. In an electric chick brooder, the temperature is set and adequate ventilation provided. Then the operator can have a peaceful night's rest or during the day time attend to other work.

Heating of the brooder with electricity gives an even distribution of heat in the brooder. Electrically brooded chicks are healthier and develop more rapidly. The mortality percentage is lower in the case of electrically brooded chicks.

Several types of electric brooders are available. A black heat type brooder consists of a curtained compartment with insulated ceiling and canopy, a thermostat, a ventilating tube and a double glass inspection door. The



Fig. 50. An electric chick brooder.
(Courtesy: Michigan State
College)



Fig. 51. The underside of a lamp type
chick brooder showing how the
feeders are placed partly under
the brooder during the first
week of the life of the chicks.
(Courtesy: Michigan State College)



Fig. 52. An electric chick brooder showing the surrounding corral to prevent wandering away of the chicks in the first few days after hatching. (Courtesy: Michigan State College)



Fig. 53. Growing chicks need room for proper growth. The chicks should have access to sunlight while the chick brooder is kept inside the brooding house. (Courtesy: Detroit Edison Co.)

brooder may be supported on a rope and pulley system to facilitate cleaning. This type of brooder is kept close to the ground and therefore has comparatively less fire risk than the radiant type.

In the radiant type, the heating element is visible on the underside of a cone-shaped structure hung from the ceiling. In this type there is no problem of ventilation and cleaning, but the energy consumption is higher. It is preferable to have the characters of the two types combined in one. The operating temperatures are maintained at 90° F to 100° F inside the brooders. The size of the brooder should be based on providing 7 square inches per chick and 14 square inches per poult or bird. When the brooder is used prior to March 15, a capacity of 10 square inches per chick should be provided.

In the recent years, lamp type of chick brooder has found favor with the farmers. In this type, the source of heat is an ordinary lamp. The lamp also provides light for the chicks, so essential for their healthy growth. 440-watt to 1200-watt lamps are used according to the size of the brooder. The photographs on the next page show this type of brooder. During the first week of the life of the chicks, the brooder is surrounded by a metal ring or a corral to prevent wandering away of the chicks. Later this corral is removed. Also for the first few days, the chick feeders are placed under the brooder. These feeders are gradually removed away from the brooder.

Ultra violet rays for laying hens and baby chicks:

Laying hens should assimilate large amounts of calcium in their system for laying eggs with strong shells such as will hatch strong and healthy chicks. This is best done by vitamin D present in certain foods. Lack of this vitamin results in development of rickets in poultry birds and chicks. Sunlight provides vitamin D and helps in the assimilation of calcium into the animal's body. In winter months, less sunshine is available. Artificial sunlight in the form of ultra violet rays is an excellent substitute for sunlight invented so far. The ultra violet lamp popularly called sunlamp contains mercury vapor between tungsten electrodes. These lamps have replaced the older quartz mercury type and carbon arc lamps previously used.

The sunlamp serves for lighting as well as a source of ultra violet rays. Baby chicks growing under ultra violet light are healthier and more sturdy than otherwise.

Cooling and storage of eggs:

United States Department of Agriculture statistics indicate that revenue from eggs could be greatly increased if the farmers cool eggs immediately after collection and then store at proper temperatures. Electric refrigeration prevents spoilage of eggs. A home made cooling device consists of fanning an open tank of water and allowing the cool air to pass over the eggs. The latter are kept in screen bottomed buckets to facilitate circulation

of the air. An ordinary electric fan is a very simple and handy device for cooling eggs by this method.

Cooling and storage of poultry:

The quality of dressed fowl is maintained by refrigeration. In storing for longer periods, a freezing unit keeps the poultry from deteriorating in quality. A more thorough description of home refrigeration and freezing has been given in Chapter VI ante.

Cleaning, candling and grading of eggs:

Eggs are cleaned satisfactorily by hand buffing. Cloth buffers operated by fractional H.P. motors save time and labor at negligible extra cost.

Candling of eggs with an electric light facilitates determination of the quality of eggs and rejection of poor quality eggs. This eliminates the inferior quality eggs from the shipped stocks, thereby avoiding penalty against entire production.

Grading of eggs brings better income for heavier eggs which are considered superior in quality. Hand grading is a slow job. It is simplified and speeded up by using electric graders. Usually eggs are sold in three separate grades according to their size and weight.

Water supply:

As already pointed out, all livestock improves in health if water is provided for drinking at all times. In poultry keeping, apart from resulting in healthy birds, constant water supply increases egg production by nearly



Fig. 54. Warm water for the laying birds pays big profits in the form of more eggs produced. (Courtesy: "Northern Illinois Farm Life" magazine)

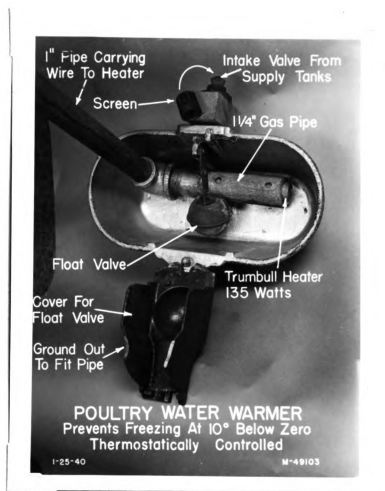


Fig. 55. Courtesy: Detroit Edison Company.

10 percent. Continuous supply of water can be best maintained by an automatic controlled electric pump. A float in the water tank operates the switch when the level of water in the tank falls. This starts the pump and keeps it working until the water level in the tank raises the float far enough to throw the switch open.

Hot water:

In the winter months, the birds should be provided with warm water for drinking. This can be done by passing the water through an electric water heater. The provision of warm water has been found to increase the egg production by 12 to 15 percent during the winter months.

Other uses in poultry farming:

In addition to the uses detailed above, the poultry farmer uses electricity in lighting, cleaning and ventilating the poultry house as discussed in Chapter VI. Feed grinding or feed cracking and feed mixing are some of the other uses. These have been described in Chapter IX. To prevent contagious diseases appearing in the poultry stock, sterilamps have been found to be useful. Providing sterilamps in laying houses aids in controlling bronchitis and other respiratory diseases.

CHAPTER X

Uses of electricity on the farm:
In horticulture:

Orchards form an important part of agriculture in the United States. Fruits constitute a considerable part of the food of the people. Due to the seasonal changes in climate, it is not possible to obtain fresh fruits and vegetables at all times during the year. Preservation keeps fruits and vegetables in reasonably fresh condition. Electrical power finds an important place in this field.

Soil heating and sterilization:

Electric methods of soil heating and soil sterilization have been discussed in Chapter VIII. Hotbeds in a nursery improve the seed germination and produce vigorous seedlings. Returns from an orchard depend considerably on the quality of seedlings planted. Hotbeds therefore find favor with the nurserymen.

Lighting and glass houses:

Experiments have proved that seedlings and flowers grow better under sunlight. The greenhouse construction is based on the principle of providing as much sunlight to the plant as possible. In absence of the sunlight, artificial sunlamps provided in greenhouses help vigorous growth of young plants. Artificial lighting of greenhouse with sunlamps at night time in effect, provides more light hours for the young plants. This results

in better foliage and helps the plants to become disease resistant in earlier stages of growth. Also it helps in early maturity of flowers. Provision of artificial sun-lamps in nurseries and flower beds is thus amply repaid in the form of higher prices for the seedlings and flowers prevailing in the market during the earlier part of the season.

Spraying of insecticides:

Several fruits require spraying with insecticides to prevent insect attacks or plant diseases in the ripening stage. Timely spraying saves large quantities of the crop from being destroyed. Common method of spraying is by hauling a tank of the spray solution or powder and forcing the spraying material through a nozzle held pointing towards the trees. Hand-sprayers like bucket sprayer or knapsack sprayer employing a small tank under pressure may be used for lighter work. Peerless dust gun is a handy device for spreading dust on the trees for small orchards.

For large orchards, tractors are used. Large tanks of the spray material are hauled behind the tractor and one man directs the spray nozzle towards the trees. By adjusting the speed of the tractor and the opening of the sprayer nozzle, the desired quantity of the insecticide can be evenly spread over the whole area. Some engineering companies specialize in the manufacture of spraying equipment. Various types and sizes of sprayers

have been put on the market by these companies.

Electric spray plants are employed in many orchards in several parts of the United States. These plants are located at convenient places in the orchard. They are stationary. The pipe lines lead to all the trees to be sprayed. The principle of spraying is the same in stationary electric units as well as a movable unit operated by a tractor i.e. the spraying material is forced out through a nozzle and sprayed over the trees.

The advantages of a stationary electric spraying plant are:

1. Savings in time by one half to two thirds the time required in movable units.
2. Rough ground can be sprayed without difficulty and without waste of the spray material.
3. There is no damage done to the trees and irrigation ditches.
4. Packing of the soil which results from the hauling of the tank wagon behind a tractor is avoided.
5. Weather conditions do not interfere with operation of spraying. Time factor in spraying insecticides is of vital importance. Electricity makes spraying possible after rains even in wet fields where portable units cannot be taken.
6. In portable units, the efficiency of the worker determines the quality of spraying. The man

handling the spray nozzle has to be attentive at all times. This element is avoided in stationary spray plants resulting in more effective resistance of the crop to insect and disease attacks.

7. Stationary plants are less likely to need repair or go out of adjustment.

Cost of spraying by a stationary electric unit is no greater than that by portable units. Electric stationary spraying units should be installed at a convenient low level location. This will save the spray liquid in the pipes by allowing it to flow back into the tank after spraying is finished instead of allowing it to run out of the tank if it were placed at a higher level.

Removing spray residue from the fruits:

The residue of insecticidal spray is harmful to human health. It should be removed from the surface of the fruits before using the latter for human consumption. Washing with water removes the spray residue satisfactorily. The washing is best done by spraying water from nozzles held close to the fruits. In the case of fruits having oily or waxy coating, hot water is necessary. The fruits are kept floating in water tanks and the pressure of the water jet is enough to perform the job of cleaning.

The use of electric power economizes the cost of pumping and heating water. The entire process of cleaning

is simplified and made automatic by using electrical methods in pumping water, heating, etc. as described before.

Excessive washing of fruits affects the keeping quality of the fruits. Therefore dilute chemical solutions are used for washing. These solutions destroy the poisonous properties of the spray residue. For example a very dilute Hydrochloric Acid solution washes the arsenic residue from fruits like apples. The process of washing with a chemical solution is the same as for washing with water.

Fruit preservation by refrigeration:

Refrigeration is the best method of preserving the keeping qualities of a product. Fruits, vegetables, eggs, dairy products and other foodstuffs can be kept in fresh condition for several days by domestic refrigeration. Milk can be kept without souring for several days by refrigeration. Apples, oranges, tomatoes, cabbages, etc. can be stored for longer duration at low temperatures. As discussed in Chapter VI, when the foodstuffs are to be stored for several months, freezing of foods is recommended. Freezing can be practiced for fruits, vegetables or meat alike. Reference has been made to the preservation of foods by refrigeration and freezing in Chapters VI and VIII. The details of refrigeration and freezing methods, the variations in operating temperatures for various foodstuffs, etc. are beyond the scope of this book and are therefore omitted.

Fruit canning:

Canning is a common method of preservation of fruits. Fresh fruits along with some preservative usually sugar solution are sealed in sterilized cans at higher temperatures to kill harmful bacteria. Use of electricity facilitates handling and movement of the cans by means of chain elevators. It is well employed in washing fruits, heating water and sterilizing and sealing cans. By employing "a moving belt principle", wherein a moving chain carries the cans from the department of work to another, the entire process of canning is simplified.

Dehydration:

During World War II, dehydration of fruits, vegetables, meat and fish saved a lot of transportation and storage space so vitally needed. Dehydrated products retain most of the qualities of the fresh products. Apples, peaches, pears, plums, prunes, raspberries, crab-apples, apricots, blackberries, blueberries, etc. when dehydrated under controlled temperature, humidity and velocity of air, retain a flavor very much similar to their natural flavor. They regain original volume and appearance when re-hydrated.

Fruits like gooseberries, strawberries, and cherries do not give good dehydrated products, due to excessive bleeding. Dehydration of grapes is common for certain varieties only. The dehydrated grapes are available in the market in the form of raisins.



Placing Fresh Food in Dehydrator
Mrs. Russell H. Kerr, Housewife - Bal Axe Sales Office
advertising 3-17-45 : 51752-16

Fig. 56. (Courtesy: Detroit Edison
Company.)



Food Dehydrator and Dried Food Exhibit - Bad Axe Sales Office

Advertising

3-17-43 : 61752-2

Fig. 57. (Courtesy: Detroit Edison Company.)

The process of dehydration consists of passing the washed fruits from the cooler end of a heated tunnel to the hotter end, the humidity and movement of air in the tunnel being kept under control. The fruit is usually carried in trays mounted on trolleys. The tunnel is fitted with glass windows and thermometers to facilitate inspection. The air circulation is controlled by an exhaust fan and a chimney. The cooler end of the tunnel is usually kept at 125° F approximately and the hotter end at 135° F or so depending upon the type of the fruit to be dehydrated. Humidity is kept around 25% varying with the amount of water to be removed from the fruits.

Among vegetables, potatoes, turnips, spinach, and squash can be well dehydrated. Rhubarb and asparagus do not give satisfactory dehydrated products. Some vegetables require blanching before dehydration.

Fruit grading:

Grading of fruits according to weight or size brings better returns from the better fruits. Usually a $\frac{1}{2}$ H.P. motor operates a medium sized grader with a capacity of about 25 boxes an hour. Electric apple grading machines are available on the market. Bulb graders and potato graders are also used by some vegetable growers.

An electric fruit grader machine operates at negligible cost and saves much time and toil. It brings more price for larger fruits.



FIG. 53. An Illinois farmer uses an electric potato grader on his farm. The grader requires three attendants, one for feeding the potatoes into the elevator, one for sorting out rejected potatoes and one for bagging. (Courtesy: "Northern Illinois Farm Life" magazine.)

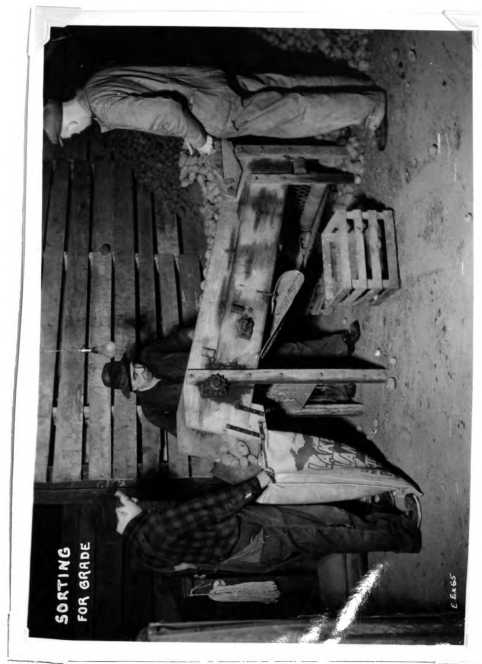


Fig. 53. Another type of an electric potato grader suitable for smaller farms. (Courtesy: "Northern Illinois Farm Life" magazine.)

Other uses in horticulture:

Apart from these uses in horticulture, electricity is useful in horticultural experimental work same as in any other laboratory. In lighting and cleaning, in soil heating, in the sterilization of laboratory apparatus, etc., electricity is commonly used.

CHAPTER XI

Uses of electricity on the farm:
Miscellaneous uses:

In the preceding chapters, the uses of electricity in the various branches of agriculture have been discussed. Besides these, electricity is used in a number of miscellaneous ways on the farm. E.g. in farm shop, portable electric motors, cotton ginning, wood sawing, paint spraying, sheep shearing, stump removal, bug latching, seed potato cutting, pea vining, burglar alarms, electric trucks and in numerous other ways with which we are so familiar in our everyday life that we are apt to ignore their importance. This chapter describes these miscellaneous uses of electricity on the farm.

Farm shop:

The present day farmer has realized the economic advantage of owning a small repair shop to be able to do the minor repair of implements and machinery at home. Tool grinding and sharpening of knife blades has often to be done on a farm. An adequately equipped farm shop therefore repays amply by saving frequent trips to town. The equipment likely to be of maximum use and economic to maintain in a farm shop is listed below:

1. Steel drill: This should be portable and electrically operated from a convenience outlet.
2. A drill holder: To serve as a stand for the portable drill.



Fig. 60. Electricity is a handy source of power for the farm workshop. Notice that the workshop is adequately lighted by electric lamps. (Courtesy: "Northern Illinois Farm Life" magazine.)



FIG. 61. Portable light for the farm workshop. The lamp is adjustable so as to throw light where needed and avoid glare. (Courtesy: Michigan State College.)

3. Grind stones and tool grinders.
4. Emery stones.
5. All-wheel dresser: To smooth the grind stones and emery wheels.
6. A combined rip and cut off saw.
7. Soldering iron: Electric soldering iron is a handy device convenient to work with.
8. A steel lathe.
9. A wood lathe.
10. A buffer.

Outside this list, there might be other pieces of light electrical equipment according to needs of the farmer or the neighborhood. For example, a larger meat grinder, painting and spraying equipment, etc. could be installed in the workshop building. If considerable replacement of metallic bearings is done on the farm, a portable electric metal melting pot for babbiting bearings could be installed in the farm workshop.

Most of the equipment listed above will be operated by fractional H.P. motors. The total consumption of electrical energy will vary with the amount of use of the equipment. On the whole the energy cost is negligible in view of the convenience it affords and the saving in repair charges of the farm equipment. Lighting of a farm shop should not be neglected. Adequate light for the workers is important for their health as well as for speed of work.

Portable electric motor:

A fractional H.P. motor makes an excellent portable



FIG. 62. An Illinois farmer uses a portable motor for the operation of an elevator on his farm. (Courtesy: "Northern Illinois Farm Life" magazine.)

source of power. It can be used to operate several electrical devices by a suitable pulley and belt arrangements. For example, a water pump, washing machine, meat grinder, feed grinder, rotary wire brush cleaner, corn sheller, fanning mill, grindstone, concrete mixer, etc. could all be operated by a portable motor.

Portable motors may be mounted on a tripod or a trolley. Larger motors with 3 to 7½ H.P. capacity are supported on wheels to facilitate transport. Fractional H.P. portable motors are mounted either on tripods or wooden boards for convenience in handling.

Cotton ginning and pressing:

Electricity is being used for cotton ginning and pressing work in factories. Large cotton growers have such factories adjoining their farms. Smaller growers generally get the ginning and pressing of cotton bales done in a neighboring factory. Electricity is used almost invariably in modern cotton gins.

Wood sawing, planing, etc.:

A portable motor is well adapted for wood sawing. Many farmers cut their firewood from their own wood lot. Sawed logs for firewood and other city uses bring increased returns. A 5 H.P. motor will satisfactorily operate a circular saw. Usually larger motors are employed for the operation of saw machines, planers and other wood machines. The length of the logs cut varies from 12 to 24 inches or more as required. The energy consumption is



Fig. 63. A farmer's wife in Northern Illinois uses a portable electrically driven pump to inflate her tires. (Courtesy: "Northern Illinois Farm Life" magazine.)



Fig. 64. A portable motor may be used in operating a concrete mixer. (Courtesy: "Northern Illinois Farm Life" magazine.)

more with shorter lengths. For cutting the logs into planks or boards, an electric hand saw is used.

When smoother finish is required, the planks should be planed by an electric planing machine. A portable motor will do both the jobs of sawing as well as planing. The operation speed of the circular saw or planing machine is usually equal to the speed of the motor i.e. approximately 1450 r.p.m. A variation up to 500 r.p.m. On either side does not interfere with satisfactory operation.

Painting and spraying:

A fractional H.P. motor furnishes satisfactory power for a small paint sprayer used for coating wood with preserving material, painting the house and furniture, spraying disinfectants, etc. It is also adapted for use in tire pumping and whitewash removal. The removal of whitewash is done by employing high air pressure and forcing the air through a small nozzle. An electric sprayer prevents waste of paint and performs the job more evenly. No retouching is necessary for jobs done by an electric sprayer. The extra cost is negligible while the savings in time and improvement in the quality of work are valuable to the farmer.

Sheep shearing:

Using electric clippers for sheep shearing makes the job simpler and more even. Electric clippers reduce shearing time to less than half that required for hand



Fig. 65. An electrically operated circular saw suitable for farm uses. (Courtesy: "Northern Illinois Farm Life" magazine.)



Fig. 66. An electrically operated paint spray used by an Illinois farmer. This unit may be used for pumping (see fig. 63.) (Courtesy: "Northern Illinois Farm Life" magazine.)

shearing by clippers or blades. In a large flock this savings in time is well appreciated. Energy consumption of electric clippers is very small. Early experiments in Oregon proved a savings in cost of shearing by nearly 15% when electric clippers were substituted for hand clippers.

Stump removal:

Often times the job of removing ugly tree stumps from the farm presents a problem to the farmer. A process of destroying these stumps has been developed by electrical methods.⁷ No blasting is necessary. The electrical method employs the principle of a blower which makes the stump burn faster. It consists of a vacuum cleaner fixed with a special 8-tap head. In each of these taps is fixed a nozzle. The nozzles consist of $\frac{1}{2}$ inch pipes varying in length from 4 to 12 ft. Each nozzle is connected to each of the eight taps in the head of the vacuum cleaner. The fire is started by using crude oil or crank case oil. As the stumps burn, the nozzles are pushed deeper into the stumps to burn them deeper. One nozzle thus burns each root stump.

One man can operate about six stumps simultaneously. Normally a 4-foot stump burns in eight hours. The type of wood determines the rate of burning. For example pine, spruce and fir burn quicker regardless of moisture content. Cedar resists fire successfully being wet and porous. The rate of burning in cedar stumps is therefore slower.

Bug hatching:

Certain types of bugs eat and live on other types of bugs which are harmful to crops. For example lady bird beetles live on mealy bugs or aphids which are pests on citrus trees. Lady bird beetles are therefore hatched artificially by raising mealy bugs on potato sprouts. The room temperature is kept uniform at 70 to 80° F by an electric thermostat and space heaters. Enough ventilation is provided in the room for the sprouting potatoes and for the insects in the room. In California, these beetles are sold to citrus growers and others in capsules of ten each.

Seed potato cutting:

Cutting the seed potato for planting is a slow job if done with a knife by hand. An electric cutter does the same job in less time with less labor. The cutting is more even. Due to the proper cutting, the percentage of germination of potato tubers is likely to be higher.

Pea vining:

Pea vining and shelling of peas is economically done by using a 20 H.P. motor. The vines are fed at one end in a specially designed machine which automatically does the job of separating the pods from the vines and shells the peas out of the pods. The vines and pod skins are delivered separately from the shelled peas.

The modern practice of using a field pea viner operated by pulling it behind a tractor has to a certain extent

replaced the use of electricity in pea vining. It is likely that the field pea vining will supplant the stationary pea vining methods except in the areas where the vines and pod skins fetch high prices as livestock feed.

Burglar alarms:

Theft of livestock and property along the highways has become increasingly common in the United States. One method of protection is by keeping the area well lighted. The use of burglar alarms is another method. A simple installation causing an alarm bell to ring and light up the particular area of burglary protects the lives and property of the farm family.

The principle of operation is that the alarm bell rings when the circuit is opened. The circuit is closed by hand. The current through a solenoid or relay is kept low enough so that once the circuit is opened even for a moment, it cannot be automatically closed. Thus the bell keeps ringing until reset by hand. A flood light for the yard connected to this alarm, can be made to light up when the alarm is on.

If an indication regarding the area of burglary is desired, a separate alarm outfits for each area will be necessary. The yard lights for each area are then connected to the respective alarm bells.

Electric truck:

Electricity is not commonly used in trucks. Gasoline

has been found to be an excellent fuel for long distant transport. For shorter distances some trucks have been used to operate on electric power. In the Thirties, in the state of Wisconsin, a dairy farmer used a 42-cell battery to deliver his products through a 14½ mile route daily.⁸ The batteries were charged daily by means of a 30 ampere mercury arc rectifier operated from the a.c. mains. The energy consumption was found to be 37½ H.W. hrs. for 100 miles. The net cost of operation as calculated including depreciation, insurance, interest and energy consumption was between 3 to 4 cents per mile. No further details regarding the economics of using electric power in trucks have been worked out.

Individual hydro-electric plants:

In areas where a natural flow of water is available in the form of a stream or some other source of water power, small hydro-electric plants may be installed to supply electricity to a farm. Where power company service has not yet reached, such individual electricity producing units are invaluable. The cost per kilowatt hour of energy is high for individual plants. In the United States, the use of electricity has been so well recognized that the high cost of producing electrical energy by individual units, does not interfere with the use of electrical power.

To generate power by hydro-electric methods, the water in the stream is made to fall from a height of a

few feet. This fall operates an impulse wheel which in turn operates the generator. The power produced in this manner varies from a few hundred watts to several hundred kilowatts. The cost of the plant or the unit will vary accordingly.

Various voltages can be produced by means of hydro-electric plants. The more common voltages produced by individual generating units are 32 volts and 110 or 115 volts. In either case the installation should be designed so that it could be used on bloc for power company service or NIA line service when it becomes available.

All the electrical equipment and appliances provided that due care is taken in their installation, are safe and easy to control. Most of them are actually less expensive than the non-electrical methods or the hand methods otherwise in use. In the case of others that are more expensive, the extra cost involved is disregarded for the safety and ease of operation.

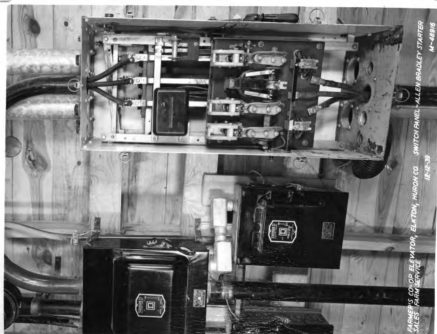


FIG. 60. A properly designed and properly installed electrical system insures plenty of power to do the job and avoids trouble. (Courtesy: Detroit Edison Co.)



FIG. 67. A poorly installed lamp is a hazard. Faulty installation should be guarded against. (Courtesy: Michigan State College)

CHAPTER XII

Ownership and Operation of the Electrical Equipment:

In a survey recently carried out in the Mason Dansville power line territory of Michigan, it was observed that the utility of the electrical equipment rather than its cost was the governing factor in ownership of the various electrical devices by the farming families. Under the existing financial status of the American farmers, this observation may reasonably be held true for most states of the Union.

Electric lighting is the first item desired by all the farm families. "Let us have electric lights" is the primary urge of the American farmers. The order of preference for the rest of the equipment varies with the individual needs and the type and extent of farming. For example, some farmers attach more importance to the utility of a milking machine and would even prefer it to having a pressure water system on the farm. A farmer's wife may prefer an electric iron and a washing machine to the milking machine. No order of preference would therefore be accurate. Considering a mixed farm, however, the observations in regard to twenty main items of electrical equipment, made in the Mason-Dansville power line, indicate an order of preference as follows.^t

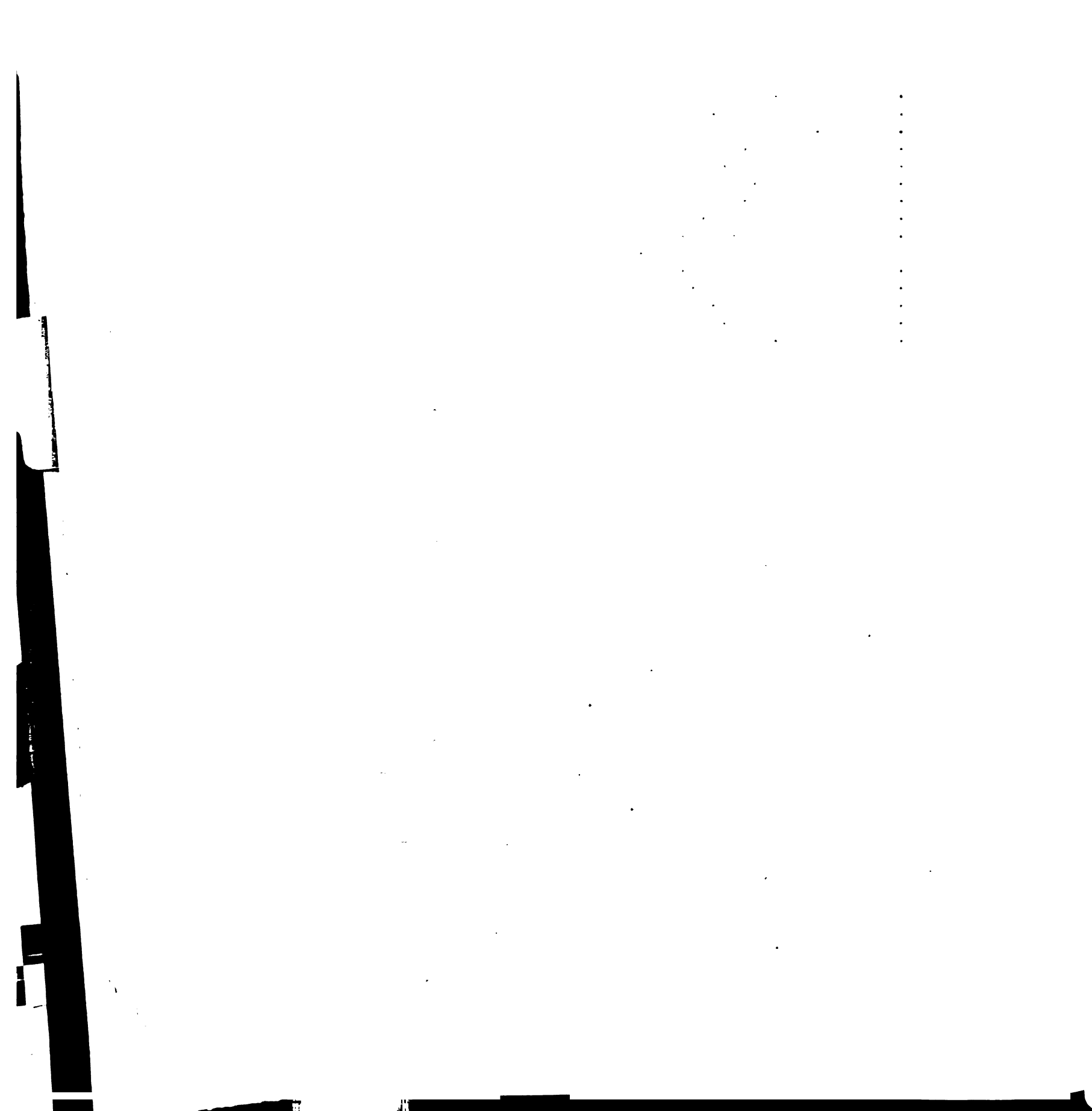
1. Electric lights in the farm house.
2. Pressure water system.
3. Washing machine.
4. Electric lights in the barn.
5. Refrigerator (household).
6. Electric stove.

7. Flat iron.
8. Milking machine.
9. Radio.
10. Water heater.
11. Vacuum cleaner.
12. Milk cooler.
13. Feed grinder.
14. Deep freeze unit.
15. Utility water, 5 H.P., for silo filling
and other heavy jobs.
16. Electric incubator.
17. Electric wood saw.
18. Electric welder.
19. Electric drill.
20. Hay drier.

The remaining items of electrical equipment and machinery are not applicable to all farms generally.

Study of Costs limited to home appli-
ances only:

The object of this work is to examine the cost from the point of view of their being applied to the farming conditions in India. The absence of data for mechanical power requirements on Indian farms makes this study very difficult. The farm holdings in India vary from a few acres to several hundred acres, being owned either by individual farmers or joint families. Due to the almost entire absence of electrical machinery on the farms, it is not possible to foresee accurately, which of the machinery has greater scope in India. The use of electricity in India could be foreseen in the farm homes, for irrigation and drainage, in mixed farming and in the rural industries much in the same manner as discussed in the preceding chapters. Due to the smallness of holdings and other agricultural conditions described in Chapter I,



there is no immediate prospect of electricity being employed in all the farm uses detailed here-to-fore. In this work therefore, the consideration of costs is limited to the main items of household uses only, namely:

- Lighting
- Pressure water system
- Washing machine
- Household refrigerator
- Electric stove
- Hand iron
- Radio
- Water heater
- Vacuum cleaner
- Utility motor, $\frac{1}{2}$ H.P. for miscellaneous uses.

The consumption of electrical energy has however, been discussed for all the items that make use of electricity on the farms.

The initial cost of household electrical equipment:

Due to the difference in quality of the products placed on the market by a number of manufacturers and the amount of use to which it is put by the various farm families, it is hardly possible to generalize the cost of ownership and operation of the various electrical appliances. The situation created by World War II added to the inaccuracies of such generalization. All attempts at estimating the average costs therefore, serve only as a rough guide in indicating the desirability or otherwise of owning the equipment.

During the war, most of the electrical appliances were not available in the open market. After the war, some of the manufacturers have resumed production but the

price levels are highly uncertain due to economic and political turmoil within the nation. Labor strikes and the official policy of price control are two of the important causes for this uncertainty of price levels. When the Office of the Price Administration (OPA) was abolished in 1946, the prices of some commodities went up while the prices of other commodities fell down; more items of electrical machinery appeared on the market. When the OPA was restored in the latter part of the year, the price levels were restored, but the availability of the electrical appliances and equipment was still uncertain.

After the elections in November, 1946, with the victory of the Republican representatives over the Democrats, the price situation is likely to change all over the country. The OPA has withdrawn the ceiling price levels for several commodities including electrical equipment. Thus the estimate of cost, if based on the price levels in 1946, will be greatly distorted and inaccurate. It is therefore, that the following cost figures are based on the 1942 price levels. These price levels may be expected to be revived after the intra-national economic conflict subsides within the next few years.

The life of electrical equipment:

The life of the electrical equipment is a variable factor depending upon the amount of use it is put to and the care with which it is handled. Wiring installation

once carefully done will ordinarily need no major repairs or replacements within 20 to 25 years. Most of the electrical equipment discussed above will last for about 15 to 20 years without any appreciable expense on repairs. Allowing for the difference in the makes of equipment and the way in which they are handled, the life of all the electrical equipment is considered to average in the neighborhood of 15 years.

The cost of ownership:

The ownership of the electrical equipment during the year involves several items of cost, namely:

- Depreciation
- Interest
- Repairs
- housing the equipment
- Insurance
- Taxes, etc.

All these items are more or less variable. For example, the depreciation during the earlier years for new equipment is comparatively more while the repair expense is almost nil. In later years, the depreciation cost reduces while the repair cost increases. The annual cost of ownership therefore, varies to a certain extent depending upon these items. For the field machinery, these items of cost are comparatively higher than for the household equipment.

Assuming the life of the electrical equipment to be 15 years, the cost of ownership in one year has been worked out to be approximately 15 percent of the initial cost. This is for all field machinery. For power machinery,

the annual cost of ownership has been estimated at about 20 percent of the initial cost. For the estimates in this an average depreciation of 15 percent annually is allowed on all equipment.

The quality and the make of the equipment are the matters of choice and individual preferences of the farmers. For our estimates, the costs provide for a reasonably superior quality of equipment of any reliable make, which could be afforded within the financial means of an average American farmer. The following statement indicates the approximate cost of ownership in one year of the electrical equipment, based on the price levels existing in 1942.⁹

<u>Item</u>	<u>Initial Cost</u>	<u>Annual cost of ownership (15% of ini- tial cost.)</u>
Cost of wiring a five-room farm house, providing adequate number of lights and convenience outlets.	\$200.00	\$30.00
Pressure water system: Deep well water pump.	135.00	20.25
Washing machine.	85.00	12.75
Household refrigerator.	110.00	16.50
Electric range; 4 burner type, with oven.	150.00	22.50
Hand iron.	5.00	.75
Radio.	50.00	7.50

Water heater, 60 gal- lon tank capacity.	300.00	45.00
Vacuum cleaner.	65.00	9.75
Utility motor, 1/2 H.P.	<u>25.00</u>	<u>3.75</u>
Total	\$1,135.00	\$168.75

Manufacturers of the equipment:

In the statement above, the prices have been based on any reliable make of appliances having reasonable longevity and efficient service. Among the number of makes available in the American market, the following makes are considered reliable and not very expensive:

<u>Equipment</u>	<u>Manufacturer</u>
Lamps and wires	General Electric Co., Mela Park, Cleveland, Ohio
Water pumps	F. E. Meyers & Bros. Co., Ashland, Ohio
Washing machines	"Maytag" Co.
Refrigerator (house- hold)	General Electric Co., Mela Park, Cleveland, Ohio
Hand iron	General Electric Co., Mela Park, Cleveland, Ohio
Electric range	"Hotpoint", General Electric Co., Mela Park, Cleveland, Ohio
Radio	Westinghouse Mfg. Co., Pittsburg, Penn.
Water heater	General Electric Co., Mela Park, Cleveland, Ohio
Vacuum Cleaner	"Eureka"
Utility Motor	General Electric Co., Mela Park, Cleveland, Ohio

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Cost of operation:

The cost of kilowatt hour consumption is the main item constituting the cost of operation of this equipment. Other items such as lubrication and cleaning forming a part of the cost of operation, are almost negligible for electrical machinery and are therefore omitted in these cost calculations.

The cost of operation of the electrical equipment will evidently vary with the amount of use to which it is put. More energy consumed, more is the cost. The statements appearing hereafter indicate the kilowatt hour consumption of the various pieces of electrical equipment in a farm home or on the farm. The data is based on the NEA statistics available in 1946. It has been published by the Westinghouse Electric Corp., Pittsburg, Penn.

No common unit of the amount of work could be made applicable to all the electrical appliances since the nature of work performed by each varies considerably. The units adopted for the various appliances have, therefore, been mentioned in a separate column.

The cost of electrical energy has been based on a general rate of 2¢ per kilowatt hour; since in most of the states, for larger amounts of electrical energy consumed, the rate is in the neighborhood of 2¢ per kilowatt hour or even less. In other states where the rate is higher, 2¢ or less per kilowatt hour is the target of

the RMA efforts.

The following statement gives an idea of the approximate monthly consumption of electrical energy for the main household electrical appliances:¹⁰

<u>Item</u>	<u>Unit</u>	<u>A.W. hr. Consump- tion per unit.</u>	<u>Cost of Oper- ation per mo. @ 2¢ per A.W. hr.</u>
Lighting (household)	One month, for a family of 5 members.	20	\$0.40
Water pump (deep well)	One month, for a family of 5 members, @ 2.5 watts per 1000 gallons.	2.5	0.15
Washing mach- ine	One month, for a family of 5 members.	3	0.06
Refrigerator (household)	One month, for a family of 5 members.	35	0.70
Hand iron	One month, for a family of 5 members.	2	0.04
Electric range	One month, for a family of 5 members.	120	2.40
Radio	One month, for a family of 5 members.	8	0.16
Water heater	One month, for a family of 5 members.	240	4.80
Vacuum clean- er	One month, for a family of 5 members.	2	0.04
Utility Motor ½ H.P.	One month, for a family of 5 members, @ one hour use per day.	15	0.30
		<u>452.5</u>	<u>9.95</u>

Average monthly consumption of electrical energy for other equipment:

The following statement shows the average monthly consumption in K.W. hrs. for the rest of the electrical appliances in use on the farms.¹¹ The details for the farm home equipment are given separately from those of the farm equipment:

<u>Item</u>	<u>Unit</u>	<u>K.W. hr. Consump- tion per unit.</u>	<u>Cost of Oper- ation per unit @ 2¢ per K.W. hr.</u>
Farm home equipment:			
Clock	One month, one family	2	0.04
Coffee per- colator	One month, for a family of 5 persons.	5	0.10
Curling iron	One month, for a family of 5 persons.	0.5	0.01
Dishwasher	One month, for a family of 5 persons.	2.5	0.05
Fan (house- hold)	One month, for a family of 5 persons.	2	0.04
Fan (kitchen)	One month, for a family of 5 persons.	3	0.16
Freezer	One month, for a family of 5 persons.	125	2.50
Heater (glow- ing or radi- ant)	One hour of use	1	0.02
Heating pad	One hour of use	0.5	0.01

<u>Item</u>	<u>Unit</u>	<u>K.W. hr. Consump- tion per unit</u>	<u>Cost of Oper- ation per unit @ 2¢ per K.W. hr.</u>
House heat- ing (oil burner)	One month, for a family of 5 persons.	25	0.50
Ironing mach- ine	One month, for a family of 5 persons.	10	0.20
Sewing mach- ine	One month, for a family of 5 persons.	0.5	0.01
Toaster	One month, for a family of 5 persons.	3	0.06
Waffle iron	One month, for a family of 5 persons.	2	0.04
Farm equipment:			
Barn venti- lator	One month, per cow.	2.5	0.05
Bottle wash- er	1000 bottles	0.5	0.01
Brooder (for chicks)	One chick	0.5	0.01
		to 3.0	to 0.06
Churn	100 lbs. of butter	1.5	0.03
Clipper (for horses or cows)	One hour	0.1	0.002
Concrete mixer	One cu. yard of concrete.	0.5	0.01
Corn husker - Shredder	100 bushels of corn.	30	0.60
Cream separ- ator	1,000 lbs. of milk.	0.5	0.01

<u>Item</u>	<u>Unit</u>	<u>K.W. hr. Consump- tion per unit.</u>	<u>Cost of Oper- ation per unit @ 2¢ per K.W. hr.</u>
Dairy water heater	5 gals. of hot water per cow (at 145° F.)	1	0.02
Ensilage cutter	One ton	1	0.02
Electric fence	One month	7	0.04
Feed grinder (One H.P. Hammer mill)	100 lbs.	0.5	0.01
Fly trap	One month	5	0.10
Grain ele- vator (one H.P.)	1,000 bushels	4	0.08
Grain seed cleaner and grader	100 bushels	1	0.02
Green feed cutter (also used as feed shredder)	One ton	2	0.04
Hay baler	One ton	2.5	0.05
Hay hoist	One ton	0.33	0.066
Hotbed	One sq. yd. per day	1	0.02
Incubator	Per set of 25 eggs	1	0.02
Irrigation pumps	One acre-foot of water lifted through one foot.	3	0.06
Milking mach- ine	One month, per cow	2.5	0.05

<u>Item</u>	<u>Unit</u>	<u>K.W. Hr. Consumption per unit.</u>	<u>Cost of Oper- ation per unit @ 2¢ per K.W. hr.</u>
Milk cooling	One month, for cooling ten gal- lons of milk daily.	30	0.60
Paint Spray- er	1,000 sq. ft.	1.5	0.03
Poultry house lighting	One month, 1,000 birds	6	0.12
Poultry wat- er warmer	Per day, for 1,000 birds	1	0.02
Straw cut- ter	One ton	2	0.04
Threshing machine	1,000 bushels of grain	125	2.50
Tool grinder	One hour of use	0.5	0.01
Ultra violet lights for poultry	One month, 100 hens	10	0.20
Utility Mot- or (3 H.P)	One hour of op- eration	3	0.06
Water pump (deep well)	1,000 gallons	1	0.02
Wood saw	One cord of wood	2	0.04

CHAPTER XIII

The present position of rural electrification in the United States:

The fact that rural electrification has made a rapid progress as compared to other progressive countries of the world has been brought out in the earlier chapters. The graph on the next page indicates the stages of progress from the early days in 1923 when the Committee on the Relations of Electricity to Agriculture made its first report pertaining to the rural electrification statistics. The steepness of the curve of the graph in the recent years indicates the impetus received by rural electrification due to the federal assistance and the efforts of the REA.

Intensity of rural electrification in different states:

The following table shows the intensity of rural electrification in the various states of the Union. The data has been obtained from the U.S. census figures and the Edison Electric Institute statistics. The U.S. Bureau of Census defines a farm thus: "any tract of land of three or more acres used mainly to produce agricultural products, or any place of three acres or less, where the owner or tenant devotes his entire time thereon to agriculture, or the annual value of agricultural products exceeds \$250. (Note: Poultry and game raising, floriculture and horticulture and similar pursuits fall within this classification.)"V The tendency of the utilities is to relax this definition and consider any individual unit of farm whether

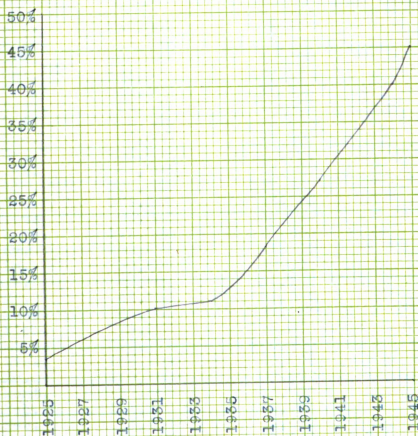
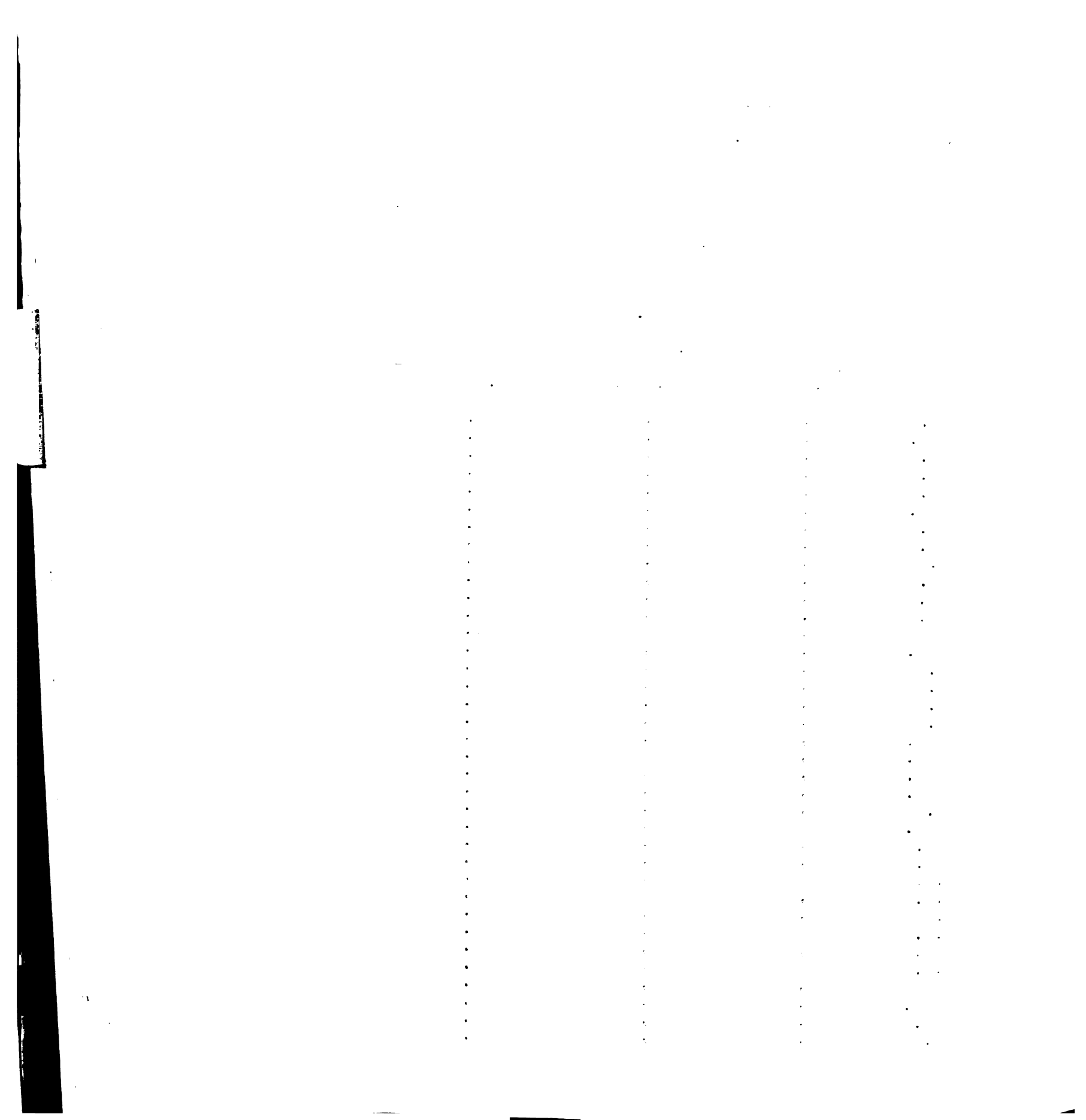


Fig. 69. Percentage of farms electrified in the United States. (Courtesy: U.S. Census data.)

in accordance with U.S. Bureau of Census' definition or not, as a separate farm. The data regarding the number of farms electrified in the table having been collected by the Edison Electric Institute according to the utilities' definition of a farm, presents a rather exaggerated appearance in regard to the percentage of farms electrified as shown in the last column.

Name of State	No. of Farms (Jan. 1, 1945) ^W	No. of Farms Electrified (Dec. 31, 1945) ^X	Percentage of Farms Electri- fied.
Ala.	245,061	75,300	30.9
Ariz.	17,139	3,700	65.9
Ark.	203,527	43,500	24.0
Cal. ³³	141,377	146,200	103.7
Col.	42,103	23,200	53.6
Conn.	24,832	23,000	93.7
Del.	9,531	3,400	38.1
Fla.	63,330	23,300	37.4
Ga.	233,353	33,500	37.6
Ida.	41,703	35,300	85.8
Ill.	201,431	140,000	67.3
Ind.	173,231	143,100	81.5
Iowa	202,333	151,100	72.0
Ians.	142,376	47,300	35.2
Ky.	242,671	71,300	29.5
La.	132,333	43,000	36.7
Me.	43,261	24,100	55.7
Md.	43,333	23,300	63.7
Mass.	43,061	27,200	58.6
Mich.	179,673	165,300	92.0
Minn.	130,771	100,000	69.4
Miss.	264,704	51,900	21.5
Mo.	244,569	33,600	36.6
Mont.	37,363	13,700	33.2
Neb.	111,333	40,900	38.5
Nev.	3,400	1,300	34.3
N.H.	13,313	13,700	71.2
N.J.	27,550	25,300	91.3
N.M.	23,213	3,300	27.7
N.Y.	153,333	127,200	83.3
N.C.	231,173	113,100	59.6
N.D.	63,643	7,100	10.2
Ohio	223,333	123,300	55.3
Okla.	172,371	42,000	24.3
Ore.	64,263	53,300	82.9
Pa.	173,339	134,300	75.3



<u>Name of State</u>	<u>No. of Farms (Dec. 1, 1912)*</u>	<u>No. of Farms Electrified (Dec. 31, 1912)*</u>	<u>Percentage of Farms Electrified.</u>
R.I.	3,000	2,300	37.3
S.C.	133,873	39,300	33.7
S.D.	32,212	3,300	12.3
Tenn.	233,235	34,300	33.2
Tex.	330,133	133,300	33.3
Utah	21,515	11,300	33.2
Vt.	27,321	17,400	32.2
Va.	170,310	31,500	47.3
Wash.	25,175	30,300	27.2
W. Va.	101,334	33,300	33.3
Wis.	173,303	133,400	73.7
Wyo.	17,207	3,000	43.4
<u>Total United States</u>	<u>3,010,515</u>	<u>7,330,100</u>	<u>30.2</u>

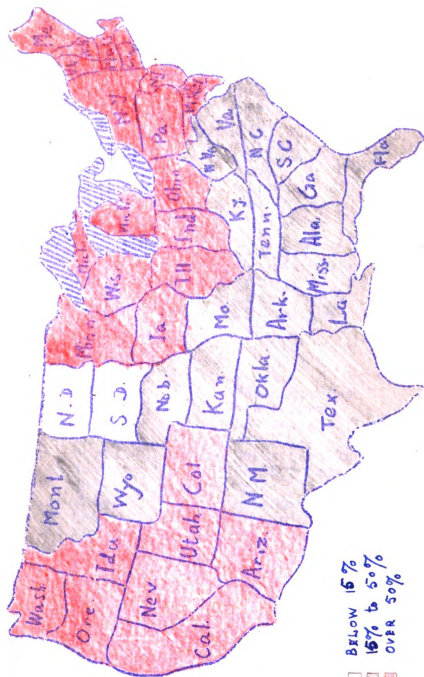
The map on the next page shows the intensity of rural electrification in the different states. A general observation of facts indicates that wherever there are larger farms, the percentage of electrification is less and in the areas where there are smaller farms, the percentage of electrified farms is more. This is partly because on the smaller farms there are more enterprises like dairy, poultry, pig breeding, sheep rearing, nursery, floriculture, etc. in addition to farming; and partly because there are more farms per mile of line.

The future of rural electrification in the United States:

As to whether rural electrification has any future in the United States or not, could be judged by considering the following questions:

1. How much importance does rural electrification have in the economic, social and cultural well-being of the nation?

MAP OF THE UNITED STATES
SHOWING 48 STATES OF THE UNION



PERCENTAGE OF FARMS ELECTRIFIED IN THE UNITED STATES.

Fig. 70. 43 STATES OF THE UNION

Ala.	Alabama
Ariz.	Arizona
Ark.	Arkansas
Cal.	California
Col.	Colorado
Conn.	Connecticut
Del.	Delaware
Fla.	Florida
Ga.	Georgia
Ida.	Idaho
Ill.	Illinois
Ind.	Indiana
Ia.	Iowa
Kan.	Kansas
Ky.	Kentucky
La.	Louisiana
Me.	Maine
Md.	Maryland
Mass.	Massachusetts
Mich.	Michigan
Minn.	Minnesota
Miss.	Mississippi
Mo.	Missouri
Mont.	Montana
Neb.	Nebraska
Nev.	Nevada
N. H.	New Hampshire
N. J.	New Jersey
N. M.	New Mexico
N. Y.	New York
N. C.	North Carolina
N. D.	North Dakota
Ohio	Ohio
Okla.	Oklahoma
Ore.	Oregon
Pa.	Pennsylvania
R. I.	Rhode Island
S. C.	South Carolina
S. D.	South Dakota
Tenn.	Tennessee
Tex.	Texas
Utah	Utah
Vt.	Vermont
Va.	Virginia
Wash.	Washington
W. Va.	West Virginia
Wis.	Wisconsin
Wyo.	Wyoming

2. How much effort is being put by the Government and the utilities in promoting the development of rural electrification?
3. How do the people react to the efforts of the Government and the utilities in the development of rural electrification?

Regarding the first question, the rational importance of rural electrification has already been brought out in the preceding chapters.

The second question is considered in the later paragraphs.

As regards the third question, the reaction of the majority of the people is evident from the rapid progress of the rural electrification in the United States within the past 25 years. There is, no doubt, as in all new development work, an amount of opposition to the efforts of the Government and the utilities in the electrification of the rural areas. But there is an overwhelming majority of the people supporting these efforts.

Now the second question regarding the efforts by the utilities and the Government. These efforts have been partially discussed before. They are constantly aimed at:

1. Reduction in the cost of electrical energy supplied in rural areas.
2. Modification of the laws affecting the extension of electricity to the rural areas in the different states.
3. Research in the design of electrical appliances and equipment to the farm uses.
4. Education and training of the farmers in the method of using the newly developed equipment, familiarizing them with the research activities

of the Government and the utilities, and obtaining their cooperation the development of rural electrification.

The efforts of the Government and the Utilities in these four directions go hand-in-hand. The cooperation of the American Society of Agricultural Engineers and farmers' organizations is obtained in the efforts of the Government. The chief organization representing Government efforts in rural electrification, is the REA. An elaborate description of the results of these joint efforts are beyond the scope of this work. An illustrative summary of these efforts in the various States, during the post World War II period, follows:

Reduction in the cost of electrical energy in the various states:

During the years 1945 and 1946, the rate of electrical energy have been reduced by several power companies almost all over the United States. This reduction was possible mainly because of the removal of the federal excess profits tax after World War II. A few of the instances of revision and reduction of rate schedules are cited here.

In Arizona:

Central Arizona Light and Power Co. has reduced the rates of electrical energy by nearly 10.2 percent as follows:

Energy Consumed:	Rate:
First 12 K.W. hr.	\$1.00
Next 103 K.W. hr.	3.0¢ per K.W. hr.

Next 130 K.W. hr.	2.5¢ per K.W. hr.
Over 230 K.W. hr.	1.5¢ per K.W. hr.

All energy consumed for heating water.	1.2¢ per K.W. hr.
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Proposed rates:

Energy Consumed:	Rate:
First 12 K.W. hr.	30.0¢
Next 130 K.W. hr.	2.5¢ per K.W. hr.
Over 230 K.W. hr.	1.5¢ per K.W. hr.

All energy consumed for heating water.	1.0¢ per K.W. hr.
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The Tucson Gas, Electric Light and Power Co. was ordered by the Arizona Corporation Commission to reduce the rate schedules effective March 1, 1946. The company has been ordered by the Commission to reduce the rates further beginning January 1, 1947.

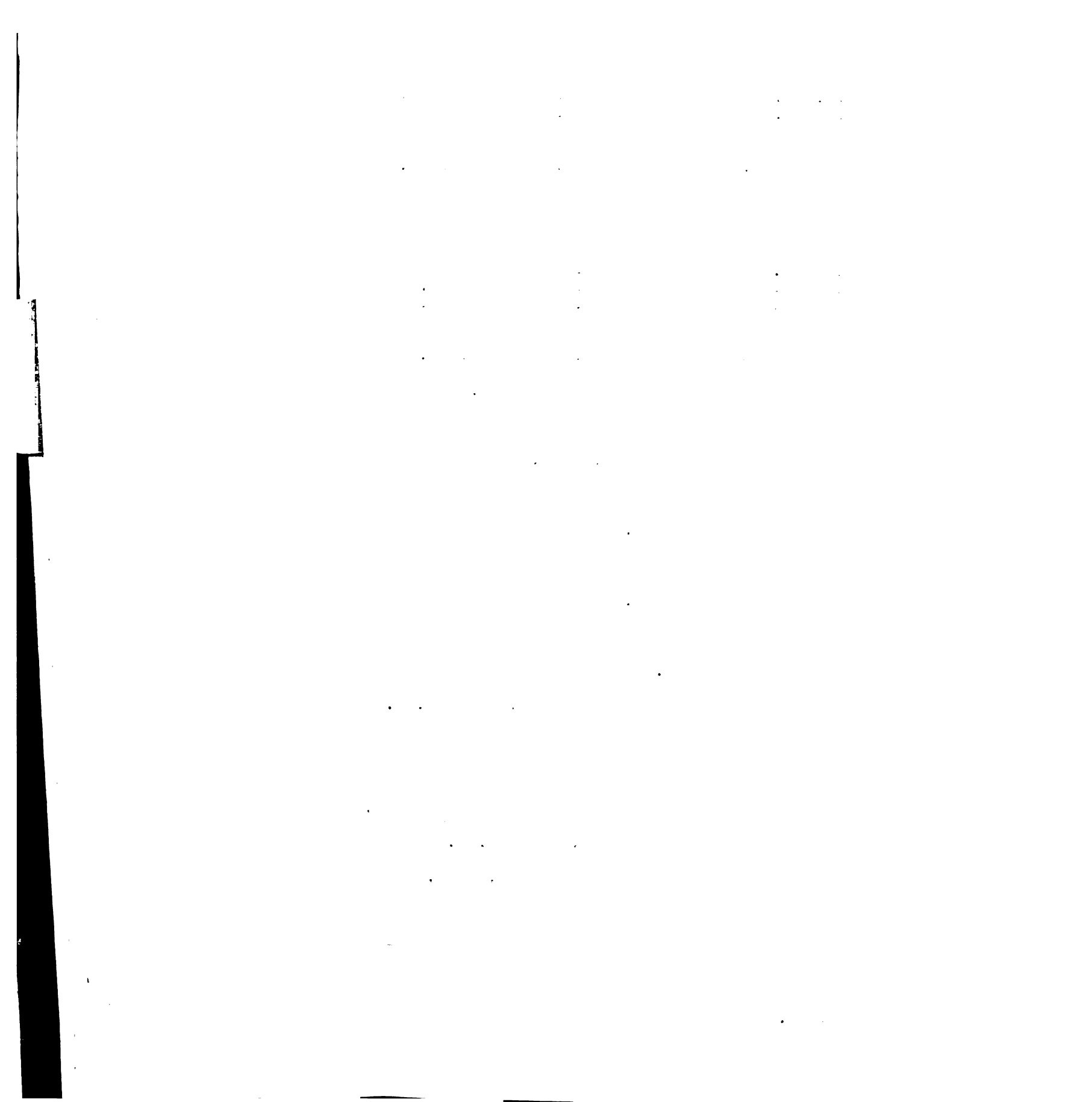
In Arkansas:

Arkansas-Missouri Power Corp. has increased the rural lines by nearly 100 percent and reduced the rate for rural customers by nearly 30 percent. The monthly minimum charge per customer has been reduced from \$2.50 to \$1.75.

In Colorado:

The Municipal Electric Plant in Colorado at Lamar effected a reduction in rate schedules by nearly 3 percent. The minimum charge was reduced from \$1.25 to \$1.00. The revised rates were given effect from January 1, 1946.

Also the municipal plant revised the rates for Colorado Springs bringing about a reduction in the annual electrical bills for the home and commercial users to the extent of nearly \$100,000.



In Georgia:

Carroll Electric Membership Corp., Carrollton, Ga., have reduced their rate schedules. All electrical energy over 200 K.W. hr. per month will be supplied @ 1.5¢ per K.W. hr. under the revised rates.

Also Water and Light Commission has announced a 10 percent reduction in rates of electrical energy.

In Illinois:

The following companies have reduced their rate schedules fixing 5¢ a K.W. hr. for the first 25 K.W. hr. consumed, 3¢ a K.W. hr. for the next 75 K.W. hr. and 2¢ a K.W. hr. for electrical energy consumed over 100 K.W. hr. per month.

The Commonwealth Edison Co.
The Public Service Co. of Northern Illinois.
Western United Gas and Electric Co.
The Illinois Northern Illinois Utilities Co.
The Central Illinois Public Service Co.

The revised rates will bring about a savings of nearly \$6,500,000 to Illinois users of electrical energy annually.

In Louisiana:

Gulf States Utilities Co. which covers parts of the State of Texas also, has fixed the top rate of electrical power consumption at 4½¢ per K.W. hr. as against the previous top rate of 5½¢ per K.W. hr. This reduction in rates has been given effect since January 1, 1946 and made applicable to all the consumers supplied by the Gulf States System in both the States.

In Missouri:

The Union Electric Co., St. Louis, Mo., has reduced the rates and simplified in the rates schedules. The power lines of this company extend to some of the Illinois State and Iowa State consumers. The revised rate system will have only two schedules, one for urban users and the other for the rural users, instead of the eight schedules existing previously. The savings to the customers will be about 10 percent of their electric bills.

In Oregon:

Hood River Electric Cooperative has effected a 24 percent reduction in rates charged the home consumer on the farms. For the city dwellers in the city of Hood River, the revised rates have lowered the cost of electrical energy by 10 to 21 percent.

Portland General Electric Co. and North-Western Electric Co. have revised the rates for electrical energy with special offer to commercial consuming large quantities of power.

In Virginia:

Virginia Electric & Power Co. has reduced its rates for various consumer's purposes to the extent of nearly \$1,363,000 annually beginning April 1, 1946. The reduced rates will save a total of \$510,000 for residential consumers, \$730,000 for commercial consumers, \$36,000 for municipalities (for lighting purposes) and \$32,000 for other State Institutions.

The Virginia Corporation Commission order the Northern Virginia Power Co. to reduce the rates effective May 1, 1948.

These are only a few illustrations of reduction in cost. Besides, in several other states like Idaho, Indiana, Iowa, Kentucky, Maryland, Michigan, New Mexico, New York, North Carolina, Oklahoma, South Carolina, Tennessee and Texas, the rates of electrical energy have been reduced.

Modification of laws concerning rural electrification in the United States:

The following instances will indicate the trends of current legislation towards rural electrification.

In Massachusetts:

A bill was introduced to prohibit the seasonal charges for electricity and gas service by the utility companies. This was defeated by a vote of 102 to 101.

In New York:

A bill was introduced into the house to abolish the New York State Power Authority. The bill was not passed.

Dwyer bill was passed to amend the New York City Administrative Code. This authorized the New York City Water Supply Board to permit the use of water for generation and sale of electrical energy subject to certain restrictions.

Stephens bill was passed amending the city law to extend by one year the tax imposing powers of the cities of

New York State, up to a maximum of one percent of gross operating income of utilities.

In Texas:

An Act was passed by the 45th General Assembly exempting the sale of utility equipment in cities of less than 3,000 population from the state claim store tax.

In Virginia:

Spiers bill was introduced into the house with a view to imposing additional licence tax upon water, heat and power companies. The bill was rejected by a vote of 10 to 5 by the House Finance Committee.

A general survey of the recent legislation in the various states will indicate that while rural electrification has a fairly strong opposition in some states like Massachusetts and New York, it has been welcomed in other states like California, Michigan, Ohio, Oregon, Utah, Washington and others. In the states of Alabama, Arkansas, Kansas, Missouri, Tennessee and Texas the proposals for increased taxation on the electrical energy consumed by the REA cooperatives were defeated. In Idaho and Texas, a reduction in taxation was granted to the electrical cooperatives.

Research in the design of electrical
Appliances and Equipment:

With the growing number of farms being electrified, the utilities all over the United States have been greatly interested in the improvement in design of electrical appliances and equipment which would be most efficient

for use on the farms. A number of inexpensive appliances with low power rating have been designed for the various uses as indicated heretofore. Among the recent interesting improvements in design are:

In California:

A manufacturer has placed on the market an "electric dogmaster" for cooking frankfurters by a high frequency method.

In Colorado:

A new type of electric fan has been perfected by an inventor in Denver, Col. It is designed on the principle of a double curve of a bird's wing which moves with the least disturbance and effort.

In Illinois:

Sits Holding Corp., 4600, W. Huron St., Chicago, Ill. has announced a new luminous plastic material used in switch plates and convenience outlets. The plastic material has high light retention value. Once exposed to daylight or artificial light, even for a few minutes, the plates will emit a blue-white glow in the dark for nearly 8 hours.

In Michigan:

Experiments are in progress at the Michigan State College for the design of an electric frost prevention device. The principle of operation of this device is to radiate infra-red radiant energy to the plants and soil in the area.



Fig. 71. An experimental electric frost prevention device developed at the Michigan State College. The device consists of two units of heating elements placed under semi-oval aluminum reflectors. The two units are placed alongside each other. Each unit consists of 4 sections placed end to end. The heating element for each unit is continuous (Courtesy: Michigan State College.)

The experimental unit of the radiation type frost prevention equipment is shown in the accompanying figure. It consists of sections of heating elements protected on the upper side with aluminum reflectors of suitable semi-oval shape. The sections are supported on posts such that the heating elements are about 10 feet from the ground. These units are rather expensive in their present stage from the point of view of their initial as well as operation cost.

Meanwhile an oil-heated type of frost prevention unit has been perfected which utilizes kerosine oil in radiating heat energy to the surrounding objects, walls of buildings, plants and the soil.

In New Jersey:

In Bloomfield, N.J., an ultra violet lamp which destroys kitchen bacteria and kitchen smell has been developed.

In New York:

A pressure cooker with a broiler in the top has been designed by a manufacturer. It browns and tenderizes the toughest cuts of meat at the same time.

A thermo-alarm system has been developed to sound an alarm when the temperature of a building rises or falls beyond the set limits. The system has a control box in the house and is inexpensive to install. It can also be used as a burglar alarm system.

In Ohio:

A new type of electric washing machine in which the

clothes are swirled instead of being agitated in a tub, has been designed in Cleveland, Ohio. It is expected to be on the market by the end of this year.

The Hobart Brothers Co., Troy, Ohio, has developed a low cost electric welder specially designed for rural power lines. It has a wide range of operation drawing from 20 to 130 amps on a 230-volt single phase line.

The Hobart Brothers Co., has also designed a combined battery-charger and arc-welder which may be conveniently used on the farm for welding and battery charging purposes.

General Electric Co., at Cleveland, Ohio, has announced a new type of 40-watt lamp for illuminating the inside of refrigerators. The lamp is smaller in size and frosted on the inside. It is designed for normal 120-volt lines and has a rated life of 1,000 hours.

These developments and the progress in the short period following World War II, are but the result of cooperation among the Governments, utilities and the farming population. They are all indicative of the progress of rural electrification in the near future.

Education and training of the farmers:

The last phase of the Government's effort in extending the benefits of rural electrification to the farmers is that of the spread of the education and the knowledge of the better methods among the farmers. This is done mostly with the help of the U.S. Extension Service.

The activities of the Extension Service in the United



States already referred to in this book comprise the publication of general and technical bulletins, distribution of these bulletins among the farmers, issuing news letters to the farmers, radio programs, announcements of weather forecasts, holding meetings, conferences, short training courses for farmers, county and state fairs, demonstrations, lecturers, etc. and exhibition of movies or any visual aids. 4-H Clubs for boys and girls is an interesting activity of the Extension Service. The Extension activities in the United States have been summarized by C. B. Smith in his book, "The Agricultural Extension System of the United States", published in 1930.

The utilities greatly assist this effort in education of the farmers by publication of information bulletins and guide books; by holding demonstrations and taking part in meetings; and by exhibition of illustrative movies, pictures, models and other visual aids. The efforts of the utilities are similar and parallel to those of the Government.

Place of utilities in the REA programs:

During the past decade, REA has been the principal organization in the field of rural electrification. Combined efforts of the REA and the power companies in the extension of rural lines and education of the farmers have facilitated the task of rural electrification which the REA took upon itself to perform. There are several programs of development in progress in the various states.

A few instances of the work in progress in the different states will illustrate what place the utilities occupy in the REA development and extension programs.

In Indiana:

The Board of Public Works, City Hall, Logansport, Ind., has a plan in progress for changing the distribution voltages from three-wire, 2300 volts to four-wire, 4160 volts in the municipal electrical installations. This will enable an increase in the areas served at present.

Also the Board of Public Works, City Hall, Jasper has under way a plan for additions and extensions in the local municipal steam generating plant.

The REA has allotted the Hendricks Rural Electric Membership Corp., Danville, Ind., a sum of \$55,000 for the construction of new rural lines and electrical installations in the rural areas covered by the membership of the Corporation.

In Iowa:

State Board of Education has approved plans for expansion and improvements in the existing power plant at the Iowa State College, Ames. The cost is estimated to be nearly \$700,000. The additional installations will add to the research and educational facilities available at the college.

In Kansas:

The REA has made an allotment of \$40,000 to Leavenworth Jefferson Electric Cooperative, Leavenworth, Kansas,

for the installation of new rural lines and additions to the existing lines in the State of Kansas.

In Kentucky:

The REA has allotted the Fleming-Iason Rural Electric Cooperative, Flemingsburg, Ky., a sum of \$300,000 for the construction of new rural electric lines, generating stations, etc. and improvements in the existing installations in the state.

In Louisiana:

Sewerage and Water Board, New Orleans, La., has a plan in progress for the expansion of the waterworks power station.

The REA has made an allotment of \$200,000 to Jefferson Davis Electric Cooperative, Jennings, La. for the electrification of unelectrified farms in the state.

In Massachusetts:

A new power house has been planned by Ludlow Manufacturing and Sales Co., Ludlow, Mass. The primary urge for the installation of a power house comes from an existing local textile mill.

In Minnesota:

A new 7,500 H.P. plant is being installed at Foot Lake by Otter Tail Power Co., Fergus Falls. The plant is expected to function in 1947. The estimated cost is nearly \$1,000,000.

The plans for increasing the capacity of the municipal plant in Minneapolis, Minn. are under way.

The Water and Light Commission, Virginia, Minn. has plans for improvements and additions to the local municipal power plant.

During the year 1943, the REA has allotted \$545,000 to cooperatives in the State of Minnesota for the construction equipment as follows:²

Central Minnesota Cooperative Power Association, Clements, Minn.	\$245,000
Red Lake Electric Cooperative, Red Lake Falls, Minn.	\$200,000
Lake Region Cooperative Electrical Association, Pelican Rapids, Minn.	\$100,000

In Missouri:

The REA has allotted the Consolidated Electric Cooperative, Mexico, Mo., a sum of \$100,000 for erecting new rural lines and installation of additional equipment in the State of Missouri.

In Nebraska:

Six more REA districts will be served by a new transmission line from the existing installations of Central Nebraska Public Power & Irrigation District, Hastings, Neb. The new transmission line is planned to make way for further extensions from the North Platte Transmission lines of the Platte Valley Public Power & Irrigation District. The project in hand at present is estimated to cost \$700,000.

Consumers Public Power District, Lincoln, Neb., has planned out a five-year expansion program beginning 1943.

The expenditure planned for the year 1946 is in the neighborhood of \$3,000,000.

In Pennsylvania:

Metropolitan Edison Co., Reading, Penn., has plans in progress for large additions to the generating station at Middletown.

In Oregon:

North-Western Electric Co., Portland, Ore., has plans for installation of additional transmission lines operating at 110,000 volts. The cost will be nearly \$500,000. Several additions to distribution lines have been planned.

In Tennessee:

The Town Council of Clarksville, Tenn. has plans for renewing the street-light installation on modern lines.

In Texas:

Water and Light Department of Brownsville plans an extension and improvement in the municipal steam-electric generating station.

In Washington:

Public Utility Districts have in progress plans for extension of rural transmission and distribution lines.

The extension in the hydro-electric generating station of the Pacific Power and Light Co., Portland, Ore., at Neches, is under way.

In Wyoming:

The Bureau of Reclamation, Denver, Col., has in progress installation of new 34,500 volt transmission lines

and 2,400 volt distribution lines. These lines will primarily supply the construction works at Boysen Dam, Wyo., a part of the Missouri Basin Project.

There are numerous such instances of progressive efforts by the Government as well as the utilities in the various states. These few quoted above however, illustrate the position that the utilities occupy in the Government efforts.

Future Plans of the RRA:

The extensive surveys conducted by the RRA have resulted in the postwar plans for complete electrification of rural America. The report of the Inter-bureau Committee on Postwar Programs of the United States Department of Agriculture, published in 1945, outlines these plans. They provide for the extension of the electrical lines to 3,655,000 rural consumers within the next five years. The estimated cost based on prewar expenditure data, is \$1,040,000,000.²¹

It has been estimated that due to this extension in rural lines, the consumers will require \$470,723,000 for wiring, \$267,248,000 for plumbing and \$1,279,249,000 for electrical equipment. Parallel to the national 5-year program of extending rural lines therefore, is another 5-year program of financing the consumers. Under this program, the amounts estimated above will be spent in five years from the date the consumers are connected to the lines.

In addition to these future programs, expenditures are to be incurred in financing those consumers who were connected in 1944 i.e. before the report of the Inter-bureau Committee referred to above, was prepared in 1945. The total expenses for this item has been estimated at \$2,500,051,000.

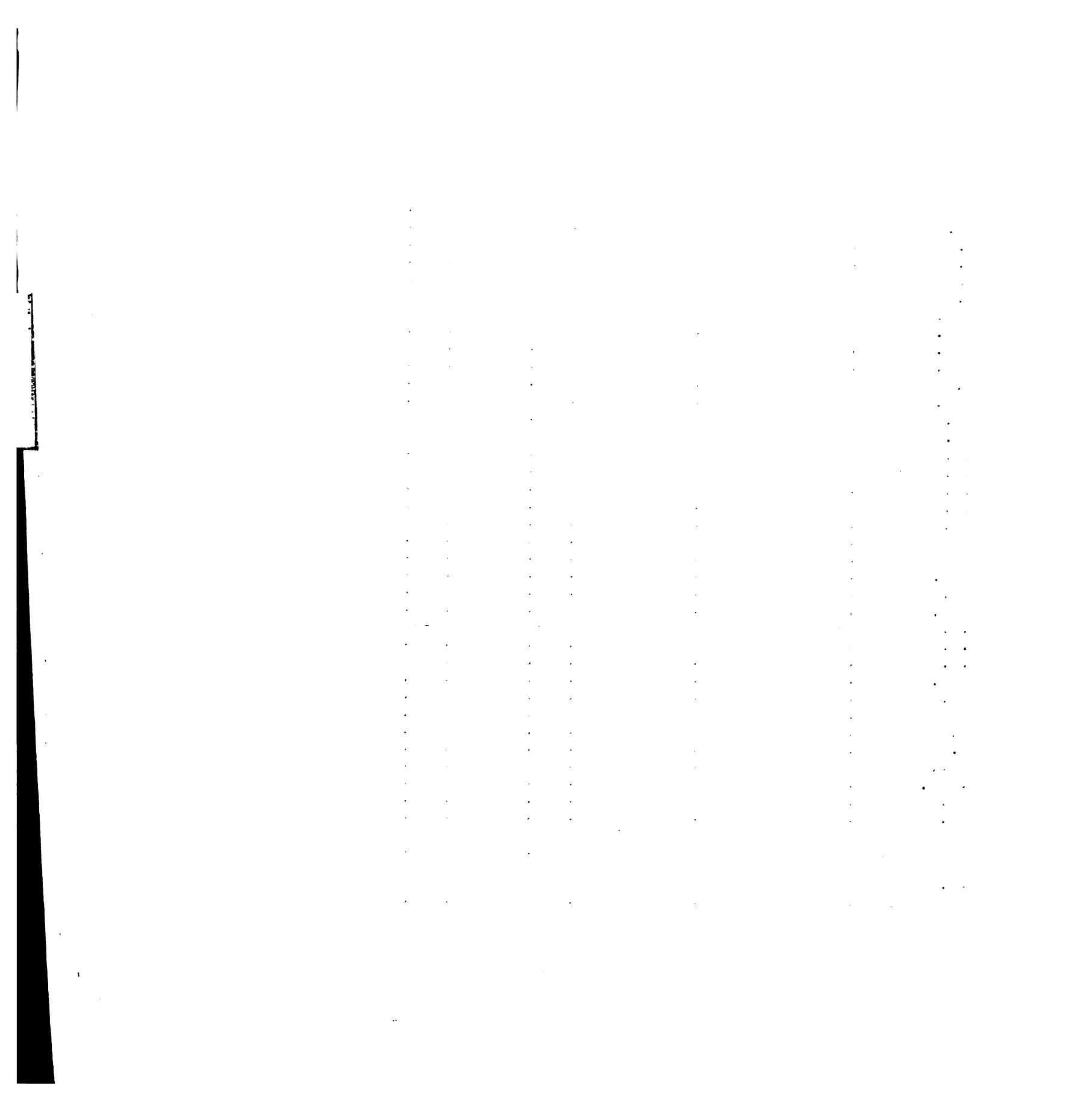
Federal allotments for the three-year tentative program of the REA:

The REA has a tentative three-year program of rural electrification in progress. This program forms a part of the Inter-bureau Committee's plan. It involves a total investment of \$560,000,000, which will be loaned by the REA to its borrowers throughout the United States. This amount is in addition to the previous federal allotments to the REA which amounted to a total of \$564,333,134 till June 30, 1945. The accompanying table indicates the extent of the tentative programs outlined by the REA for different states in the three-year plan.^{b1}

State	Rural consumers to receive service	Total man-years of labor	Investment required for program	
			Distribution lines	Related facilities
	Number	Number	Dollars	Dollars
Ala.	42,700	5,000	10,000,000	2,000,000
Ariz.	3,200	1,000	2,000,000	100,000
Ark.	47,400	7,000	15,000,000	5,100,000
Cal.	3,700	800	1,500,000	750,000
Cal.	13,900	3,000	8,000,000	3,400,000
Conn.	--	--	--	--
Del.	3,000	500	1,000,000	350,000
Fla.	10,100	1,300	5,000,000	1,750,000
Ga.	33,500	10,000	20,000,000	8,000,000
Ida.	3,100	1,000	3,000,000	1,250,000
Ill.	42,700	7,800	15,000,000	4,500,000
Ind.	34,800	8,000	10,000,000	4,525,000

State	Annual con- sumers to receive service	Total man- years of labor	Investment required for program	
			Distribution lines	Related facilities
	Number	Man-year	Dollars	Dollars
Iowa	51,000	10,000	20,000,000	7,000,000
Kan.	27,300	4,000	3,000,000	3,500,000
Ky.	10,000	3,000	10,000,000	3,500,000
La.	37,000	8,000	10,000,000	3,100,000
Me.	1,700	200	400,000	125,000
Ma.	3,000	1,200	2,500,000	800,000
Mass.	--	--	--	--
Mich.	12,500	2,000	4,000,000	3,600,000
Minn.	37,700	11,000	22,000,000	2,500,000
Miss.	33,300	3,000	12,000,000	3,500,000
Mo.	114,000	15,000	30,000,000	18,500,000
Mont.	10,300	2,000	4,000,000	1,100,000
Neb.	24,700	3,500	11,000,000	2,300,000
Nev.	500	100	200,000	55,000
N.H.	2,800	500	1,000,000	950,000
N.J.	300	200	300,000	150,000
N.M.	3,800	1,500	3,000,000	1,150,000
N.Y.	3,600	1,000	2,000,000	350,000
N.C.	71,200	3,000	10,000,000	10,000,000
N.D.	13,300	3,000	3,000,000	3,000,000
Ohio	13,300	2,500	3,000,000	2,750,000
Okla.	77,700	10,000	28,000,000	13,800,000
Ore.	13,300	2,500	5,000,000	2,000,000
Penn.	17,200	3,000	6,000,000	3,500,000
R.I.	--	--	--	--
S.C.	31,000	3,000	7,500,000	3,550,000
S.D.	14,700	3,000	6,000,000	1,750,000
Tenn.	37,900	6,000	12,000,000	4,600,000
Tex.	137,200	21,000	30,000,000	16,000,000
Utah	2,500	400	750,000	300,000
Vt.	4,000	800	1,500,000	1,350,000
Va.	26,200	4,000	8,500,000	6,700,000
Wash.	12,200	3,000	6,000,000	1,750,000
W. Va.	3,200	500	1,000,000	350,000
Wis.	34,400	6,000	12,000,000	3,700,000
Wyo.	3,900	2,000	4,000,000	1,300,000
Alaska	900	200	400,000	300,000
Virgin Is.	1,000	100	200,000	200,000
U.S. and Territories	1,599,300	202,000	403,750,000	175,455,000

This tentative program of the FEA is calculated to aid in stabilizing the national economy during the present period of economic turmoil almost all over the United States.



It will provide employment to the unemployed and bring the benefits of the electrical methods within the reach of millions of farmers whose farms still await electrification.

The importance of the future programs of
rural electrification in national economy:

The complete plan as outlined by the Inter-bureau Committee, envisages a total expenditure of over 5½ billion dollars. It will require over 2 3/4 million man-years of work, which will provide employment to the American labor and returning veterans. The rural industries will make progress. It will facilitate decentralization of large national industries and encourage individual enterprise. The aim of the entire plan is to spread more education among the people of America, raise their standard of living and ultimately to enhance the economic, social and cultural progress of the nation.

CHAPTER XIV

General conditions of agriculture
in India:

In order to realize the usefulness of electricity and electrical equipment in India, it is desirable to have a general picture of the agricultural conditions and the farmers' life in the country. This chapter therefore describes the topography, climate, soils and the methods of raising and handling farm crops, rearing cattle, handling dairy produce, processing and preservation of foods, etc., as they exist in India.

Topography, soils and climate:

The subcontinent of India extends over an area of 1,531,400 square miles or 1,012 million acres approximately. It extends nearly 2000 miles North-South and 2000 miles East-West at the widest points. It has a population of 339,000,000. The country as a whole is divided into three main regions:

1. Mountainous region covering the North, Northwest, Northeast, Southwest, and parts of the Southeast in India.
2. Submontane region consisting of table land about 1000 feet to 3000 feet in attitude covering the whole of the Southern peninsular area called the Deccan plateau¹ and the land lying on the borders of the mountainous region.
3. Agricultural plains consisting mainly of the great Indo-Gangetic plain² lying between the two great rivers of India viz, Indus and Ganges. This plain covers the most part of the Northern and Central India extending westwards along the

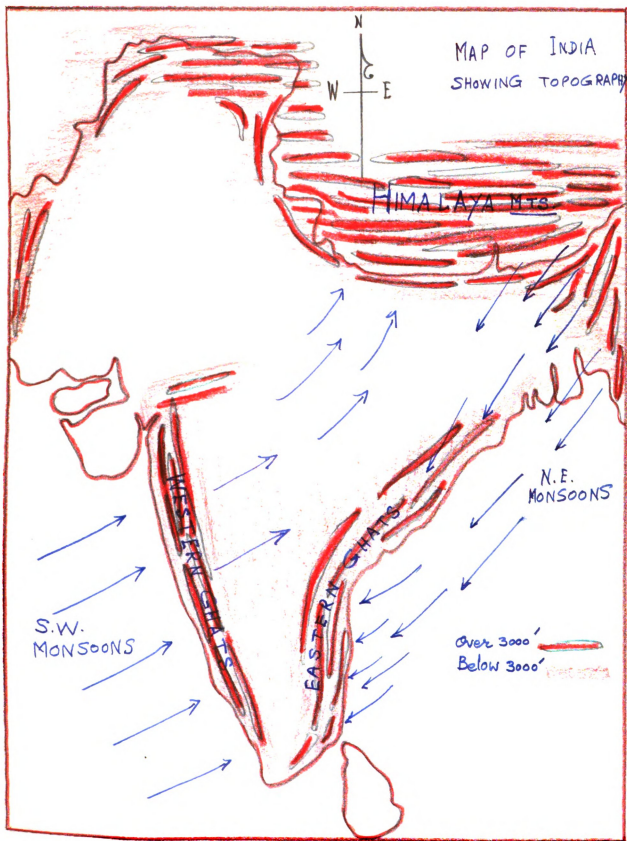
banks of the Indus River and eastwards along the banks of the Ganges River. The land of this region consists of rich riverian soils and is thickly populated. Besides this large agricultural plain, there are valleys scattered all over the country.

The total culturable area of the country is 353,000,000 acres besides forest land of about 63,000,000 acres. Out of this only 212,000,000 acres is cropped annually to support over 300,000,000 people and approximately 380,000,000 head of cattle, sheep and goats. Nearly 37,000,000 acres is not available for cultivation.

The annual rainfall is received mostly from the monsoon winds blowing from the Southwest to the Northeast direction across the country during the summer months, viz. June to October. In the winter months, the monsoon winds blow from Northeast to Southwest causing light showers of rain in the eastern parts of the southern peninsula. (See map of India on the next page.) The rainfall varies in intensity from less than one inch to over 450 inches annually in different parts of the country. The bulk of agriculture is in the areas having annual rainfall between 15 to 150 inches. In areas where the rainfall is less than 15 inches, agriculture mainly depends on irrigation for which either large canal and tank-irrigation systems or well-irrigation and pumping systems¹³ exist.

The soils are generally rich in plant food with plenty of nitrogen-fixing bacteria found in the roots of stray-growing Leguminosae plants¹⁴ all the year around.





They vary from sandy "Desert Soils"¹⁵ to heavy "Black Cotton Soils."¹⁶ Besides, there are patches of medium "Red Soils"¹⁷ and the rich "Forest Soils".¹⁸ Except for localized patches of wet areas in the regions of heavy precipitation, the land is generally classified as "Dry Land" as against the "Wet Land" in most of the European countries and most parts of the U. S. A. One of the problems of agriculture therefore is conservation of soil moisture as against the problem of drainage of excess water in the European and American soils.

Crops grown:

Due to the almost unlimited variety of soil and climate, nearly every crop known to agriculture can be grown in one or the other part of India. The various kinds of food grains, oil seeds, fibers, drugs and narcotics, spices and condiments, vegetables, sugar crops and fodders are among the crops grown in India. The two major food crops of the country are rice and wheat covering 69,000,000 acres and 26,000,000 acres respectively out of the total area of 187,000,000 acres under food crops. Among other food crops are millets, sorghums, barley, pulses¹⁹ and corn (maize).

Seasons and methods of cropping:

The wide variation in the cultivation practices as suited to the different soil and climatic conditions, makes it almost impossible to state a general method of cropping for India as a whole. Over a large part of the

country, however, two seasons of cropping are recognized during the year:

- (1) From the month of May to the middle of October: This is the rainy season in India called the monsoon season. The crops grown during this season are locally called the 'kharif crops'. This season is also called the 'kharif season'.
- (2) From the middle of October to the beginning of May: This is the non-rainy season in India. The crops grown during this season have to depend mostly on the soil moisture retained by the soil after the rainy season and partly on artificial irrigation. These crops are called the 'rabi crops'. This season is also called the 'rabi season'.

If the rabi crops are early-maturing such as certain types of sorghums, they may be harvested by the end of January. In that case hot weather crops such as vegetables or other irrigated crops may be sown in the month of February following the rabi crops. These hot weather crops are harvested by the month of May.

Thus there are three seasons of cropping in India, the 'kharif season', the 'rabi season' and the 'hot weather season'.

The farm operations comprise the usual sequence of plowing, clod-crushing, harrowing, manuring, sowing, weeding (or inter-culturing), irrigation, application of fertilizers wherever necessary, harvesting, threshing and winnowing or processing and preparation for the market according to the requirements of the individual crops. For certain crops, special treatment of the soil is necessary for proper growth. E.g. spices, condiments, sugar cane, tobacco and vegetable crops like potato,²⁰ suran²¹

require special treatment of the soil from time to time during the period of their growth.

Investment and capital:

The farm holdings are generally small. Often only a few acre fields are held or filled by a farmer. There is a tendency of the farmers to invest as little as possible in permanent structures, machinery, farm roads and farm-fencing. Animal power is mostly used for draft. Manual labor is preferred to mechanical labor due to high cost of the latter. All the farm operations are generally handled jointly by a farmers' family which either jointly owns a piece of land or works on a farm for a landowner, also called 'zamindars'. The farmers receive for their labor approximately one third of the total produce or income therefrom after the harvest of the crops. Within this income, usually the farmer is to use his own implements and draft animals necessary for raising the crops. This system of landowners and farmers together with other existing defects in land tenure system and in the laws of inheritance, has resulted in the fragmentation of land holdings and has reduced the standards of living of the farmers in India.

Agricultural implements used:

The agricultural implements used are usually indigenous and simple in construction. They require almost no initial investment. These implements have repeatedly been reported upon by the experts appointed from time to time

as remarkably well suited to the operations for which they have been designed. They can be easily repaired without outside aid. Usually the implements for plowing, harrowing, and inter-cultivation comprise a wooden head piece, a wooden handle, a wooden beam for being tied to the yoke for the draft animals and an iron working part suitably designed for various agricultural operations.

Irrigation:

Irrigation is usually given by means of a network of ditches or channels. The water is allowed to run through these channels by gravity. Where the land is higher than the level of the irrigation water available, the latter is raised by means of a persian wheel, wheel²² or other form of water-lift employing animal power. Pump irrigation is used in certain areas especially in orchards. These pumps are usually operated by oil engines.

Harvesting:

Harvesting is done by hand labor. For crops like wheat, millets and sorghums, a sickle is used to cut the crop close to the ground by hand labor. For other crops the method of harvest is adjusted according to the nature of the crop, e.g. hand-picking for cotton, digging for potato and suran, etc.

Threshing and winnowing of grain:

Threshing of grain is done by letting the animals tread over the grain. Winnowing is done by dropping the grain from a height of about eight to ten feet on a windy

day. The grain is separated from the chaff by the action of blowing wind. On some farms, mechanical threshing and winnowing machines are used. These machines, though found useful, have found little favor with the farmers due to the initial investments of capital required for the purchase of imported machinery.

Storage:

For grain crops, the grain is commonly packed in gunny bags.⁸⁵ Bagging is done by hand labor. Other crops are packed according to the nature of the crops.

A farmer stores his produce in crudely constructed store houses. For several crops, no covered store-houses are used at all. But for expensive crops like tobacco, spices and certain vegetables, store-houses are constructed. Larger farms have specially constructed store-houses for storing crops like potatoes, tobacco and grain crops.

Hay-making:

Hay-making is usually not practiced in India. Wherever practiced, manual labor is used for harvesting. Animal drawn mowers are also used for harvesting. Bundling is done by hand labor. Bundles of hay are dried by exposure to the sun. No mechanical method of drying is practiced. The bundles are then transferred to the barn by hand labor.

Sugar cane crushing:

In many parts of India, crushing of sugar cane is done on the farm. A sugar mill is usually used for crushing. Sugar mills are operated by animal power. The

sugar cane juice is then boiled over a specially constructed furnace in specially made large boiling pans. By boiling, the sugar cane juice is converted to crude sugar locally called "gani".⁵⁴ For the manufacture of refined sugar, the sugar cane is sent to the sugar factories where it is crushed in machines operated by prime movers. The production of refined sugar in India made appreciable progress during the past years until its progress was checked by the World War II.

Care of the animals:

Fodder crops are fed to the animals either in the form of green feed or as ensilage. Feed cutting and ensilage-cutting is done by means of a knife cutter operated either by animal power or by mechanical power.

Draft and dairy animals on the farms are usually stalled in poorly lighted barns constructed without professional advice. Ordinarily farms in India are not provided with electrical installations. In large dairies supplying their produce to the cities, the barns are constructed under architectural advice. Some of these barns are provided with electrical installations.

Drinking water is provided to the animals at intervals from an open tank by the herd attendants. Usually no water heating arrangement is made in the barns. Cleaning of the barns is done by manual labor. Sheep and goats are kept in barns. Almost no machinery or electrical equipment is used for maintaining these herds. Sheep

shearing is done with hand operated clippers.

Milking the animals, cleaning the dairy utensils and most of the animal husbandry work is done by manual labor. This is partly due to the high initial cost of imported machinery and partly due to the costly rates of electrical energy. In smaller dairies handling only milk supply and smaller quantities of dairy produce, almost all the work is done by manual labor. Larger dairies are usually equipped with electrical power for milk pasteurization, cream separation, butter manufacture, cheese manufacture and other dairy processes.

Food processing and preservation:

Food processing and preservation is usually done in the factories which are specialized in handling such work. Usually such factories are equipped with electrical power and lighting. Due to high initial cost of electrical machinery and high electrical energy costs however, the use of electrical equipment is limited in extent. Mechanically operated devices are commonly used in food processing, dehydration, fruit preservation, extraction and bottling of fruit juices, preparation of marmelades, jellies, ketchups, etc. Freezing of foods is not commonly practiced on any noticeable scale.

The farmer's home and living:

The farmer's life in India is on the whole full of toil and drudgery with meager wages in return for him and his family. The farmer's home is usually crudely built

with the help of his family. He is deprived of all modern conveniences such as electric lighting, flowing water supply, water and house heating arrangements and mechanical appliances. Due to inadequate communication systems and highways in the rural areas, the farmer is almost entirely cut off from the cities. He is usually content with his lot if his crops have not failed. His knowledge about the world is limited to his family and neighborhood. He knows little about modern homes and home conveniences. Due to his illiteracy, he is unable to make a judicious use of his finances, labor and the utility services available to him.

CHAPTER XV

Development of electrical power
in India:

The electrical energy first came to be used for lighting and industrial purposes early in the twentieth century in the various parts of India. Generation of electricity was largely by oil engines. The first hydro-electric plant of any magnitude in India - rather in the entire East, was inaugurated in 1902 in the Mysore State²⁵ on the Cauvery River.²⁶ This plant is situated at Swasamudaram²⁷ and was started primarily with the object of supplying electrical power to the Kolar Gold Fields, about 92 miles away from the site. The plant has since expanded. About 50,000 lighting and power customers are supplied with 42,000 kilowatts from this plant at present. Besides, there are other smaller hydro-electric stations in the Mysore State such as the Shimsa Falls plant producing 17,200 H.P. A new hydro-electric station to produce 42,000 H.P. at the first instance has been planned at the Jog Falls²⁸ where a natural waterfall of 955 feet exists.

The electrical transmission system in the Mysore State comprises 366 miles of transmission lines carrying 73,000 volts and 37,500 volts.

Hydro-electric energy in Bombay Province:

The greatest hydro-electric undertakings in India are centered in Bombay, which is India's greatest manufacturing

center and ranks second largest, next to London, among the cities of the British Empire. The Tata Hydro-Electric Agencies Limited²⁹ have several hydro-electric projects or schemes in Bombay supplying nearly 2,000,000 people, a total of approximately 331,000 H.W. at normal capacity. Out of this total supply, 150,000 H.W. is used in cotton mills and other factories in the vicinity of Bombay. In the northern parts of Bombay Province¹, a Grid System is underway similar to a British Grid System. The Northern Bombay Grid System will receive its supply from the existing hydro-electric works besides the two new hydro-electric stations to be installed at Bhanderdona and Bhatgar.

The chief consumers of electricity in Bombay are the Bombay Electric Supply and Traction Company (B.E.S.T. Co.), the Bombay Baroda and Central India Railway (B.B. & C.I. Rly.), the Great Indian Peninsular Railway (G.I.P. Rly.) and the city and suburbs supply companies in the neighborhood of Bombay. Electricity in this part of the country is used largely for industrial purposes and operating streetcars, railroads, etc. besides lighting and other uses in the homes.

The cost of electrical energy in Bombay is the lowest in the whole of India. There has been a steady decrease in the rates of supply of electrical energy resulting in increased consumption and demand. The present rate for electrical energy for industrial purposes averages 0.32

anna³⁰ per H.P. hr. (commonly called 'one unit' of energy).

Electrical power in Madras Province:

Of the remaining parts of South India, hydro-electric plants exist in the Province of Madras¹ and in the State of Travancore.²⁵

In Madras, the Pykara Hydro-Electric Scheme utilizes a fall of 3,100 ft. available in the passage of Pykara River in the Nilgiri District. The power is generated at 11,000 volts, 50 cycles and stepped up to 110,000 volts by means of transformers. The transmission is done on 110 K.V. or 66 K.V. lines. In addition there are smaller lengths of 11 K.V., 22 K.V. and 33 K.V. transmission lines. The Pykara Hydro-Electric System has developed comparatively rapidly since the beginning of its development in 1923.

Among other Hydro-Electric works in Madras are the Mettur Hydro-Electric and the Papanasam Hydro-Electric Schemes.

At the Mettur Power, the power is generated at 11,000 volts, 50 cycles, 3 phase and stepped up to 66,000 volts and 110,000 volts for transmission purposes. The plant is situated alongside the Mettur Stanley Dam which is one of the largest block masonry works of the world, 176 ft. high primarily meant for the canal irrigation schemes of the Province. The peak load of this power house has reached 14,000 H.P.

The Papanasam Scheme has just started operation in 1943. The power house comprises three vertical units of 3 phase, 50 cycle generators. One more generator unit is to be installed. The power house is situated at the foot of the Papanasam Falls alongside the Papanasam Dam across the Takkaspanni River in the Tinnevely District.

The Government of Madras has under consideration the Nuchkhand Hydro-Electric project on the borders of the two Provinces of Madras and Orissa¹. The plant will have an installed capacity of 51,750 H.P. initially increasing to 107,500 H.P. as the demand for electrical power increases in these districts.

Electricity in Travancore State:

In the State of Travancore,²⁵ electrical energy has been produced and supplied by private companies during the past twenty years. In 1940, a Government controlled hydro-electric system called the Pallivacal Hydro-Electric System came into operation. The power station has three units of 11,000 volts, 3 phase, 50 cycles alternator sets, each 4,500 H.P. capacity. Only two sets are in constant use thus providing a total effective capacity of 9,000 H.P. The third set is used as a standby. Transmission is done at 66,000 V overhead transmission lines. Demand for electrical energy has been on the increase and the State Government is alive to the increased needs of the State. The chief uses of electricity in this

State on the farms are the removal of water from the water logged areas by pumping, irrigation and sugar cane crushing. It is likely that more electrical energy will be produced and made available to the prospective consumers in the State.

Electricity in Kashmir State:

In the Northern India, hydro-electric works exist in Kashmir State²⁵, the Punjab Province and the United Provinces¹.

In the Kashmir State there are small hydro-electric power houses on Jhelum and Kishten Ganga Rivers besides oil engine generating units for local supply. These schemes are more important because of the development that may be expected from them. The Governments of Kashmir State and Jammu State²⁵ have under consideration schemes for additional production of hydro-electricity by utilizing the waters of the River Indus near the town of Gardherbal. Installation of the power houses at Pahalgam, Anantnag and Udhampur²⁷ and a large scale scheme of producing electricity from the waters of the River Chenab, & distributing of the River Indus are also under consideration.

Electrical power in the Punjab Province:

In the Punjab Province¹, the hydro-electric plants exist on the Uhl and Lomba Dag Rivers. The prominent hydro-electric scheme of the Province is the Mandi²⁷ Hydro-Electric or the Uhl River Hydro-Electric Scheme. The



power plant is situated near the town of Shanan. The initial installed capacity of the power plant at Shanan is 43,000 H.P. Electrical energy is generated at 11,000 volts, 3 phase, 50 cycles and stepped up to 132,000 volts for the purpose of transmission. This is the highest voltage adopted in India for transmission lines. Schemes are in hand with the Government for installation of more hydro-electric plants in the Province. The need for cheap and more electricity has been felt in this part of the country for operating more electric pumps and for introducing tube wells for irrigation purposes. This is believed to be of value in bringing under cultivation, the large areas of land which have no regular source of water supply.

Electrical power in the United Provinces:

In the United Provinces, a Grid System has been in operation for domestic, industrial and agricultural purposes. The Ganges Canal Hydro-Electric Grid makes use of the seven of the ten falls available for electrification in the Province. 27,000 H.P. energy is available from these falls besides steam power production of electricity. Two new schemes of 13,500 H.P. and 23,000 H.P. capacity respectively are in hand. The important use of electricity on the farm in this area is pumping of water from tube wells for irrigation purposes. The Government has under way the Ganges Valley State Well Scheme extending over 1,650 tube wells. Two additional schemes,

one at Ferozabad⁵⁷ on the Ganges Canal and the other Ganga Canal Hydro-Electric Scheme with an installed capacity of 55,500 H.P., are also under way in the Province.

Potentialities of India as regards to the
Development of electrical power:

The potentialities of India as regards the production of hydro-electric power have been considered to be enormous. An English engineer in a book called "HAPPY INDIA" gave a rosy picture of the hydro-electric resources of India several years ago. He figured the total length of the mountain ranges of the Himalaya and other mountains of India as nearly 3000 miles. Then he calculated the total quantity of water that flows down from the mountain tops in the form of melting snow and the rainfall run off from watersheds through the rivers into the sea annually. By this method he estimated that 150,000,000 H.P. could be generated from the falling water and rivers alone. Evidently this estimate is rather optimistic. More accurate estimates as indicated in the Reconstruction Committee of Council's First Progress Report published on March 1, 1944, show that from the existing, nearly ten times the electrical energy produced in India, could be generated.

Trends towards further electrification
of India:

The present electrical energy consumption in India is approximately 1,500,000 H.P. The need for more electrical energy is evidenced by the increasing imports of

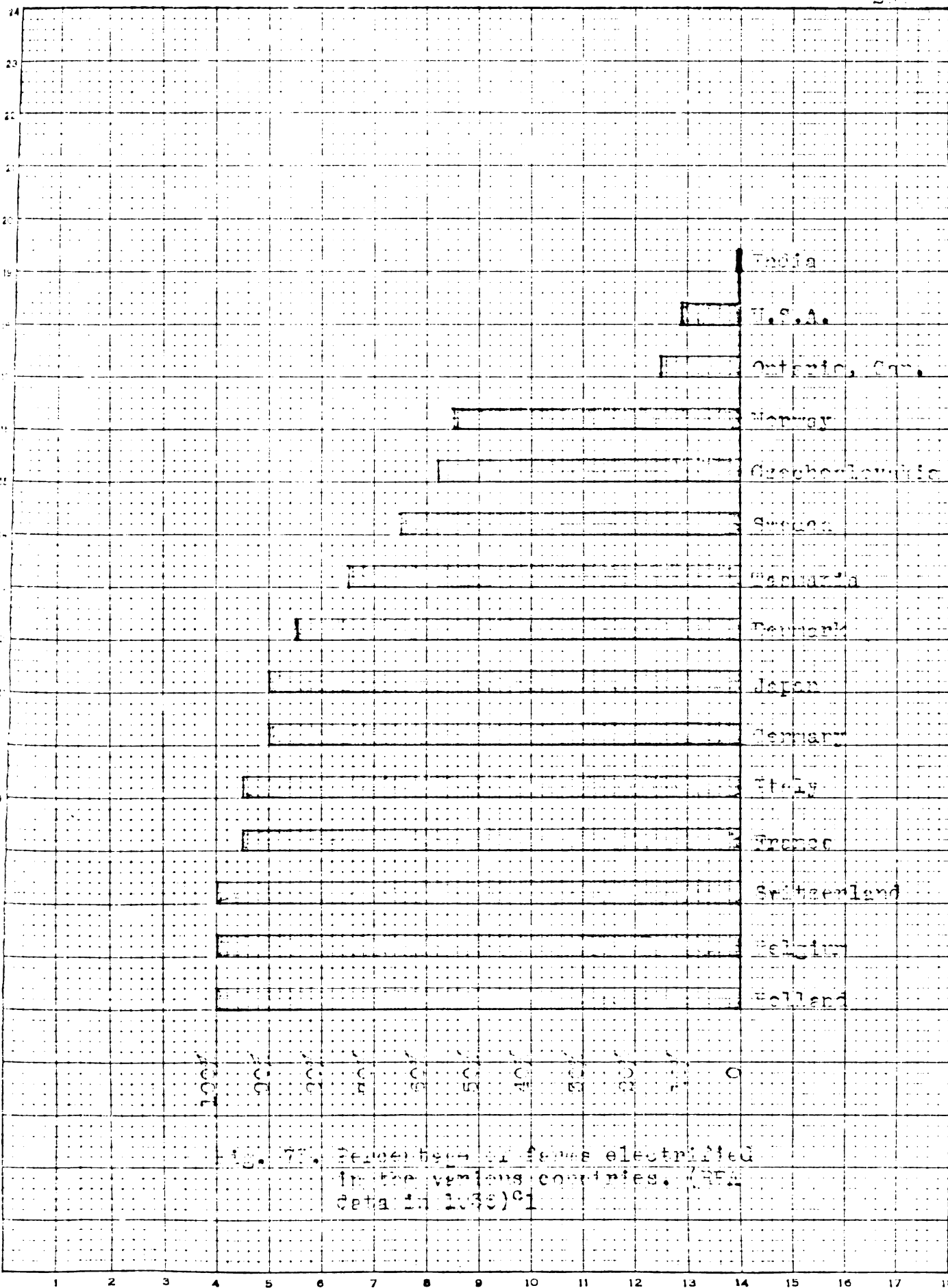
electrical machinery from the European and American countries. The figures as available before World War II for the year 1930-32 indicate a total import of electrical machinery worth Rs. 51,000,000²⁰. The trends of the India's industry, agriculture and home life have been in favor of the development of more electrical power and its wider distribution. The various Provincial Governments¹, the native States²⁵ and the Central Government have embarked on the development of the hydro-electric resources in the respective parts of the country during the recently stimulated nation-wide development program launched in 1944.³¹ Several new projects are underway. Some of these projects are receiving priority over the projects in other fields of development.

Statistics of the farms electrified
in the various countries:

The following figures indicate the approximate number of the farms electrified in the various countries as compared to India in 1936:³¹

Holland	100 percent
Belgium	100 percent
Switzerland	100 percent
France	95 percent
Italy	95 percent
Germany	90 percent
Japan	90 percent
Denmark	85 percent
Tasmania	75 percent
Sweden	65 percent
Czechoslovakia	58 percent
Norway	55 percent
Ontario province, Canada	15 percent
U.S.A.	11 percent
India	Nil.





In the other English-speaking countries such as New Zealand and Australia, there is great interest in rural electrification by the respective Governments. Figures of rural areas electrified in respect of these countries are not available. The technique of the development of the rural electric lines is similar to that in the United States discussed later in this book i.e. through the cooperative system.

CHAPTER XVI

Obstacles likely to be met with in
the electrification of rural India:

Ever since its creation, the world has been in a state of what may be called flux. This flux consists of the numerous universal, geographical, economic, political and social changes that take place around us every day, every minute and every fraction of a moment. Some of these changes could be felt or perceived. Others are even beyond the limits of human perceptibility.

Man has made efforts to adapt these changes to his needs and partly to adapt himself to these changes. By reason of geographical separation and by virtue of cultural, linguistic and religious ties, man has been separated into large groups of people talked of as nations. The efforts of different nations have resulted in different civilization and degrees of progress of the nations.

The people of India constitute a nation comprising nearly one-fifth of the total population of the world. This nation occupies only one-thirtysecond of the total area of the world. Its land forms a major part of the Orient.

Historical records and the geological findings have proved that the people of India had the earliest beginnings of civilization in the world. The recent excavations at 'Mohar-jo-Daro'³² have taken the estimated ancient civilization of India as far back as 5000 or 10,000 B.C.^{d1}

Historical background of the Indian Economics:

The economic and cultural superiority of the Orient in the distant past has been well acknowledged by the historians and geological experts of the modern ages. During the first two centuries of the Christian era, the mainstay of the Roman Empire was the trade relationships with India and China.

During the Dark Ages, following the ancient economic world mastery by the Romans, the Chinese Empire and the Indian Empire established extensive trade relationships in the eastern and the far eastern countries including Japan, Phillipine Islands, Central Asia, Persia and the east coast of South Africa.⁶¹ Attracted by the lofty heights of the social and economic development, the Middle Eastern rulers invaded the north western and central parts of India. There was a series of invasions. Among the principal invaders were the Mongolian, Afghan, Persian and Greek rulers. Many of these invasions were characterized by looting of wealth, destruction of art and weakening of the political unity of India.

The evidence of the economic prosperity of India and China is vividly found in the historic account of the travels of Marco Polo, a business man from Venice, who travelled in the far east in the thirteenth century.⁶¹ His book appeared to most readers like fantastic stories. Two centuries later however, Columbus was fascinated by Marco Polo's accounts of China and India. He set out for

Columbus and incidentally discovered America, - the new world of today.

Until the Industrial Revolution in Europe, the French, Portuguese, English and other European business men actively took part in trading with India. In the struggle for the supremacy of trade relationship with India, among the European nations, the British outwent others. They obtained trade privileges from the Indian rulers and began to take interest in the economic and political matters of India.

Beginning of the British Rule in India:

The rivalries among the native rulers whose unity had been split up by the middle eastern invaders, and internal warfare, presented an easy opportunity for the Englishmen to gain a strong foothold on India. They started with the fortification of their business centers and ended up in conquering the whole country.

India has ever since, continued to stand ear-marked as a nation of poverty, illiteracy, famines and religious strife among the people.

As pointed out in the first chapter, efforts have been made from time to time, to improve the condition of the people. These efforts have failed. It is not within the scope of this work to discuss the causes of the failure of these efforts. Suffice it to say that no previous efforts have been of enough magnitude to relieve the poor conditions of the people.

The Government Program of postwar
development in India:

During 1944-45, the Government of India chalked out a development program for the whole of India. This program aims at an all round development of the country and far exceed any attempts in the past at improving the living conditions of the people. It is based primarily on the development of industry as well as agriculture.

For the development of agriculture, an improvement in the methods of production is essential. Improvement in the methods of production includes primarily the mechanization of farming. For mechanization, the presence of some source of power on the farms is essential. In the present age, electricity furnishes the cheapest source of power. Steam power is considered as far too obsolete for being introduced on the farms.

Questions to be considered for the
electrification:

To examine the possibility of successfully electrifying the farms in India, the following five questions have to be considered:

1. Whether there is enough use for electrical or other machinery on Indian farms.
2. Whether the farmers in India have enough financial means to afford electrical installations on the farms and take advantage of the electrical methods.
3. Whether there are enough natural resources to generate electrical energy and supply it to the rural areas at economic rates.

4. Whether the country can supply and produce enough electrical appliances and equipment at low rates within the financial reach of the farmers.
5. Whether the farmers can take advantage of the electrical methods in view of their illiteracy.

Scope of the use of the electrical farm machinery:

As to the question of whether there is enough use for electrical farm machinery in India, there is considerable difference of opinion. As described in the first chapter, the methods of agricultural production are still more or less primitive. The arguments opposed to the use of electrical machinery on the farms have stressed the fact that India is primarily an agricultural country, that nearly 75 percent of the people are engaged in agricultural occupations, and that the introduction of mechanical methods will throw millions of the Indian farmers out of employment which will add to the already existing problems of rural unemployment.

Granted that the mechanical methods will displace many farm laborers and farmers from their farming occupations. Keeping the economic implications of mechanized farming aside for a moment, it cannot be denied that the use of machines on the farms will reduce the hours of work, increase the returns from the farms and eliminate the drudgery and toil of the farmers' work. The farmers that will be displaced by mechanization, should and will in the ordinary course, be more than absorbed in other

enterprises, mainly industries. Even the very industries producing the farm machinery will need men. Men will be required for selling and distributing these machines. Besides hundreds of thousands of men will find work in producing raw materials for the agricultural machinery.

Thus farm mechanization will ultimately create more employment for the rural population and help solve the rural unemployment problems.

Similar situation in the United States:

The United States had opposition during the early stages of farm mechanization. This opposition was overcome when it was proved to the farmer that with mechanization of the farm more efficient use of labor is possible, that the wages of labor increase and the prices of manufactured goods decrease thus enabling a higher standard of living for the workers. The increased buying power of the workers and a rise in their standard of living results in the creations of new industries and occupations which require more laborers, salesmen, clerks and other staff thus creating enormous opportunities for employment. It was proved by actual statistics collected by the U.S. Census Bureau that innumerable new occupations for men and women were created and the number of men and women engaged in each occupation multiplies several times during the period from 1890 to 1930.

Mechanization of farming, and the development of industry:

Mechanization of farming methods must be supported by

the development of industry. In an address delivered before the American Society of Agricultural Engineers convened at the Elmhurst Hotel, Milwaukee, Wis., in 1940, Mr. Harry C. Davis, Director of Research, Farm Equipment Institute, expressed the statement that:

"Mechanization of the farm, in view of increasing mechanization in industries whose products farmers buy, was a positive necessity to prevent agriculture from being submerged to a state of poverty such as prevails in other parts of the world where it is done without the help of the machines".¹¹

The need for industrial development in India:

In India, the Farooq Enquiry Commission, appointed after the great famine of 1943 in India, reported in 1945, that:

"Improvement in diet and a rise in the standard of living are very nearly equivalent objectives. In order to increase agricultural production and improve national diet, simultaneous industrial development to augment the total wealth of the country is essential. The growth of the industry will itself help to solve some of the most thorny problems of village economy, such as; excessive population pressure on land, rural unemployment, etc. There can be no question that India possesses great potentialities for industrial development which have as yet been opened up only to a small extent."¹²

Speaking of 'other rural economic problems', the Farooq Enquiry Commission, said:

".....We are convinced that unless the numbers employed in industry are increased very considerably, efforts to raise the standard of living of the great mass of the population will labor under a severe handicap and may prove fruitless. It is essential that a proper balance between agriculture and industry should be established; this cannot be achieved except by industrial expansion."¹³

Small size of land holdings:

One obstacle in the way of mechanization of farming methods which is rather serious in India, is the smallness of farmers' holdings. Due to the existing laws of inheritance in the various parts of India, the land holdings have become divided and sub-divided from generation to generation according to the number of members in the family. This has resulted in 'fragmented holdings', often times each holding comprising small units of only a few acres or less.

The answer to this objection will be found firstly in the modification of the laws of inheritance wherever necessary. Efforts have been already in progress during the past two decades by the Provincial Governments, in modifying these laws.

Secondly this problem of 'fragmented holdings' could be handled by forming farmers' cooperatives and by employing methods of collective farming. The objectives of such cooperatives would be to unite the farmers of a neighborhood into a group of farmers engaged in a joint farming enterprise. Often times the farms are odd shaped and situated at different elevations. Cooperative efforts at correcting these factors would be of a great help in consolidating these small units of farms into large blocks of land which could be tilled on a cooperative basis. These cooperatives will have to be given support by the Provincial Governments and granted such

facilities as the right of eminent domain, expropriation from heavy taxation, etc.

In India, there is considerable uncultivated land which could be cleared of the existing vegetation and used for agricultural production. In that case the fragmented holdings do not present an immediate obstacle in the way of mechanization of agriculture. In their first report published in March, 1944, the Reconstruction Committee of Council, said:

"India is believed to possess more than 111 million acres of land classified as culturable waste, a substantial portion of which is believed to be capable of cultivation though at a higher cost and at a considerable capital expenditure over reclamation." [1]

Low financial standing of the farmers:

The second barrier in the way of mechanization of farming methods in India is the meager financial status of the Indian farmers. Admitted under the existing financial conditions of farmers in India, it is almost impossible to expect farmers to buy imported agricultural machinery at comparatively exorbitant prices.

One solution will again be found in cooperative methods. By cooperation of the Government and the farmers' organization, by exempting the farmers cooperatives from taxation, duties, etc., it will be possible to lower those exorbitant costs and bring them within the reach of the farmers. The establishment of the rural electrification cooperatives will greatly reduce costs of installation and operation of electrical equipment. Groupings plans

of the cooperatives such as the 'group purchasing plan', 'group wiring plan', etc. may be well utilized for the reduction of costs.

The farmers' cooperatives may purchase the more expensive machinery by a 'joint purchase system' wherein the farmers will subscribe for the purchase of the machinery which otherwise they may not be able to buy individually. The machinery purchased under such plan may be operated on a rental basis or any other basis agreeable to the members of the cooperatives.

The cooperative system is not unknown in India. Several individual purpose and multi-purpose cooperatives are already in existence. These cooperatives get facilities from the various Provincial Governments in different forms such as; grant of loans at low rates of interest, concessions in taxation, etc. These cooperatives work more or less on a similar basis as the cooperatives in the United States as discussed in Chapter IV.

Another solution to this financial problem is the encouragement of the local production of agricultural machinery, which amounts to industrial development. Machinery produced locally will be cheaper than imported machinery. As pointed out by the Famine Enquiry Commission and by other authorities on industrial matters, local manufacture of machinery in India is possible and desirable in India. What is lacking is the effort to unearth the industrial capacities of the country.

The question of natural resources:

The third question to be considered for the mechanization of farming in India, is that of natural resources for the production of electrical energy. This has been partly discussed in the Second Chapter. Also it has been pointed out elsewhere in this book that India has tremendous resources for the production of hydro-electric power. The discussion of the question as to whether or not India has adequate natural resources for the production of electrical energy to facilitate industrial progress and adoption of mechanical methods of production on Indian farms, constitutes a separate subject of study. For the purpose of this work, it is enough to take the opinions of the authorities.

After a survey of the sources of electrical energy in India, Mr. J. W. Neares, Electrical Adviser to the Government of India reported in 1921 that a minimum continuous water power of nearly six million kilowatts with a maximum of 13 million kilowatts could be developed could be developed excluding all the great rivers of India which were not investigated then.⁴¹

In their first report in March, 1944, the Reconstruction Committee of council appointed by the Governments of India at the beginning of the postwar planning for India, reported:

"At present, India is very poorly supplied with electric power, the total energy generated being only of the order of one-fiftieth of that generated in the United States and about one-ninth of

that of the United Kingdom. On the other hand the potentialities of development are enormous. Technical investigations show that less than a tenth of the definitely ascertained and practicable sources of hydro-electric power have yet been exploited."11

As regards the possibility of extending electricity to the rural areas, the Tarne Enquiry Commission of 1943, foresees rural electrification of India. While discussing the development of planned industry, the Commission stated:

"It is clear that hydro-electric development is an important factor in the decentralization of industry generally and its spread in small towns and rural areas."1

Wherever hydro-electric power could not be produced or supplied from the nearest hydro-electric works, individual generation units may well be used. The cost of imported generation units being prohibitive, individual units are likely to be less popular until their production is begun in India. Mr. V. K. Mathews, Electrical Commissioner with the Government of India in his speeches before the Central Technical Power Board has repeatedly stressed the need for the local manufacture of the electrical generation equipment in India. Simultaneous with the development of hydro-electric power, manufacture of generation equipment in India would greatly encourage the increased use of electrical power.

Possibility of economic production
of farm equipment in India:

A fourth consideration prior to the mechanization of agriculture in India, is the possibility of economic

production of farm equipment in India at low rates within financial means of the farmers.

In the past few centuries, India has made little progress in the manufacture of agricultural machinery mainly because there was no demand for such machinery. The possibilities of production of machinery have been proved during World War II when a variety of complicated machinery was being produced for war purposes. It is understood that these capacities of production developed during war period have found little use in meeting the civilian needs of the country. With slight modifications, the war production machinery could be adopted to producing suitable agricultural implements and machinery. This is a phase of industrial development which has been considered essential for the effective mechanization of farming methods. Local production of agricultural machinery will lower the costs of improved machines now imported at exorbitant prices. Reduced costs of machinery will promote the mechanization of farms and hence the agricultural production.

In a speech delivered before the Central Technical Power Board in February, 1945, on "National Planning of Electrical Development in India," Mr. F. M. Mathews, Electrical Commissioner with the Government of India, emphasized the need for the production of electrical distributing equipment like transformers switch gears, line hardware, etc., in India. He believed that the

manufacture of electrical equipment in India should be economical.

The principal solution to the question of supplying agricultural machinery to the farmers at low rates, therefore lies in the nationalization of the production of this machinery.

Ability of the farmers to take advantage of the modern methods of farming:

The last and the most important of all considerations is that of the farmers' educational standing. "Are the farmers capable of taking advantage of these new methods of production?" Under the existing conditions of literacy in India, considering an average farmers, the answer is a definite "No."

Simultaneous with this situation is the situation of land tenure in India. In a majority of cases, the ownership of the land rests with the land-owners. Many of these land-owners are from the class of literate people. While it is hard to convince the actual farmers or the tillers of the lands, it should not be so very difficult to convince this class of people that the mechanical methods of production have been proved to be better and more productive from the economic standpoint. An effective solution therefore, lies in:

1. A publicity campaign designed for the literate class of the farming population by means of visual education, charts and other suitable extension methods sponsored by the Departments of Agriculture.

2. A basic education of all farmers and their children, which will classify them as life-time people and enable them to make maximum use of their finances and the utility services available.

Large scale effort necessary for successful electrification in India:

For the success of these measures outlined in this Chapter, a large-scale effort is necessary. A nationalized program will achieve far speedier results than individual efforts. The latter will limit the facilities of rural electrification only to the richest people. For the average farmer, 'cooperative effort' is the best solution. Given enough support and facilities by the Government, cooperatives formed for the purpose of rural electrification are bound to succeed in extending the electrical service to the rural areas either from the existing power resources or by generation of electrical energy either individually or in groups of cooperatives. The question of the costs of supplying electrical energy and electrical equipment is likely to present difficulty in the electrification of rural India. This question could be handled on the lines similar to those adopted in the United States. The cost of ownership and operation will also have to be brought down in a similar manner as done in the United States.

In this book, no attempt is made to work out the costs of ownership and operation of electrical equipment in India. This is because no data is available regarding the power requirements on Indian farms. The electrical

equipment produced in other countries, is priced by the manufacturers according to the costs of production in the respective countries which are comparatively higher than those of a large scale manufacture in India. Any discussion of this problem, based on the data available in the United States will involve several inaccuracies. This will, however, form a separate subject of an interesting study.

CONCLUSION

The conclusion:

India is fortunate in having the precedents of other countries which have made progress in the field of rural electrification. The development of engineering skill in the countries like the United States, France, Germany and other parts of Europe, has paved the way for the electrification of rural India. The cooperative methods developed in these countries could be well utilized in India. In addition, many of the errors committed by other countries which slowed down their progress, could be avoided in the extension of electricity to the Indian farms.

Measures necessary to be desirable for successful electrification of rural India:

The success of rural electrification in India is dependent upon the success of the development in other enterprises, namely; industry, education and the exploitation of natural resources. For the development of these enterprises, a large-scale national effort is essential. For the success of rural electrification, however, the following measures would be necessary or at any rate desirable.

1. Raising the percentage of literate population in the rural areas.

Literacy among the rural people will enable them to understand the comparative advantages and disadvantages of the newer methods of production as also it will enable

then to make an efficient use of their available finances. This may be achieved by providing adequate education facilities in the rural areas and by making primary education free and compulsory wherever necessary.

3. Education of the farmers and propagating among them the knowledge of the improved methods of cultivation including mechanized farming and employment of simple electrical devices on the farms.

For this, a vigorous education campaign is necessary. The campaign may involve activities similar to those of the Extension Service in the United States. Visual education, printing and distribution of literature, holding meetings, fairs, demonstrations, radio programs and other methods of educational publicity should be adopted. The farmers should be taught how to interpret the weather data and take precautionary measures to save their crops from damage by effects of unforeseen changes in weather. Knowledge of the improved methods of cultivation should be spread among the farming population.

Boys' and girls' clubs like the 4-H Clubs of the United States should be encouraged. This will create the farm boys' and girls' interest in the improved methods by setting up a friendly rivalry among them.

For the purpose of education of farmers and directing the energies of the younger generation raised on farms towards interesting hobbies of practical utility in life, an efficient system of extension work similar to the U.S.

Extension Service is highly desirable in the country.

3. Development of the hydro-electric power in the different parts of India.

For the development of hydro-electric power, the efforts of both, the Government and the utilities would be necessary. A thorough survey of the water power available in the country should be undertaken. Full exploitation of that power will assist industrial as well as agricultural development. It will reduce the cost of generating electrical power, a factor on which rests the success of rural electrification. Low cost of electrical power will promote the use of electrical appliances. This will increase the demand on the manufacture of the electrical equipment, wiring and installation materials. Mass production of these commodities will again lower their costs. Thus the cycle will be repeated resulting in the spread of electrification in the country.

4. Development of the industry.

This has been considered essential for the progress of a nation as evidenced by the example of other progressive nations who enjoy the benefits of an economic superiority in the world.

By industrial development is meant the manufacture of all industrial products including agricultural machinery and the power-generation equipment which would be used on the farms for increased agricultural production. This will reduce the costs of the agricultural machinery



necessary in mechanical methods of farming as also it will be possible to design of equipment and machinery suitable for the local requirements.

5. The arrangement of the individual power-generation units in the areas where hydro-electric power is not available from central stations.

For this it is necessary that the power-generation units be manufactured in India to reduce the initial cost of such units which might otherwise be a deterring factor.

These units might be operated on fuel oils.

6. Search for more raw materials including mineral oils, required for industrial and agricultural progress.

More raw materials will lower the production costs of machinery. More fuel and lubricating oils will reduce the cost operation of the equipment. Where hydro-electric power is not easily available, this will lower the costs of electrical energy produced. It will reduce the cost of tractor farming and the transport of industrial as well as agricultural products.

Development of the mining industry and a survey of the mining areas is necessary. Large deposits of ores and mineral oils are said to exist in the mountainous regions of India.

7. Opening of the cultivable waste lands existing in India.

Before opening up any virgin land for agricultural

purposes, due consideration should be given to its importance for other purposes such as: forest or other reserves. Heavy land cleaning machinery may have to be imported in the earlier stages till India produces similar machinery locally with modifications in design suited to the local requirements.

8. Development of the cooperative methods of farming, production, and marketing of produce.

The formation of farmers' cooperatives should be encouraged by granting them facilities such as; the right of the eminent domain, loans at low rates of interest for specified purposes, exemption from certain taxes, heavy customs and import duties, etc. Methods of collective farming and grouping system should be developed as suitable to the local requirements.

9. Development of highways and communication systems.

This will assist the distribution of agricultural machinery and the marketing of the agricultural and industrial products. It will greatly assist in achieving a better distribution of food among the people.

India is believed to have an excellent telegraph communication system. The highway system is however, yet inadequate and poorly developed. It is necessary that a convenient network of highways be constructed all over the country to facilitate transport from the farms and between towns and cities.

Besides there is ample scope in the development of railroad communication. Mr. V. L. Mathews, Electrical Commissioner with the Government of India, has emphasized the scope of electrification of railroad communication in India.

The progress of radio communication has been comparatively slow. Developments in this field will enable closer contact of the farmers with the city markets. Also with an efficient broadcasting system, education of the farmers and rural development work is made more efficient.

10. Introduction of the national elements in the formation of industrial and economic policies of the nation. In the past the national leaders have complained against the presence of an anti-national element in the industrial and economic interests of the country. The following paragraph quoted from Pandit Jawaharlal Nehru's³⁴ book entitled "The Discovery of India", published in 1946, will illustrate the national feeling towards this issue. While discussing the destruction of India's industry and the decay of her agriculture, he says:

"India became progressively ruralized. In every progressive country there has been, during the past century, a shift of population from agriculture to industry; from village to town; in India this process was reversed, as a result of British policy. The figures are instructive and significant. In the middle of the nineteenth century about fifty-five percent of the population is said to have been dependent on agriculture; recently this proportion was estimated to be seventy-four percent. (This is a pre-war figure.) Though there has been greater industrial employment during the war, those dependent

on agriculture actually went up in the census of 1911 owing to the increase of population. The growth of our large cities (chiefly at the expense of the smaller towns) is apt to mislead the superficial observer and give him a false idea of Indian conditions."r1

It is therefore necessary that the alien element in the formation of the national and international policies be eliminated as far as possible. This will include the switch-over of control over large industrial concerns, which have considerable effect on policy formulation, from the anti-national elements to the national elements present in the country.

The future of rural electrification in India:

With the recent political changes in India and the advent of the National Government having come into existence, the alien influence on the economics of the country is likely to decrease. The impetus received by the industry during the war period should therefore continue to promote the national industrial progress.

While the National Government is faced with the immediate task of settling the communal disturbances, a serious famine hovers around the country. To avert the famine, more agricultural production and better distribution of food-stuffs is essential. It should therefore, be not long before the development of agriculture and industry takes place in India.

The development plans have already been laid out by the former Government of India prior to the formation of

the National Government. The plans aim at an all round development of the country. They provide for a raise in the education and health of the people, development of the industry and hydro-electric power, improvement in the highways and communication systems, development of the agricultural and mineral resources, and in numerous other fields of development.

Modification of these plans will have to be necessary according to the policies of the new government. The efforts of the National Government are likely to receive better public cooperation partly due to the sincerity of efforts and partly due to the psychological effect on the minds of the people who have struggled in the past years for the formation of a National Government.

The conditions in India are therefore favorable for a revolutionary economic progress. The agricultural and industrial progress constitutes an important part of the entire plan of progress in the country. The progress of agriculture and industry needs must be preceded by the development of electrical power.

In the immediate future in India, there are three multi-purpose projects similar to the Tennessee Valley Authority in the United States. The three projects combine the purposes of irrigating nearly 6,000,000 acres of unirrigated agricultural land and generating about 1,500,000 h.p. of hydro-electric power. Besides these three main projects, there are numerous minor projects.

The hydro-electric power generated will be used in the development of industry and agriculture. As a result of all these projects, India's food production is estimated to increase by nearly 2,000,000 tons annually.⁷⁵

The period of transition from agriculture to industry and from the primitive methods of production to the mechanical methods is likely to be rapid and hard for the people to adjust to. But like every other country, India has to undergo industrialization. The development of electric power is the first essential for industrialization. On the farms, this electrical power will find ready use in the cottage industries for which there is an unlimited scope in India.

Nearly 80 percent of the Indian population live in approximately 700,000 villages. About 75 percent of the people toil in the hard way, from dawn to dusk, on the farms. Yet their lives and the lives of their family rest on a thin string between existence and starvation. What they need is an assured income which they have been denied in the past.

What India needs therefore is a new plan of economy; a plan that will eliminate the wide gulf between the living standards of the rich and the poor; that every man, woman and a child will be assured of a healthy living and that every citizen, every family will be provided with at least the minimum necessities of life; a planned economy that would place India again in lime light and would regain for her, her lost position in the world economics.

SUMMARY

The object of this study is to review the historical and the development aspects of rural electrification in the United States with a view to the possibility of their application in India.

The text describes the early efforts of the utilities and the organizations like the NRPA before and after the creation of the REA, in promoting the use of electricity on the American farms. It discusses briefly, the social and economic importance of rural electrification and the obstacles overcome by the various agencies such as the utilities, the NRPA, the college and the REA, which have been responsible for pioneering and the progress of rural electrification in the United States. The methods employed by these agencies in promoting the use of electricity on the farms and in extending the rural electrical service, such as the establishment of electrical co-operatives and the Extension Service activities in educating the farmers in the economic way of using electricity on the farms and in the farm houses, are described.

The various uses of electricity on the farm in dairy, poultry, animal husbandry, food processing, storage of feeds, horticulture, farm workshop and in the farm home are described. The economic aspect of these uses of electricity is dealt with for the conditions existing in the United States. The approximate initial cost and the annual cost of ownership and operation of the electrical

equivalent units of electrical power is indicated. The electrical energy consumption for the various electrical appliances as a unit of farm and in the farm home are indicated.

The present position of rural electrification and its future in the United States is briefly discussed by considering the work being done in the different states. The financial allocations made in the past years and for the future program of the U.S. have been summarized to indicate the extent of development and progress that has taken place in the past and that might be expected in the future, in the field of rural electrification in the United States.

The general conditions of agriculture in India are described, indicating particularly the methods of farming and handling the farm produce. The development of electrical power and the present status of electrical energy production in the various parts of India is summarized. The statistics of rural electrification in the different countries are represented graphically.

The need for rural electrification in India, is indicated by quoting the views of authorities. The probable difficulties in electrifying the Indian farms are outlined in view of the existing land tenure, financial status of the farmers and the lack of industrial development in the country. The factors essential for the successful extension of electricity to the rural areas in India

the author's view.

The book is a valuable source of successful electrification of rural areas. The success of rural electrification in India, are indicated.

The text is illustrated by maps, graphical representation and photographs wherever necessary. The footnotes are given at the end of the text. These are followed by a list of the literature cited and bibliography respectively.

ANNEXURE

1. British India is divided into eleven Provinces, each under a Governor and Provincial Government. The latter is under the general supervision and control of the central Government which may be said to direct all this work, compared to the Federal Government in the United States.

The names of the eleven Provinces are: Bombay, Madras, Bengal, United Provinces, the Punjab, Bihar, the Central Provinces and Berar, Assam, the North West Frontier, Orissa and Sind.

2. The 'cultivator' has been used by Dr. Voelcker in his report in 1887 meaning 'farmers'.

3. Dr. Voelcker suggested the forest areas be restored for fuel and fodder purposes. These areas he referred to 'Fuel and Fodder Reserves'.

4. U.S. Extension Service is an organization of the U.S. Department of Agriculture, for spreading education and information among the population of the rural areas, by publishing literature and other activities as explained in the text.

5. During the twenties, the rural electrification statistics showed that there were 3 customers for every mile of the less electrified areas, and that the lowest farm consumer used about 100 k.W. hr. of electrical energy per month. Hence this was taken as the basis of extending electricity to new customers. This basis has since been changed. Rural lines are extended to customers even if they are two per mile. Monthly consumption of electrical energy has greatly increased.

6. These calculations are only approximate based on the rates prevalent during the twenties.

7. A transformer is required at each stage where the voltage is changed. Thus for stepping down the transmission voltages to the distribution voltages and the latter in turn to the domestic purpose voltages, transformers are required.

8. The name of American manufacturer.

9. These prices are approximate and based on the price levels in 1940.

10. H.W. hr. consumption figures have been taken from "Electrical World", Dec. 3, p. 102, periodical, published by the A.E.E.E.
11. Deccan Plateau: The portion of central and southern India varying generally between 1,000 to 3,000 ft. above sea level. It is bounded by the Western Ghats (mountain ranges) on the one side and the Eastern Ghats (mountain ranges) on the other.
12. Indo-Gangetic Plain: A large plain lying between the two great rivers of India, viz. Indus and Ganges.
13. Soil irrigation system in India primarily comprising a subsoil, a d. and a canal system for distributing water has existed in India for several hundred years. Also well-irrigation and pumping in the form of hand pumps, country water lifts operating a bucket-lever system or persian wheels have been used since ages. Animal power is more common for water lift purposes than mechanical or electric power.
14. The roots of plants belonging to LEGUMINOSAE family of the Plant Kingdom contain Nitrogen - fixing bacteria. The latter draw atmospheric Nitrogen and make it available to plants in the form of plant food. Examples of such plants are: ACACIA, CASAHUA (locally called Tabul), CAJANUS INDICUS (locally called Arhar), CAJANUS CASSIA, Cicer AFRICANA (usually called Gram) and several species of PISUM and Vicia.
15. Desert Soils in India lie in the western and mid-western parts adjacent to the Indo Gangetic plain (see map) where the soils are light and sandy, rainfall is in the neighborhood of one to three inches or less and no irrigation systems exist.
16. Black cotton soils are rich heavy soils overlying the rocky soils and found in patches all over India.
17. Red soils are derived from the rocks and are found in patches mostly in the southern parts of India.
18. Forest soils cover about 66 million acres of Indian soils. They are rich for cropping, yielding often times three to four times the normal crop yields.

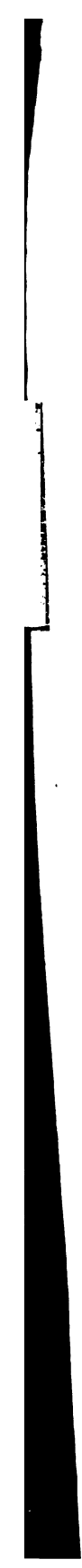


19. Pulses are commonly grown throughout India. They are leguminous food grains and form the backbone of Indian agriculture because their soil recuperation value in the rotation of crops. Examples of the principal pulses are: CASSIA (locally called Arhar), GLYCINE (locally called Moong) and several species of PHASEOLUS and MESE.
20. In India radish is grown on a comparatively small scale for vegetable purposes only.
21. Caran is a vegetable. Fields have to be specially laid out for planting Caran three or four feet apart. The edible part is the underground stem which swells to the size of a squash before the leaves begin to wilt. The crop is then ready for harvest.
22. Shad is a water lifting device operated by animal power. A leather sack attached by means of a rope to the yoke of a pair of oxen moving forwards and backwards draws the water out of the well and pour it into irrigation channels.
23. Gunny bags are sacks made of jute. Normal size has a capacity of about 250 lbs. of wheat.
24. Jal: Crude sugar, dark brown in color obtained by boiling sugar cane juice in open boiling pans over a fire.
25. Besides British India, there are several hundreds of Indian States. The latter are ruled by sovereign native rulers owing allegiance to the British Rule in India.
26. Cauvery: A swift flowing river in southern India.
27. Proper name of a town.
28. Jog falls: India's highest falls having a water-fall of 955 ft. in the bed of a river lying on the border of Mysore Province and Mysore State.
29. A group of business firms operating under a joint directorship and financial interests in various parts of India.
30. In India the standard money is Re 1/- (one rupee), equivalent to nearly 30% of American money. One rupee is divided in 16 annas. In this paper, each anna has been valued at 2 1/2 American money.

31. After World War II, the Government of India started a development scheme for a 15-year plan covering various fields of industry and agriculture. The Department of Planning and Development was organized with Sir Arlester Jais as Honorable Member of the Viceroy's Executive Council. The membership of the Viceroy's Council has now, however, virtually changed since Sept., 1946, due to political changes in the country.
32. Mohen-jodaro is one of the recent excavations in the western part of India where the ruins of 5,000 to 10,000 B.C. have been unearthed. These indicate a high degree of ancient civilization in the Indus Valley of India. There are also other similar excavations in different parts of India.
33. For a brief work on Extension activities in the United States, also read "The Agricultural Extension System of the United States", 1930 by C. A. Smith.
34. Jawaharlal Nehru is the President of the All India National Congress and the Vice-President of the Interim Government formed in India in November, 1946. He wrote "The Discovery of India" while kept in Prison from 1941 to 1945 for a period of 1011 days when the All India National Congress was declared an unlawful organization by the Government of India during the period of World War II. He is also known as Pandit Nehru.
35. These figures are taken from the information bulletins circulated by the Information Service, Agency General for the Government of India, Washington, D.C. See, mimeographed bulletin dated Nov. 15, 1946.

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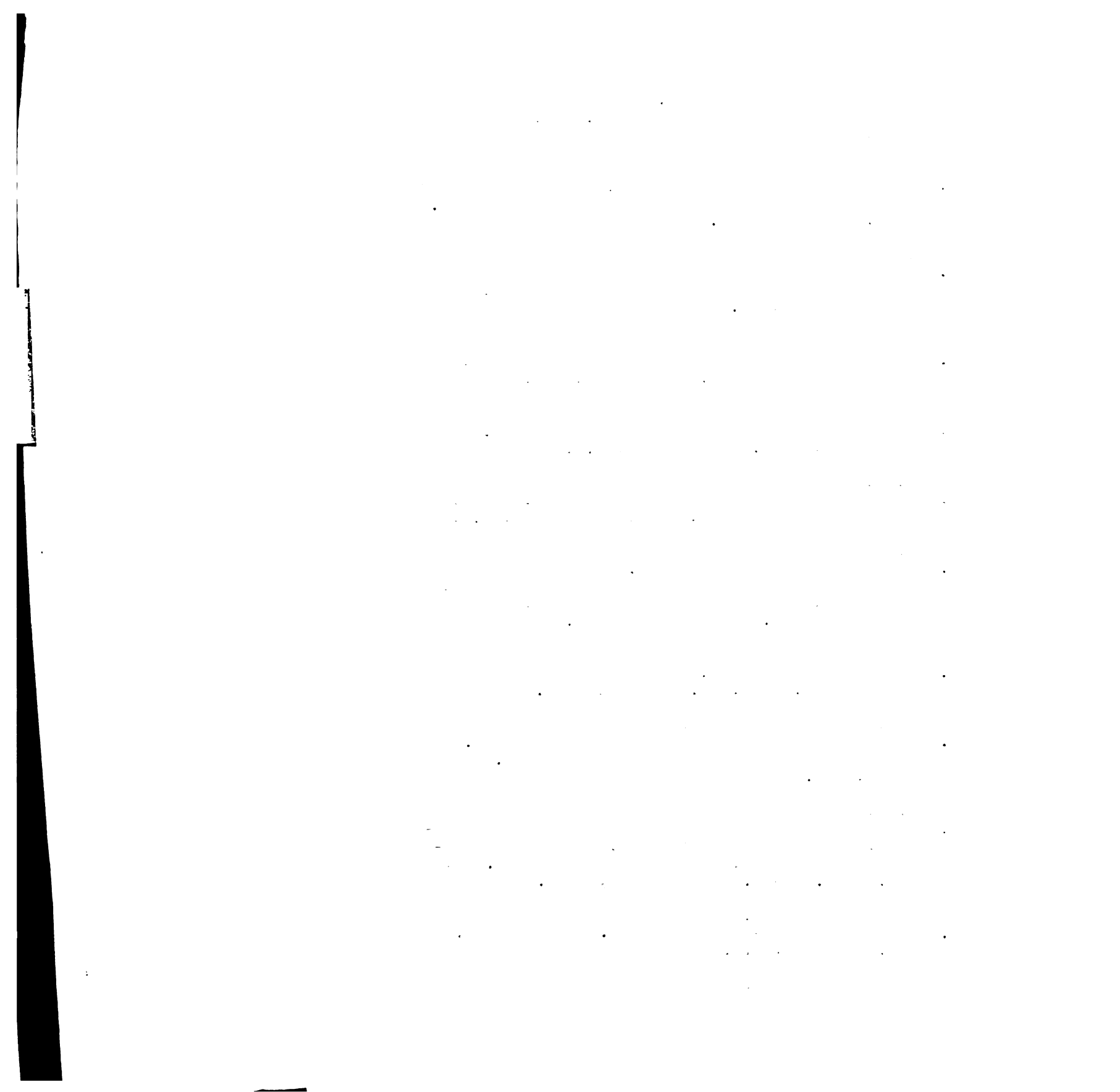
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