

PRODUCTIVITY AND EMPLOYMENT IN SELECTED INDUSTRIES

B E E T S U G A R

by

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and

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WORKS PROGRESS ADMINISTRATION, NATIONAL RESEARCH PROJECT

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THE WPA NATIONAL RESEARCH PROJECT ON REEMPLOYMENT OPPORTUNITIES AND RECENT CHANGES IN INDUSTRIAL TECHNIQUES

Under the authority granted by the President in the Executive Order which created the Works Progress Administration, Administrator *Harry L. Hopkins* authorized the establishment of a research program for the purpose of collecting and analyzing data bearing on problems of employment, unemployment, and relief. Accordingly, the National Research Program was established in October 1935 under the supervision of *Corrington Gill*, Assistant Administrator of the WPA, who appointed the directors of the individual studies or projects.

The Project on Reemployment Opportunities and Recent Changes in Industrial Techniques was organized in December 1935 to inquire, with the cooperation of industry, labor, and governmental and private agencies, into the extent of recent changes in industrial techniques and to evaluate the effects of these changes on the volume of employment and unemployment. *David Weintraub* and *Irving Kaplan*, members of the research staff of the Division of Research, Statistics, and Finance, were appointed, respectively, Director and Associate Director of the Project. The task set for them was to assemble and organize the existing data which bear on the problem and to augment these data by field surveys and analyses.

To this end, many governmental agencies which are the collectors and repositories of pertinent information were invited to cooperate. The cooperating agencies of the United States Government include the Department of Agriculture, the Bureau of Mines of the Department of the Interior, the Bureau of Labor Statistics of the Department of Labor, the Railroad Retirement Board, the Social Security Board, the Bureau of Internal Revenue of the Department of the Treasury, the Department of Commerce, the Federal Trade Commission, and the Tariff Commission.

The following private agencies joined with the National Research Project in conducting special studies: the Industrial Research Department of the University of Pennsylvania, the National Bureau of Economic Research, Inc., the Employment Stabilization Research Institute of the University of Minnesota, and the Agricultural Economics Departments in the Agricultural Experiment Stations of California, Illinois, Iowa, and New York.

WORKS PROGRESS ADMINISTRATION

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1734 NEW YORK AVENUE NW.
WASHINGTON, D. C.

HARRY L. HOPKINS
ADMINISTRATOR

September 27, 1938

Hon. Harry L. Hopkins
Works Progress Administrator

Sir:

I have the honor to transmit herewith a report on employment and productivity in the beet-sugar industry. This report presents a detailed picture of the economics of the industry and the place of technological change in its growth. Against this background it analyzes the industry's trends of employment and output per man-hour.

Since its origin beet-sugar manufacture has been highly mechanized, and since the World War there have been no major changes in methods. Yet during this period labor requirements per bag of sugar produced have been more than cut in half. Another report of the National Research Project dealt with the raising of sugar beets and showed that at the agricultural end of the industry labor requirements per ton of beets have also been considerably reduced. For the most part, this was due to the introduction of tractors and trucks and the adoption of larger, more efficient equipment for field work. Recent development of economical blocking and harvesting machinery foreshadows reduced employment for many of the hand workers who have done 50 to 80 percent of the labor on the crop.

It is estimated that more than 260,000 persons find some employment in the growing of sugar beets and the manufacture of beet sugar. The industry is necessarily a seasonal one, however, and the great majority of these people work in the industry for less than 100 days during the year. The factories employ 20,000 to 30,000 workers during the 2- or 3-month "campaign" period of sugar making which follows the harvest, but employ only 3,000

or 4,000 workers during the intercampaign period. In 1933 there were approximately 70,000 sugar-beet growers and 160,000 workers in the beet fields. On the agricultural end, activity in beet-sugar production is intermittent through the growing season, with labor-requirement peaks for thinning in the spring and harvesting in the fall. Over a season of 6 months the field laborer has perhaps 90 days of work in beets. The bulk of the field work is done by transient or casual workers, and very few of these get jobs in the factories after harvesting has been completed.

Even if the daily earnings were high - and in the beet fields they certainly are not - the small number of days per year that most of the industry's labor force is employed would mean low annual earnings and dependence on some other source for a part of the annual income. It is estimated that the average earnings of factory workers during the campaign are about \$225. The earnings of families who do the hand work on the beet crop on a contract basis have been found to be only a few hundred dollars, or considerably less than is required for support throughout the year. Opportunities for other employment in the beet-growing regions, either in agriculture or other industries, are usually very limited, and sugar-beet workers have therefore frequently had to resort to public relief with the result that in important beet-sugar-producing regions these workers have represented a high proportion of the public relief burden.

This report, prepared by Raymond K. Adamson and Miriam E. West, is a product of a cooperative arrangement between our National Research Project on Reemployment Opportunities and Recent Changes in Industrial Techniques and the National Bureau of Economic Research. The group of "Studies of Productivity and Employment in Selected Industries" was supervised by Drs. Harry Jerome and William A. Neiswanger.

Respectfully yours,



Corrington Gill
Assistant Administrator

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PREFACE

In recent years the tendency in most industries has been toward the adoption of many small improvements whose cumulative effect results in important reductions in unit labor requirements. The beet-sugar industry illustrates this tendency.

Beet-sugar manufacture is one of the small chemical-process industries of the United States, employing 20,000 to 30,000 wage earners during the fall "campaign" of operation, which lasts on the average about 70 days, and 3,000 or 4,000 workers during the intercampaign months. Supplying a vital consumers' good and benefiting from tariff protection, the industry was little affected by business-cycle conditions and grew rapidly from its beginnings about 1890 to an all-time peak output in 1933.

The man-hours required in the processing plants per 100-pound bag of sugar produced declined by 53 percent between 1917 and 1935, or from 1.06 to 0.50 man-hours. This was due almost entirely to minor improvements throughout the plants which accelerated the production process and increased the yield of sugar from the beets. The increased application of electricity made possible the introduction of a variety of instruments and other devices which facilitated more precise control of chemical processes and the mechanization of handling operations. Advances in the knowledge of chemistry have brought minor though cumulatively important refinements in processing. Machine designs have been improved and operations made mechanically more efficient.

During the period from 1890 to 1913 the increase in beet-sugar production was great enough to require increased employment in spite of rising productivity. After 1920 the productivity increases were accompanied by a sufficiently rising volume of production to maintain employment approximately level. The number of tons of beet sugar produced annually during the period 1930-35 was about 1,300,000. The limit for expansion of production by 1940 may be reasonably set at the quota of 1,487,000 tons of sugar fixed for 1937-38 under the Sugar Control Act. Should productivity continue to increase at the rate which prevailed during the 10-year period 1926-35, the man-hours of employment required to fill that quota in 1940 would be about the same as in 1935-36, when only 1,186,000 tons were produced. The recent

types of technological change in the beet-sugar industry are especially significant, since they involve relatively small capital outlays and therefore a relatively small offset in other industries to any decline in the labor requirements of the beet-sugar industry which may result from the increased productivity.

DAVID WEINTRAUB
IRVING KAPLAN

PHILADELPHIA

August 23, 1938

INTRODUCTION

This is a case study in industrial change, having as its major objective the attainment of a fuller understanding of the effects of such change upon labor displacement and reabsorption.

The processes by which employment opportunities are enlarged or restricted can by no means be reduced to a few simple rules. Industries differ widely in their economic characteristics, and, in turn, the type, rapidity, and effects of technological change vary with the conditions and characteristics of the industry. Hence, the impact of technological change must, if it is to be understood, be examined under diverse conditions, i. e., in industries having varied economic characteristics.

This report covers one of a group of five industries examined according to a common pattern of analysis. The five selected industries are brick and tile, portland cement, wheat flour, lumber, and beet sugar. These industries were selected chiefly because the principal product of each is relatively standardized. While, except in the lumber industry, the number of workers employed in any one of them is not large, it is also true that the very large industries must, as a rule, be broken down into smaller segments to attain a workable homogeneity of output and economic characteristics. The definition of the scope of the industry and the collection of the necessary data are simpler for a small, relatively homogeneous industry like beet sugar than for an equally homogeneous segment of a larger industry. It is believed that the behavior patterns ascertained for these relatively small industries will be of value as case studies illustrating the way in which changing productivity and employment are probably related in other industries.

The effects of technological change can be studied from many points of view - as revealed in the personal work histories of individual workers or in the economic fortunes of selected occupations upon which a change impinges, as associated with the history of whole communities sharing the fate of a flourishing or declining industry or with the history of the development and introduction of selected types of machines, or, lastly, as recorded in the output and employment records of individual establishments in selected industries.

The last-mentioned approach is used in the survey covered by this report. The unit of analysis is a single, relatively homogeneous industry. An effort is made to bring to bear on the problem all the available pertinent data, but a major distinctive feature of the survey is the collection of year-by-year time series for individual plants.

As a minimum these plant series cover employment, in terms of man-hours, and output, in standardized units or in a form reducible to equivalent units.¹ For many plants supplementary data were collected showing major equipment changes and their effects, changes in investment in equipment, and changes in the distribution of costs, in the volume of power and raw materials used, and in the unit prices of products. The period of time covered varies. A few records extend back for 25 years or more; for a substantial fraction of the beet-sugar industry data are available for nearly two decades. As a rule a plant was not surveyed unless data could be obtained for at least 7 years. Most of the data were compiled by field agents directly from the company records, supplemented by verbal information from the plant executives.

Two other distinctive features of these productivity surveys should be noted: (a) the attention to the integrated aspects of the industry and (b) the effort to relate the changes in productivity to financial and economic characteristics.

In recognition of the fact that the conditions of operation in one stage of an industry may be closely related to changes in antecedent and subsequent stages, where adequate data are available an effort has been made to appraise the changing labor requirements in the entire vertical structure of the industry, from the extraction or cultivation of the raw materials to the delivery of the finished commodity to the user. In the factory stage of some of the industries surveyed, the two decades just passed have seen a substantial reduction in the labor required per unit of output. It is for this stage that we have been able to obtain the more complete and detailed information, but it is pertinent to inquire whether or not the available evidence indicates that the improvements in productivity in the processing stage have been offset by increasing labor requirements in the preparation of the raw materials used in the factory or in the distribution of the factory products. In the beet-sugar industry we

¹See tables B-7 and B-8 for plant man-hour ratios derived from the output and employment data.

have been able to supplement the detailed analysis of employment in the factory with estimates of changes in employment in the growing and transportation of the beets, in the mining and transportation of the fuel used in the factory, and in the manufacture of machinery for the factories. Also, to supplement the individual plant data concerning office labor, Mr. H. H. Westenberger made a special survey for the National Research Project of changing employment in the central offices of five of the largest beet-sugar companies.

From the point of view of productivity in the over-all vertical structure of the industry, the problem of changing labor requirements may be stated thus: Does it take more or less labor for the complete production of a good from the initial production of raw materials to the delivery to the consumer? Particularly, are such improvements in productivity as are observed in the fabricating stages of such nature that their result is an increase in the labor required per unit of output in other stages of the vertical structure? It is conceivable, for example, that a reduction in labor requirements in the processing stage may be accomplished by a geographical concentration of production which results in an offsetting increase in the labor required in distribution.

The data available for some of the elements in the vertical structure are so fragmentary and lacking in precision that the picture for the vertical structure can be painted only in broad outlines, although enough is known in general about the changes in the allied segments to reach a conclusion as to whether they limit materially the significance of the more precisely measured changes in the factory-processing stage.

An objective description of the rates of change in employment and productivity in an industry and in its constituent parts is a necessary first step, but we have sought to supplement this minimum objective analysis with whatever information would throw light on the circumstances which have determined the rates of change in total employment and in unit labor requirements.

The general scheme of analysis is to ascertain first what fluctuations in employment have taken place in the industry, then to examine, in chapter III, the extent to which the observed changes in employment are ascribable to changes in total output and what circumstances account for the changes in the level of production. Obviously that portion of the change in employment which is not ascribable to changes in the total volume of output is to be

accounted for by changes in the man-hours required per unit of output, and this leads, in chapter IV, to a detailed examination of the information concerning variation in man-hour ratios afforded by the records of individual establishments.

In analyzing these records we have endeavored to differentiate between that portion of the observed improvement which arises from improvements in productivity in plants after they first come into operation and the improvements in the industry as a whole arising from a changing plant constituency. It is conceivable that the over-all efficiency of an industry may improve without any change in productivity in the individual plants. This apparent anomaly is readily possible if the more efficient existing plants produce an ever larger share of the total product, if new plants enter the industry at a higher level of productivity than the general average, or if the plants which disappear from the industry are those with high labor requirements per unit of output.

In the effort to appraise the relative contribution of improvements in existing plants and of a shifting industry constituency we are led to examine the variations in man-hour ratios when the plants are classified by size, age, geographical location, type of management, degree of mechanization, or major differences in processes used. Aside from their contribution to the immediate problem stated above, the observed differences are of interest for the light they throw on the causes of differences in productivity.

Also, it is pertinent to examine the relative rates of change over time in the man-hour ratios of the several types of plants and the variation in rates of change in periods of active and of less active operation.

Special interest attaches, it is believed, to the estimates made for each plant of attainable capacity in each year and the percentage of capacity actually utilized. In beet-sugar factories the conditions of operation are such that the more significant figure is average daily slicing of beets rather than percentage of capacity utilized, but in the other industries surveyed it is found that a large part of the short-time fluctuations in man-hour requirements is explainable in terms of the percentage of capacity produced. Hence any estimates of the probable future employment opportunities in an industry must take into consideration not only the trend in unit man-hour requirements but, even

more, the probable influence on unit labor requirements of the anticipated volume of output.

Chapter V is devoted to a summary of the observed employment tendencies in the beet-sugar industry, particularly the relation between economic characteristics and the change in total employment and in unit labor requirements.

The present survey has been conducted cooperatively by the National Research Project and the National Bureau of Economic Research and is, in part, a continuation of a survey inaugurated by the National Bureau of Economic Research in 1927 to supplement its studies in the changing mechanization of industry. The initial stages of the survey, hereinafter referred to as the "first survey", were conducted, under the direction of Mr. Jerome, in the summers of 1927, 1928, and 1929, chiefly in portland cement, beet sugar, and lumber in the Pacific Northwest, with a smaller sampling in brick-and-tile and in wheat-flour manufacture. The "second survey" extended the lumber sample into Southern Pine areas and substantially expanded the number of clay products and flour-milling establishments studied. Data were obtained for as many years as available, covering output, man-hours of labor, and accompanying changes in methods and equipment. The early records resulting from the first survey have made it feasible to extend the present study further back in time than would otherwise have been possible, for in many instances in the intervening period data for the earlier years have been destroyed by the companies or otherwise have become unavailable. The results of the first survey were partly utilized in a report on *Mechanization in Industry* published by the National Bureau of Economic Research² but have never been fully presented.

The general plan for the second survey followed closely that of the first survey, but the subject matter of the inquiry was widened in certain respects, and the broad scope of the National Research Project made it possible to bring much supplemental and collateral data to bear upon the findings of the field study. The plans for the second survey took form under the general direction of Mr. Irving Kaplan, who in his capacity as Associate Director of the National Research Project coordinated the work of the other sections of the Project whose studies contributed to this report.

²Harry Jerome, *Mechanization in Industry* (New York: National Bureau of Economic Research, Publication No. 27, 1934).

Dr. Carroll R. Daugherty and Mr. J. van Horn Whipple collaborated in the preparation of the schedule pertaining to equipment and process changes. Dr. Elmer C. Bratt, who collected the data in the first survey of the beet-sugar industry, participated in the 1936 resurvey by drawing up some of the schedules used and by negotiating with the sugar companies for the necessary cooperation.

The basic information concerning the factory processing stage of the industry was obtained by field representatives from the records of the beet-sugar companies. The voluntary cooperation of the industry was indispensable to the success of the survey, and special thanks are due to the many executives who gave generously of their time and advice. Their cooperation was so essential and significant as to merit special and individual mention, which, obviously, we cannot give without revealing the identity of cooperating enterprises.

The evidence contained in the individual plant histories obtained in the field survey has been supplemented by the available published data pertaining to the industry and by special tabulations of data collected by other Government agencies. For the beet-sugar industry we are especially indebted to the Tariff Commission for a study of costs of manufacture in which the costs were broken down into detailed components, i. e., for groups of plants classified by size, by labor requirements per unit of product, and by other characteristics.

To a larger degree than can be readily indicated, these monographs are the cooperative product of many individuals and groups in the National Research Project. Secondary sources were examined by research units under the supervision of Mr. Alexander Gourvitch in New York and Mr. William H. Dillingham in Washington, D. C. Numerous reports for our use on selected aspects of the development and economic characteristics of the five industries resulted from this work. From the agricultural section of the Project was received a report on changing labor requirements in the growing of sugar beets.³ From the group studying railroad transportation came data on the basis of which was estimated the labor required in the transportation of various commodities. Valuable

³Loring K. Macy and Others, *Changes in Technology and Labor Requirements in Crop Production: Sugar Beets* (Works Progress Administration, National Research Project, Report No. A-1, Aug. 1937).

estimates of changing labor requirements in the production of fuel were prepared by Mr. Nicholas Yaworski.

The machine-study section of the Project under the supervision of Mr. J. van Horn Whipple and Mr. George Perazich made two major contributions to the productivity studies in the five selected industries: (a) a report on the evolution of technique and the progress of mechanization, dealing with each industry, and (b) an estimate by years of the labor utilized in the manufacture of machinery for each industry, expressed in the ratio form "man-hours per dollar" selling price of the machines. These estimates are based upon data concerning output and employment obtained from the records of establishments making machinery for the use of the five industries covered by the productivity surveys.

The analysis of the mechanization data was supervised by Mr. Alfred J. Van Tassel and the analysis of labor utilized in the manufacture of machinery was supervised by Dr. Solomon A. Lischinsky.

Mr. Adamson supervised the editing and statistical analysis of the individual plant reports compiled from the records of the beet-sugar companies and also prepared the initial draft of the first four chapters of this monograph. The concluding chapter was written by Miss West, who is also responsible for substantial revisions in the content and form of organization of the earlier chapters.

It is scarcely feasible to specify all of the other members of the staff who in some way have contributed to the meticulous editing and analysis of the data utilized in this report. Specific contributions are noted at appropriate points in the text. Special mention should be made of the contributions of Mr. C. D. Bray who, after serving in an important administrative capacity in the field survey, directed the analysis of schedules of equipment changes collected from the plants. Mr. Harry A. Swanson was in charge of the analysis of the financial data pertaining to the beet-sugar industry. The sample analysis was prepared by Miss Edith H. Handler. Assistance in the editing and statistical analysis of the schedules and in the preparation of the manuscript was rendered by Mr. Joseph P. Cohen, Mr. Max Lipowitz, Mr. Virgil Scharrer, and Miss Barbara S. Holmes. Special mention should be made of the work done by Miss Alice Hirsh in the final editing of the manuscript and the painstaking checking of all the data used therein.

Our hearty thanks are due to a number of persons who read portions of the manuscript and submitted helpful criticisms. Among these should be mentioned Mr. Geoffrey S. Childs, Mr. John E. Dalton, Mr. Neil Kelly, Dr. N. G. Silvermaster, and Dr. Paul S. Taylor.

Lastly, the effectiveness of the work of the productivity surveys conducted cooperatively by the National Bureau of Economic Research and the National Research Project has been in large part due to the assistance rendered by Mr. David Weintraub, Director, and Mr. Irving Kaplan, Associate Director of the National Research Project, and to their helpful advice in the planning and execution of the work.

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CHAPTER I

A DESCRIPTION OF THE BEET-SUGAR INDUSTRY

The factors affecting the changing volume of employment in the beet-sugar industry are best understood against a background of the economic characteristics of the industry and the nature of its processes. In the perspective of history the beet-sugar industry is relatively young, increasing its production from less than 100,000 tons in 1899 to more than 1,300,000 tons in 1936. This expansion has of course been accompanied by increased employment in the industry.

The fact that the processing of sugar is dependent upon an agricultural raw material, sugar beets, makes the industry a highly seasonal one. The requirements of the labor reserve necessary to the operation of such an industry have led to significant problems largely associated with the employment of casual labor.

The product of the industry is an essential consumption good. The demand for beet sugar, however, is highly elastic for the reason that cane sugar, which is an identical product, competes for the consumers' dollar. Another factor entering into the competitive situation is found in the relatively low cost of shipment which places each processing plant upon a competitive market, nation-wide in scope. On the other hand, like the cane-sugar industry with which it competes, the industry is characterized by a high degree of centralization of control, three-quarters of the capacity of the industry being controlled by six major companies. The industry is also characterized by strong trade associations and presents an uncommonly united front. This tradition of cooperative action in respect to the common problems of the industry may be traceable in part to the fact that the industry was nurtured in an environment of protection and has been dependent to a very considerable extent upon the maintenance of that protection throughout the period of its existence.

Important from the standpoint of changing technology is the large amount of capital invested in each plant. The capital takes the form of power plants, motors, pumps, tanks, and piping upon which much skilled maintenance and repair labor is annually consumed. Hand operations are few.

Another characteristic of the industry, which should be mentioned because of its significance in the analysis of fluctuations in production, is the dependence of the industry upon the flow of raw material from farmers who are independent producers. To the extent that the farmers are economically independent and therefore free to choose between competing crops, their decisions in determining the production of sugar beets are influenced by the prices of other agricultural products competing for the use of land. The farmers' decisions in these circumstances control the extent of the operations of the processing industry. Unfortunately for the industry, its activities are dependent also upon the caprice of weather, and it will be seen in later chapters that the year-to-year fluctuations in production and employment, while quite independent of general business conditions, are closely related to agricultural conditions.

A field study of production and man-hours in the beet-sugar factories, supplemented by census data, has made possible a detailed analysis of employment in the beet-sugar factories. For the other sectors of the industry it has been necessary to rely on data collected by other groups for other purposes. While these data are not so complete as those for the beet-sugar plants, nevertheless they make possible a fairly adequate description of the trends of employment in the integrated industry.

A DEFINITION OF THE INDUSTRY

The purpose of this study is to analyze the changing volume of labor required in the beet-sugar industry, not only in the processing plant - in this case the beet-sugar factory - but also, insofar as the data will permit, the total amount of labor in the whole economic system required for the manufacture and distribution of the commodity, beet sugar. It can readily be seen that this concept of the industry will include much more than the processing plant. Included in this definition of the beet-sugar industry are (a) the processes of planting, tending, harvesting, and hauling to factory the sugar beets, (b) that part of the construction and machinery industries devoted to the manufacture of beet-sugar-plant equipment, (c) that part of the mining and petroleum industries required to furnish the beet-sugar factories with fuel, and (d) those segments of the transportation

and distribution industries devoted to the transportation and distribution of beet-sugar products. Statistics needed to analyze labor required in these segments of the beet-sugar industry are limited and often nonexistent, and this analysis will necessarily be incomplete. A statement of the general direction of trends, however, may often be given where more precise data are lacking, and it will be worth while to describe some of the difficulties involved in this type of analysis and the methods of meeting them.

NATURE OF THE INDUSTRY AND DESCRIPTION OF ITS PROCESSES

The long series of economic activities and processes required to put beet sugar on the market as a finished commodity begins with the preparation of the soil for the planting of the sugar-beet seed.¹ The labor required is carried on with the aid of the usual agricultural machinery, such as plows, disks, harrows, cultivators, and beet drill planters. The seed is planted, usually between late March and early May, $\frac{1}{4}$ to $1\frac{1}{2}$ inches deep in rows varying from 18 to 30 inches apart. The appearance of the beet rows is the signal for the beginning of cultivation to conserve moisture and to check the growth of weeds. Following the initial cultivation comes the process of blocking, which consists of removing with a hoe such bunches of plants as will leave the remaining clusters of plants well spaced, an average distance of 10 to 12 inches being desirable. The next step following the blocking process is the thinning of the beet rows to remove all plants within a cluster except the strongest one.

In western States where irrigation is required, the beet rows are supplied with water about five to seven times during the season by running water through ditches furrowed by special cultivators. Often the first irrigation is required soon after germination.

After two or three more cultivations and the same number of hand hoeings the beets are ready for harvesting. The beets are loosened from the ground by means of a special plow called a lifter, knocked together by hand to remove dirt, topped, and thrown into piles. By topping is meant the severance of the sugar beet proper from its leafy portion just below the base

¹For detailed analysis of sugar-beet production, see Loring K. Macy and Others, *Changes in Technology and Labor Requirements in Crop Production: Sugar Beets* (Works Progress Administration, National Research Project, Report No. A-1, Aug. 1937).

leaf by means of a special cutting tool. The tops are thrown into a pile and later used as cattle and sheep food, while the beets are piled separately preparatory to hauling to the factory. In case of delay in shipment of the beets to the factory they may be placed in large piles and covered with tops to prevent loss of moisture. The actual hauling of the beets to the factory is usually done by large trucks.

Blocking, thinning, hoeing, and topping are all largely hand work. The highly seasonal nature of the employment, making for a low annual income, combines with the monotony and arduousness of the work to deprive it of attraction for most laborers. Only people of a few national origins accept such employment.² When labor contracts are entered into, services are usually bargained for on a family basis, and the employment of women and children in the fields is a not uncommon spectacle.³ The agreement with the head of the family provides generally for the cultivation and harvesting of a specified acreage at a stipulated price per acre. The contract usually contains a section or clause setting forth the methods of work to be followed by the workers in the beet fields. These provisions aim to reduce sugar loss by minimizing or abolishing careless practices, for the amount of crystallizable sugar in a sugar beet depends not only upon weather and moisture conditions but also upon the skill exercised in the planting, cultivating, and harvesting of the crop.

In a beet crop the percentage of sugar in the beets is called sugar content. The sugar content may vary between 10 and 20 percent depending upon soil and weather conditions, care taken by the farmer, and ripeness of the beets. It is therefore important that a farmer insist upon careful work since the price paid for the beets varies with the average sugar content of the beets delivered by the grower.

² *Ibid.*, p. 4; Paul S. Taylor, *Mexican Labor in the United States* "University of California Publications in Economics," vol. VI (Berkeley, Calif.: University of California Press, 1930), 1, 119-20.

³ Neither the Jones-Costigan Act nor the recent Sugar Act, signed September 1, 1937, have so far been effective in eliminating child labor in the beet fields. The amount of child labor was considerably reduced, though not eliminated, in 1925, the 1 year in which the benefit payments to farmers, which were conditional on the nonemployment of children under the age of 14, were in effect. Although many contracts between processors and producers of sugar beets, as well as contracts between the producers and their contract laborers, carried the provision against employment of children in 1937, the use of children in the beet fields continued. See mimeographed release from U. S. Dept. Labor, Children's Bureau, Mar. 28, 1937; unpublished report by Walter Quinn on The Conditions of Sugar Beet Workers in Colorado in 1937 (Works Progress Administration, Section of Labor Research, Division of Research, Statistics and Records); Elizabeth S. Johnson, "Wages, Employment Conditions, and Welfare of Sugar-Beet Laborers," *Monthly Labor Review*, 46, No. 2 (Feb. 1938), 328-9.

When the beets arrive at the factory, scientific and labor-saving control devices under unified and competent management are brought to bear upon the further movements of the raw-beet material through the processing stage of the industry. To one entering a beet-sugar factory for the first time there seems to be an endless confusion of pipes, valves, pumps, motors, and tanks. There is much of this type of equipment because a large share of the processes center about the handling and treatment of liquids rather than of solid materials. Likewise, large quantities of steam and water are required in the extraction and purification of sugar. The beets, however, must be prepared before the extraction of the sugar begins.

From the storage facilities of the factory the beets are conveyed in running water through flumes to the factory, this preliminary step of conveyance serving the further purpose of partly cleaning and washing the beets. For the complete removal of rocks, sand, weeds, and other foreign material the beets are sent to washing machines, mechanical implements designed to agitate the beets thoroughly in water until all dirt is removed. The beets, satisfactorily washed, are then elevated by lifting devices to scales which record their weight automatically. From the weighing scales the beets drop into a hopper from which they are fed into slicing machines equipped with knives. Here they are sliced into long, thin strips called cossettes, usually cut in a V shape for the purpose of providing as large a surface as possible for the extraction of the sugar by diffusion.

The process of cleaning and slicing beets, just described, is one of the five chief processing operations performed by the beet-sugar factory. After this the sugar juices are removed from the cossettes by the diffusion process; the juice, much diluted with water, is purified and clarified by carbonation; the excess water is then removed by evaporation; and the resulting thick sirup is run through centrifugal machines which separate out the crystals of sugar from the molasses. The sugar is then dried and packed in bags or stored in bins for later packing and shipment.

The removal of the juice from the cossettes is accomplished by osmosis in a series of large, iron, cylindrical tanks called the diffusion battery.

After the diffusion process is completed, the beet pulp, which is a byproduct largely exhausted of sugar, may be dried and further treated in a number of ways in accordance with the purpose

for which it is desired. Wet pulp, however, receives no further attention and is removed to silos where it is later disposed of as feed for livestock. If the pulp is to be used as feed at points remote from the factory, it is necessary to remove the excess water in order to reduce haulage costs; in this case the fresh pulp is pressed and dried, with or without the addition of molasses.

The juice from the diffusion battery is pumped into a measuring tank which controls the quantity entering the carbonation process for purification. From this it enters the first carbonation tanks where the various nonsugars are precipitated by the addition of a predetermined quantity of milk of lime and by the heating and agitation of the mixture. It is then subjected to an injection of carbon-dioxide gas under pressure and the precipitate is decomposed. This juice after being filtered, recarbonized, and again filtered enters the sulphitation stage in which it is decolorized and the excess lime is precipitated. The comparatively pure dilute juice again passes through the filter press, is heated, and is ready for the evaporators.

By means of evaporation the now-thin, clear juice is concentrated, i. e., a large percentage of water is evaporated out and the liquor is boiled down to a thick juice. This is accomplished by passing the liquid through a multiple-effect evaporator consisting of four separate sectors operating under various vacuums and temperatures, after which the concentrated juice is often subjected to a final sulphitation and filtering to remove the excess lime and impurities which have a retarding effect on crystallization. The thick juice next passes to the vacuum pans in which under high pressure it is further concentrated so that the grains of sugar commence to form and finally crystallize.

When the graining is complete, the "strike" is ready to be dropped from the vacuum pan, and the massecuite now formed contains sirups which must be separated from the sugar crystals. This is accomplished by a battery of units termed "centrifugals", each equipped with a screen-lined basket revolving at a speed of about 1,000 r. p. m. into which the material flows through regulating valves. Surplus sirup adhering to the crystals is thrown off through the screen by centrifugal action, and the retained sugar crystals are washed by spraying with water. The first, or white, sugar when purged in the centrifugals is dried

by a current of warm air, screened, automatically weighed, and conveyed to storage or packed for shipment.

The liquors, termed "wash and green sirup", which have been thrown off from the centrifugal are pumped to tanks and later used in regraining in the vacuum pans. This second, low-grade masse-cuite is retained and thoroughly agitated within crystallizers until the sugar has grained. The brown sugar, after it leaves the second centrifugal, is dissolved, mixed with other sirups, reboiled, and crystallized.

The liquors from the separation of the second crystallization are generally subjected to a third crystallization and separation, from which there is a residual liquor. The recovery of sugar from this liquor by crystallization would be much retarded because of the viscosity of the attendant impurities. The sugar may be separated from the impurities, however, by a precipitation process whereby dry lime added to cold and thin solutions of the sirup combines with the sugar to form a lime-sugar compound which can be separated by filtration. From the compound, sugar is set free by the use of carbonic-acid gas, separated by filtration, and crystallized by being boiled in vacuum pans. This process, known as the Steffens process, is used in many factories for the recovery of as large a percentage of sugar as possible.

A word should be said concerning the laboratory control of the delicate and complex chemical processes in the sugar factory. During a 24-hour period numerous chemical and polariscopic determinations are ordinarily made as a guide for factory operators and as a preventive measure against losses. Because of these tests the sugar produced comes very near to recording 99.9° by polariscope.⁴ Raw sugar extracted from sugar cane is usually only 96 percent pure and contains 4 percent of ash and various foreign substances. It is called raw sugar or 96° centrifugal sugar to distinguish it from white refined sugar. The raw, brown cane sugar must be refined into granulated sugar. Usually this is done at large refineries on the Pacific and Atlantic Coasts.

⁴Sugar is never refined 100 percent pure; the Food and Drug Administration of the U. S. Department of Agriculture defines granulated sugar as sugar having 99.6 percent of sucrose. Philip O. Wright describes the polariscopic test in his book, *Sugar in Relation to the Tariff* (New York: McGraw-Hill Book Co., Inc., 1924), p. 92, as follows:

"In applying the polariscopic test, a beam of polarized light is passed through a sugar solution contained in the tube of the polariscope. It is a property of the sugar solution to rotate the beam to the right, the scale being so graduated that pure sucrose will show a reading of 100° and any other reading will show the percentage of pure sucrose in the sample. For example, a reading of 96° means that the sample is 96 percent pure."

An important adjunct to the beet-sugar factory is the boilerhouse, large quantities of both high- and low-pressure steam being needed for beet-sugar manufacture. High-pressure steam is required both for power used directly in running machinery and for generation of electric power for machinery. The low-pressure steam needed for heating juices and boiling sugar is generally exhaust steam from the high-pressure prime movers. Both high- and low-pressure steam for all purposes come from a single plant boilerhouse.

It is evident from this description of the processes that a beet-sugar plant is highly mechanized not only with respect to the actual processes but also with respect to the flow of materials, which is continuous throughout the plant from the time that the beets are first introduced into the flumes to the time that sugar flows out into sacks or bins. Of the 200 to 300 persons employed in the typical plant during the period of operation, some will be engaged in the necessary handling processes at either end, others will be engaged in handling the other materials needed, such as coal in the power plant and lime and coke in the carbonation process, some will be engaged in taking care of equipment and cleaning evaporators, and others will be mechanics, skilled operators, and technicians having charge of the various processes. As improvement takes place in the organization and equipment of a beet-sugar plant, this group of people are responsible for a larger number of beets sliced per day and a larger output of sugar both per day and per ton of beets sliced. Some persons may no longer be needed, but in general the changes will result in decreasing the number of days of plant operation, or increasing the annual production of the factory, or both. Just how these adjustments in employment take place will be given consideration in later chapters.

The processes which have just been described are not carried on throughout the entire year. The seasonality of the industry is due to the fact that, since sugar beets cannot be satisfactorily stored, the factory must operate when new crops of sugar beets are harvested. This may be as early as July in California or as late as September or early October in other States. The period of operation is known as the "campaign." Once the campaign has begun, the beet-sugar factory operates 24 hours a day until the supply of harvested beets is exhausted. This period varies from

as low as 15 days to over 100 days, and it has averaged about 70 days for the last several years. The campaign often runs into January of the next year; hence, the "campaign year" is usually defined as the year extending from March 1 to February 28.⁵

The capacity of a beet-sugar plant is usually defined as the average number of tons of beets sliced per campaign day in the slicing machines. Thus the assumption is made that the average number of tons sliced daily is equal to the possible number of tons that could be sliced per day. This assumption is based upon the fact that a sugar plant operates to the fullest extent allowed by its facilities for 24 hours per day throughout the campaign period. The capacity of a beet-sugar factory is properly not defined on a yearly basis, for in that event capacity would be a function of the number of days operated per year, which is determined by the supply of beets, as well as a function of plant facilities. By defining capacity in terms of a 24-hour day, the percent of capacity utilized is always 100 while the plant is in operation.

MARKET RELATIONS

Market for Raw Materials

The manufacturer of beet sugar is dependent upon the farmers in the immediate vicinity for his principal raw material, sugar beets. In the attempt to assure himself of a steady and profitable volume of raw material from this source, he has devised certain means to perpetuate and regularize his tie-up with the farmer-producer.

Since 95 to 98 percent of all beets are grown by independent farmers, it is customary for contracts to be entered into between the processors and the farm producers in an effort to minimize the risks inherent in the situation. The processor must have the beets in predictable volume, and the beet raiser looks to the processor to buy his beets. The contract specifies the number of acres the farmer shall plant and provides that the planting, tillage, and harvesting of the crop shall be carried on in accordance with directions given by the company from time to time. It is customary for a company's representative, usually

⁵In all tables and references to the campaign year, the year in which the campaign begins will be designated as the campaign year.

the fieldman, to supervise the work in the fields in order to see that the conditions of the contract are adhered to. The company reserves the right to reject all beets which they find are not suitable for the manufacture of sugar. The contract usually sets forth a sliding scale of prices to be paid for the beets based on the two variables, the net price received for the sugar and the sugar content of the beets. Thus by the contract system the processor assures himself of an adequate supply of raw material, barring natural hazards, and the producer receives reasonable assurance of a minimum price per ton.

A second device used by the processors to assure themselves of an adequate supply of beets is associated with the labor market. Although the farmer-producers are responsible for raising the beets, the processing companies aid them in securing an adequate supply of labor. Formerly, large numbers of workers were brought into the beet-growing areas to work in the fields each season. In some regions the companies not only recruited the workers but paid their transportation. In recent years attempts have been made to build up a resident labor supply by constructing winter homes for the workers in nearby cities and towns. In some instances, credit for groceries during the winter months has been provided. These developments have lessened considerably the annual recruiting, although it continues. During recent depression years there has been a tendency for the workers to remain near their jobs, with the result that the relief agencies have carried much of the burden of the beet workers' families in the winter.⁶ In addition to providing the supply of field labor, the companies attempt to prevent loss of their raw materials because of labor troubles by arbitrating issues. The fieldman or agricultural superintendent of the sugar-manufacturing company which holds the contract has this function.

Since the companies often make the contract for the growing of beets conditional upon a prescribed rotation of crops, a single year's contract may by indirection actually control the production of beets by a given farmer for several seasons. The financial dependence of many farmers on the beet crop may also be a factor in assuring the companies the necessary supply of beets. The processors finance the producers in part by providing

⁶ Johnson, *op. cit.*, pp. 326, 337-8; Olaf F. Larson, *Beet Workers on Relief in Weld County, Colorado* (Colorado State Agricultural Experiment Station and Rural Section, Division of Social Research, Works Progress Administration, Research Bull. No. 4, mimeo., May 1937).

them with their supply of seed on credit, the loans being paid for out of the proceeds of the sales of beets. In some areas the beet-sugar crop is the only cash crop, and the farmer finds that the banks will accept only this crop in security for short-time loans. It would appear, therefore, that these economic pressures tend to commit the producers in areas where sugar beets are principal crops to maintaining a steady flow of raw materials to the plant.

Where the agricultural resources can be diverted alternatively to the production of other crops, however, substantial variations in the quantity of sugar beets produced result, since the diverse movement of prices for agricultural products may lead the farmer, in pursuing his self-interest, to shift to other cash crops.

Industrial Organization

Six large companies owning 5 or more plants apiece operated 56 of the 80 beet-sugar plants which comprised the industry in 1934-5.⁷ These large multiple-plant corporations control not only the operations of their individual plants but also, by means of their contracts with farmers, the growing of the beets in the areas where these plants are located. This concentration of control has produced relatively uniform practices and methods, and the large scope of single enterprises has made possible extensive research and experimentation which has doubtless speeded the process of technical improvement, both in the processing plants and in sugar-beet culture.

The farmer-producers are organized into local beet growers' associations which are affiliated with the National Beet Growers' Association. The provisions of the contracts governing the raising of the sugar beets are ostensibly, at least, the result of negotiations between the local beet growers' associations and the companies, who are organized into the United States Beet Sugar Association. In 1937 the workers employed by the producers organized to improve their conditions. Their efforts availed little, however, against the farmers' contention that contracts already entered into with the processors made impossible any increase in wages for the season.

⁷ *American Beet Sugar Companies, 1934-35* (Washington, D. C.: The United States Beet Sugar Association).

As a result of the industrial organization set-up and the concatenation of circumstances surrounding the operation of the industry - the associations of processors and producers, the domination of the industry by large sugar companies, the contract system for beets and labor, and the variety of creditor-debtor relationships - the companies have succeeded in maintaining a fairly stable supply of raw materials. More recently the establishment of the quota system has introduced new stability into the market for their product as well.

The Markets for Sugar

Beet sugar, which is chemically identical with refined cane sugar, is sold in the markets of this country in competition with sugar refined from raw cane sugar from Louisiana, Hawaii, Puerto Rico, the Phillipines, and Cuba. Wholesalers and industrial consumers may buy their sugar directly from the manufacturers or indirectly through the medium of a commission broker. One of the large sugar companies reports to the Securities and Exchange Commission that "sales are made largely through independent brokers and principally to wholesale grocers, manufacturers, and chain stores."⁸

Until the establishment of the quota system in 1934, the price of sugar was based upon the world price, which was reflected in the New York market and hence in prices throughout the United States. New York City is the dominant sugar market in the country for two reasons: because well over one-quarter of the refining business of the country is located at New York City, and because the Coffee and Sugar Exchange is located at New York.⁹

The refined granulated sugar quotations are the prices of sugar sold through brokers whose commissions are paid by the manufacturers. The wholesale price of refined sugar at New York, as well as other New York quotations, is the base for refined-sugar prices throughout the country. It is not always easy, however, to see the exact relationship between New York prices and prices in other markets of the country. In the first place, a locality in which sugar stocks are accumulating at a rapid rate is likely to shade its price slightly below the New York wholesale quotation

⁸ Securities and Exchange Commission, Docket 2-2805-1, Form A-2, p. 2.

⁹ Lippert S. Ellis, *The Tariff on Sugar* (Freeport, Ill.: The Rawleigh Foundation, 1933), pp. 99-100.

for refined sugar. Or a local dealer may quote to customers prices that are based on previous sales made at prices higher or lower than the current quotations of refiners.

It is also important to note here that beet sugar usually sells at a price somewhat below that of cane. According to Dr. Ellis:

This is a trade practice, established by custom, that is based partly on a prejudice against beet sugar which grew out of a failure during the early years of beet-sugar making to refine the product perfectly, and partly on the fact that beet sugar is generally manufactured only in the form of refined granulated. Cane sugar, on the other hand, is manufactured in many forms such as granulated, powdered, and loaf, and a dealer prefers to place his order with a firm which can deliver all the varieties required by his trade.¹⁰

All price quotations in the sugar industry are customarily subject to 2-percent discount for cash within 7 days.¹¹ The method of shipment is settled in advance in the contract between buyer and seller. The basing-point system and the actual methods of price quotation are well illustrated by the following quotation taken from the report of a beet-sugar company filed with the SEC:

Sales are usually made on the *basing point* system, which consists of adding to the registrant's price the transportation costs to any point of delivery from the nearest seaboard cane refinery and absorption by the registrant of its transportation costs to such point from the factory where shipment originated.

. . . . [The sales] are generally made upon notice of an increase in price, at which time customers are permitted to contract for their requirements for a reasonable period of time at the price existing before the advance becomes effective. In most territories the purchaser is protected during the life of the contract against price reduction by the registrant.¹²

DEVELOPMENT AND GROWTH OF THE INDUSTRY

Beet-sugar production in the United States was put on a large-scale basis shortly after 1890. The delay until that date was due to lack of development of technique and skill in the growing of beets and in the methods of processing. As early as 1747, in Germany, Andreas Marggraf had extracted sugar from the beet root,

¹⁰ *Ibid.*, pp. 100-1.

¹¹ *Ibid.*, p. 101.

¹² SEC, loc. cit.

and beet sugar was manufactured commercially in Europe in the first half of the nineteenth century. Beginning in 1811 Napoleon gave a decided impetus to the study of technique and processes in France by tariff benefits and subsidies.

In the United States the first experimental attempt to produce beet sugar was initiated in Philadelphia by the Beet Sugar Society of Pennsylvania in 1836.¹³ Two years later in Northampton, Massachusetts, occurred another early experimental production of beet sugar.¹⁴ In 1852, Dr. Taylor, a bishop of the Mormon Church, made an attempt to produce beet sugar in Salt Lake City but was unsuccessful.¹⁵ The first beet-sugar factory was built in 1864 in Chatsworth, Illinois. Here 2 years later the first crop of 4,000 tons of sugar beets was raised. In 1868 the plant produced 600 barrels of sugar.¹⁶ This plant later had its machinery moved to join a cooperative venture in Sauk County, Wisconsin.¹⁷ By 1870 three factories were operating in the United States;¹⁸ by 1892, six.¹⁹ No statistics were collected for the industry between 1893 and 1897, but at the latter date nine operating factories were reported - four in California, two in Nebraska, and one each in New York, New Mexico, and Utah. Difficulty in securing beets in sufficient quantity and of requisite quality for profitable operation caused many failures during this early period. The cooperation and experimental work of the United States Department of Agriculture and of the various State agricultural experiment stations helped to overcome this disadvantage.

Figure 1 presents a picture of the growth of the industry in terms of acreage of beets harvested, beets sliced in the factories, and sugar produced from 1901 to 1935.²⁰

¹³James Peddar, *Culture of the French Sugar Beet and Manufacture of Beet Root Sugar in France* (Philadelphia, Pa.: The Beet Sugar Society of Philadelphia, Aug. 1836). After accepting this report, the society imported from France 600 pounds of sugar-beet seed and distributed the seed throughout the United States for experimental planting.

¹⁴"Progress of the Beet Sugar Manufacture in Europe," *Report of the Commissioner of Agriculture for the Year 1869* (U. S. Dept. Agr., 1870), p. 349.

¹⁵Truman G. Palmer, *Beet Sugar Industry of the United States* (Washington, D. C.: United States Beet Sugar Industry, 1913).

¹⁶*Report of the Commissioner of Agriculture for the Year 1869*, loc. cit.

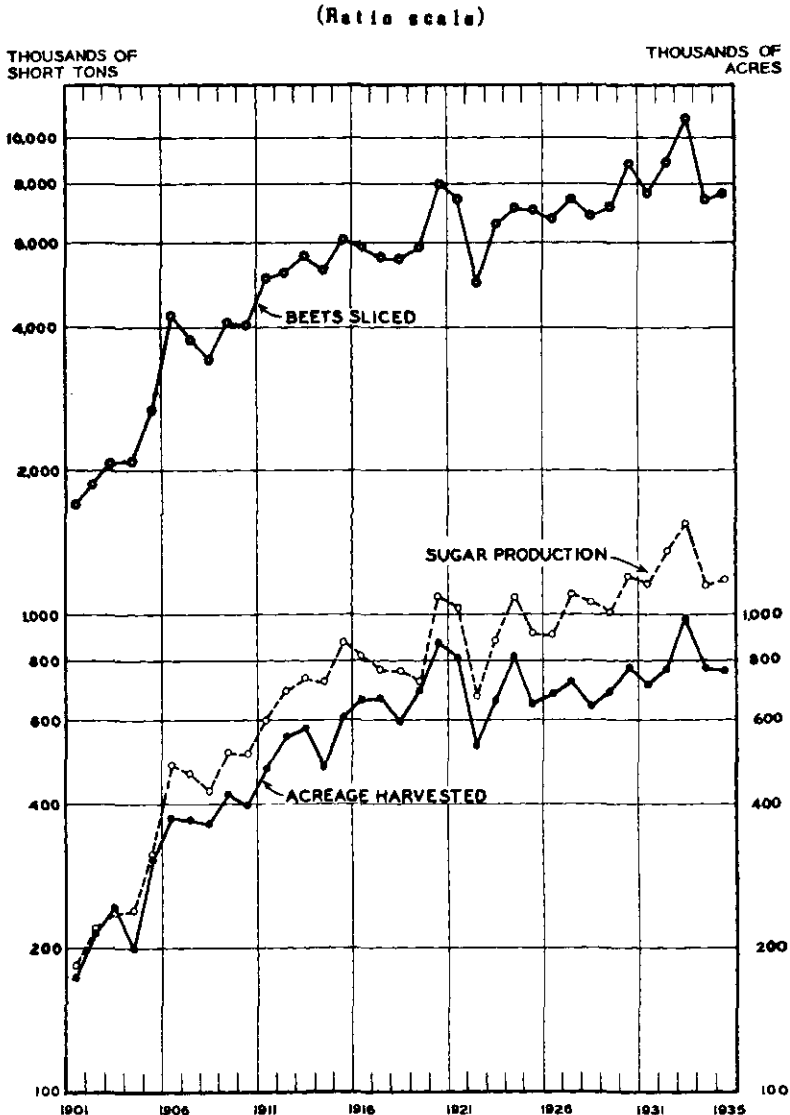
¹⁷William McMurtrie, *Culture of the Sugar Beet in France and the United States* (U. S. Dept. Agr., Spec. Report No. 28, 1880), p. 168.

¹⁸"The Beet Sugar Industry," *Report of the Commissioner of Agriculture for the Year 1870* (U. S. Dept. Agr., 1871), p. 210.

¹⁹"Beet Sugar Production," *Report of the Secretary of Agriculture for the Year 1892* (U. S. Dept. Agr., 1893), p. 467.

²⁰For the series presented in this figure and also a series showing beets sliced per acre harvested, see table A-1.

Figure 1.- ACREAGE AND PRODUCTION IN BEET-SUGAR INDUSTRY
1901-35



Based on table A-1

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The most important fact to be noted is the rapid growth of the industry from one producing 185 thousand tons of sugar in 1901 to one producing over 1,300 thousand tons in 1936. In the acres harvested and beets sliced the same general trend is to be noted, namely, a fairly steady growth with small fluctuations up through 1916 or 1918, after which all series begin to move irregularly

rapidly since the early years of the industry until in 1933 it reached 25 percent of the total.

Regional Development

Table 2 and figure 2 show the comparative development of the industry in three geographical sections of the United States for census years from 1899 through 1931. Annual production of granulated sugar is shown for plants in three groups which comprise I, all plants in California; II, the plants in all the States west of the Mississippi River except California, Iowa, and Minnesota; and III, the plants in States east of the Mississippi as well as those in Iowa and Minnesota.²² The basis for drawing these

Table 2.- NUMBER OF ESTABLISHMENTS AND PRODUCTION OF BEET SUGAR, 1899-1935^a

| Year ^b | Number of establishments | | | | Production of granulated sugar (thousands of short tons) | | | |
|-------------------|--------------------------|---------|----------|-----------|---|-----------------|------------------|-----------------|
| | United States | Group I | Group II | Group III | United States | Group I | Group II | Group III |
| 1899 | 30 | 7 | 14 | 9 | 58 | 22 ^c | 20 ^c | 16 ^c |
| 1903 | 51 | 5 | 21 | 25 | 248 | 46 ^c | 121 ^c | 81 ^c |
| 1908 | 58 | 12 | 26 | 20 | 497 | 131 | 238 | 126 |
| 1913 | 60 | 12 | 28 | 20 | 739 | 176 | 412 | 152 |
| 1918 | 85 | 10 | 49 | 26 | 719 | 125 | 422 | 173 |
| 1920 | 92 | 9 | 56 | 27 | 1,023 | 169 | 662 | 192 |
| 1922 | 84 | 6 | 52 | 26 | 749 | 87 | 514 | 149 |
| 1924 | 89 | 7 | 55 | 27 | 1,076 | 119 | 722 | 235 |
| 1926 | 79 | 5 | 46 | 28 | 893 | 68 | 643 | 183 |
| 1928 | 82 | 5 | 52 | 25 | 1,068 | 104 | 809 | 155 |
| 1931 | 67 | 6 | 49 | 12 | 1,156 | 165 | 822 | 169 |
| 1933 | 84 | 6 | 53 | 25 | 1,626 | n.a. | n.a. | n.a. |
| 1935 | 77 | 8 | 46 | 23 | 1,178 | n.a. | n.a. | n.a. |

^aCensus of Manufactures data. Group I consists of establishments in California; group II, of establishments located west of the Mississippi River, except California, Iowa, and Minnesota; and group III, of establishments east of the Mississippi River and in Iowa and Minnesota. See appendix C for description of adjustments.

^bCampaign, not census years.

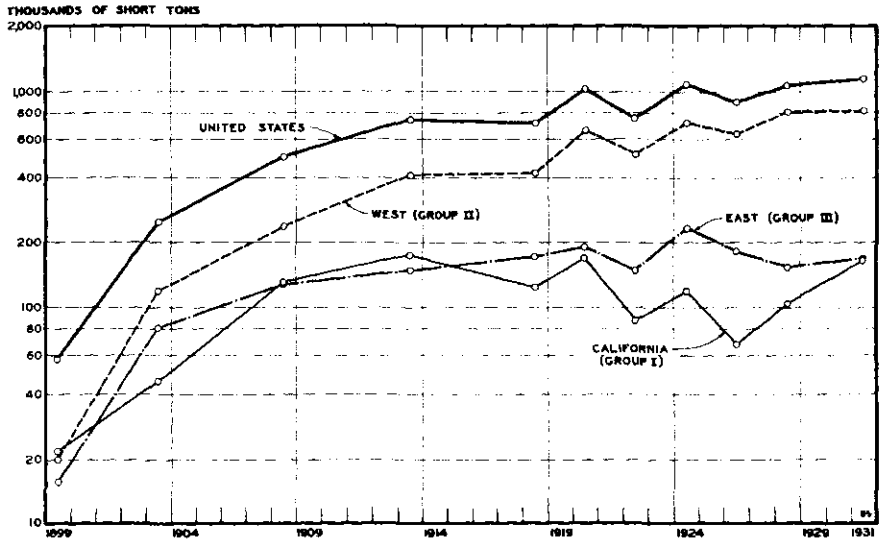
^cCensus data, in pounds, were divided by 2,000.

n.a. Data not available.

²²In 1931 group I included 6 plants in California. Group II included in the same year 17 plants in Colorado, 8 in Utah, 7 in Nebraska, 5 in Wyoming, 5 in Idaho, 4 in Montana, and 1 each in Kansas, South Dakota, and Washington. Group III included 6 plants in Michigan, 2 plants each in Wisconsin and Minnesota, and 1 each in Iowa and Ohio. In other years beet-sugar factories operated in Arizona (1 in 1908), Nevada (1 in 1926), New Mexico (none since 1899), Oregon (none since 1908), and Illinois, Indiana, and New York (none since 1908).

Figure 2.- PRODUCTION OF BEET SUGAR, BY REGIONS, 1899-1931

(Ratio scale)



Based on table 2

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particular boundaries for the groups is similarity of weather conditions. Beets are planted much earlier in California than in other sections of the country. In the Mountain States of group II all beets are grown on irrigated land, while in the Central States of group III beet crops are dependent entirely upon rainfall.²³

In 1899 California, or group I, produced a greater tonnage of beet sugar than either of the other groups. By 1903, however, group II, the western group, had become the greatest producing region. Since 1903 the plants in this area have consistently produced much larger quantities than either of the other two groups, and in most years they have produced more than the other two groups combined. Absolute production increases have been shown for group II in all years with the exception of 1922 and 1926. The all-time high for production in this group was reached in 1931, the last year for which data were available.

Groups I and III throughout the period were much more nearly equal in amount of production. In contradistinction to the

²³ Details of the geographical break-down with the adjustments made necessary because of the limitations of the data will be found in appendix C.

steady rise throughout and the 1931 peak of production in group II, it is important to notice that the California group reached its peak in 1913, while the eastern group reached its production peak in 1924. Thus, from 1913 to 1931, the greatest development in production took place in the western plants of group II. Although census data are lacking after 1931, other sources indicate a substantial increase in production in California between 1931 and 1936.²⁴ In the latter year more than 300,000 tons of refined sugar were reported from that district. During the past 5 years the increase has been about 60 percent over the previous maximum. Regions II and III had a good year in 1933, showing an increase of 26 percent and 38 percent respectively over 1931. In more recent years, however, unfavorable climatic factors have reduced output in these two regions to somewhat below the 1931 level. In spite of the increase in California, the group-II district retained in 1936 its dominant position, with about 63 percent of the total, while California followed with 24 percent, and the eastern region provided the remainder.

Land and climate best adapted to the growing of beets seem to be limited to a zone 200 miles wide stretching west from the Hudson River across the country to the Dakotas, there turning southward through Colorado, New Mexico, and Arizona, and then spreading west and northwest through Utah, Idaho, and the Columbia Valley. However, in 1936 over 50 percent of all the sugar beets in the United States were produced in California, Colorado, and Michigan.

The two chief factors other than favorable agricultural conditions which have determined the regional location of factories in the United States have been the relative profitability of the sugar-beet crop over other competing crops and effective irrigation. Availability of labor and of suitable land, on the other hand, may have been of some significance, although generally the labor necessary for work in the beet fields and in the factories has been drawn into the localities from the outside.

SUMMARY

This chapter has attempted to give a brief description of the industry, calling attention to its distinguishing characteristics,

²⁴Data from the United States Beet Sugar Association, Washington, D. C., provided through the courtesy of Mr. Neil Kelly, Secretary.

all of which will receive further consideration in later chapters. While no one of these characteristics sets the beet-sugar industry off as different from other manufacturing industries, the combination of them perhaps does. Like most of our manufacturing industries, it has grown up under the protection of the tariff. That the ownership of a large proportion of its factories is in the hands of a few large corporations certainly does not distinguish it either from other manufacturing industries or from the cane-sugar refineries. However, it combines with these characteristics a dependence upon agriculture for its raw materials and competition with the cane-sugar industry, whose source of supply of raw materials is governed by conditions different from those operating in the case of beet sugar. It has a large investment per plant and per worker, coupled with a highly seasonal activity. It is this complex of characteristics that distinguishes the beet-sugar industry from other industries. While this study is directly concerned only with this one specific industry, it is to be hoped that the attempt to relate the fluctuations in employment to given characteristics will be of more general interest with possible application to other industries.

Chapter II will be devoted to a description of the changes in the volume of employment in the industry over the period from 1900 to 1935. It is recognized that trends and fluctuations in employment may be correlated with changes in the volume of production on the one hand and with changes in productivity on the other. Hence in chapter III an attempt will be made to relate the changes in the volume of production to such factors as the demand for sugar, the governmental policies of tariffs and quotas, the changing nature of the competition with cane sugar, and the agricultural conditions affecting the supply of sugar beets. An exhaustive study of the industry and its competitive relations with cane sugar has not been undertaken, but those factors which seem to throw light on changes in production and employment have been selected for examination. In chapter IV an analysis has been made of the relationship between technological changes and employment, and these changes have been related to certain economic characteristics, such as concerted action of large companies and of the industry in bringing about a steady and gradual improvement in production, and the capital investment of operating plants.²⁵

²⁵Except as credited to another source, all data presented in this report are derived from the first and second surveys mentioned in the "Introduction." For convenient reference these surveys are hereafter cited as the NRP-NBER field survey.

CHAPTER II

THE VOLUME OF EMPLOYMENT IN THE BEET-SUGAR INDUSTRY

The beet-sugar industry has been defined in the foregoing chapter as involving all the economic functions required to place sugar in the hands of the final consumer, including the raising and transportation of the beets, the processing of the sugar, the manufacture of sugar machinery, the production of fuel used in processing plants, and the transportation and distribution of sugar.

In line with this definition employment in the beet-sugar industry is the employment in all of its vertical segments. Although the inadequacy of present-day statistics permits a relatively precise enumeration of employed workers in the sugar factories only, it will be worth while, nevertheless, to note the approximate magnitude of employment and the trends in the utilization of labor in each of the allied vertical segments as well.

The volume of employment may be defined either as the number of persons who have employment at any time in an industry, whether for a shorter or a longer period, or as the amount of labor time utilized in the industry, whether measured in years, months, and days or in the more precise terms of man-hours. The "average number of persons employed" is to some extent a compromise between these two measures. It is sometimes used to measure the typical number of persons employed during a given period, such as a year, or to measure the number of man-years of employment. However, if there are wide fluctuations in the employment figures from which the average is computed, it gives no adequate idea of the number of persons who derive their income, in part at least, from employment in the industry. In the beet-sugar industry much the larger proportion of the workers are employed for short periods of varying lengths at different times throughout the year so that average employment for a year or even for any selected period tends to be misleading if used as a measure of the number of persons who derive income from employment in the industry at some time during the period. This is true of workers both in the beet fields and in the factories. Hence, in the discussion which follows, two types of measures will be used. On the one hand, there will be an attempt to count the actual

number of people employed at any time during the year, irrespective of the length of period for which they are employed. This will be done both for the factories and for the beet fields, but in the machinery and fuel industries it will be necessary to use an average for the year to represent the number of persons. On the other hand, the amount of labor utilized will be measured in man-hours and in some instances in man-years.

VOLUME OF EMPLOYMENT IN PROCESSING

Series available from the *Census of Manufactures* showing employment in the beet-sugar factories are presented in table 3. The chief characteristic of employment in the beet-sugar factory is its decided seasonality, and upon this characteristic was based the selection of the series chosen for the table. Since more factories are at the height of the yearly campaign in November than in any other month, the peak of employment in all factories

Table 3.- EMPLOYMENT IN BEET-SUGAR FACTORIES, 1899-1935^a

| Year | Number of - | | | | |
|------|----------------|--------------|-------|-------------------|---------------------------------|
| | Establishments | Wage earners | | | Salaried employees ^c |
| | | November | May | Year ^b | |
| | (1) | (2) | (3) | (4) | (5) |
| 1899 | 30 | 3,886 | 778 | 1,970 | 350 |
| 1903 | 51 | 10,251 | 1,359 | 3,983 | 783 |
| 1908 | 58 | 16,807 | 3,432 | 7,204 | 1,184 |
| 1913 | 60 | 18,686 | 3,989 | 7,997 | 1,636 |
| 1918 | 85 | 27,064 | 6,386 | 11,781 | 2,408 |
| 1920 | 92 | 32,206 | 6,239 | 13,602 | 2,406 |
| 1922 | 84 | 23,551 | 2,665 | 7,571 | 2,031 |
| 1924 | 89 | 22,422 | 4,022 | 8,872 | 1,531 |
| 1926 | 79 | n. a. | n. a. | 7,402 | 1,470 |
| 1928 | 82 | 22,164 | 2,870 | 7,496 | 1,426 |
| 1931 | 67 | 18,306 | 2,444 | 6,241 | n. a. |
| 1933 | 84 | 29,358 | 4,239 | 10,706 | 1,201 |
| 1935 | 77 | 25,335 | 3,970 | 9,261 | 1,517 |

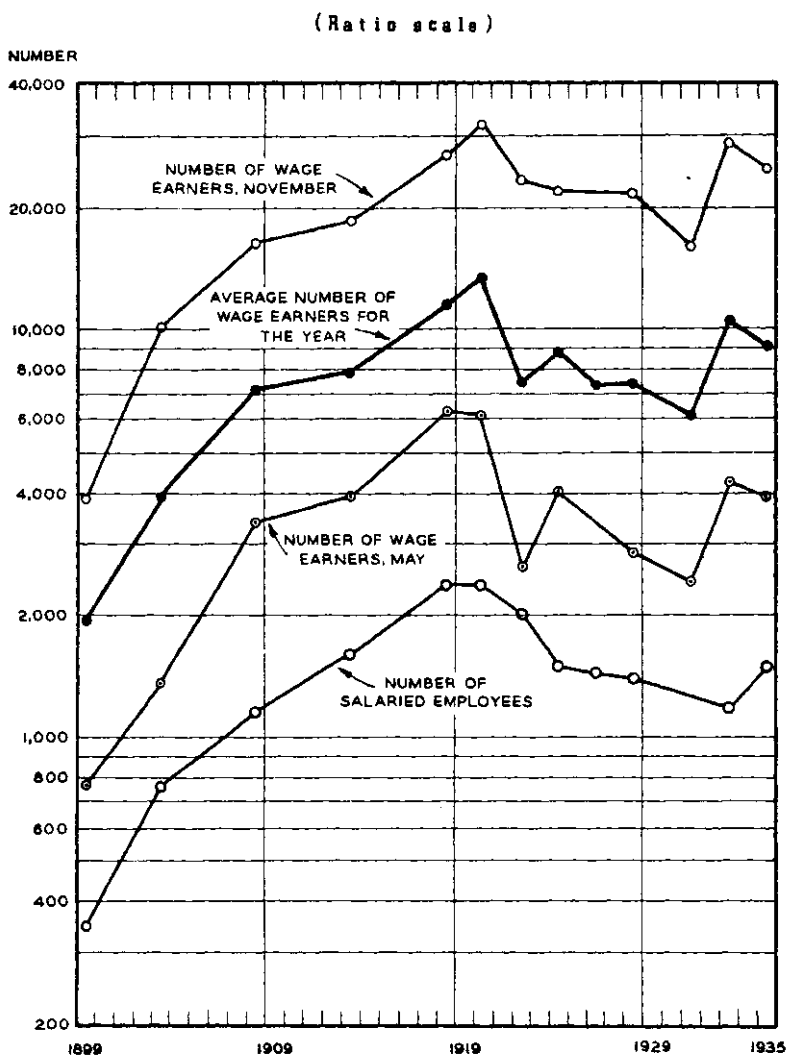
^aBased on *Census of Manufactures*. Employment data refer to the number of persons on the pay roll for the week which included the 15th of the month or some other normal week.

^bAverage of the 12 monthly figures in the calendar year.

^cData for 1899 to 1926 include, while those for subsequent years exclude, salaried officers of corporations. The census gives the number of such officers for 1928 as 21 and for 1935 as 49.

n. a. Data not available.

Figure 3.- EMPLOYMENT IN BEET-SUGAR FACTORIES, 1899-1935



Based on table 3

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combined is reached in that month. It is shown in the second column of the table.¹

The number of wage earners on pay rolls in May, listed in the third column, are given in order to illustrate factory employment for a typical intercampaign month. The months immediately preceding May usually show a smaller employment than the month of

¹Monthly employment is defined in the *Census of Manufactures* as the number of workers on the pay roll for the week which includes the 15th of the month or another normal week.

May, while months following show a gradually increasing employment until the beginning of campaign operations. The average number of wage earners for the year, in the fourth column of the table, is a simple average of the 12 monthly employment figures shown in the census. The final column presents the number of salaried employees, including superintendents, chief foremen, mechanics, chemists, agricultural field employees, executives, and central- and plant-office employees, who are customarily employed throughout the year. These data are presented graphically in figure 3.

It is to be noted that the four series in figure 3 exhibit the same general trends and that the year-to-year fluctuations, while not of the same magnitude, are similar in their direction of movement. At three periods of time, however, the movements of the four series are not similar. Between the years 1918 and 1920 the average number of wage earners for the year and the number of wage earners in November increased substantially, while the number of salaried employees and the number of wage earners in May declined somewhat. This reflects a change in 1919 by two large companies from two 12-hour shifts during the campaign period to three 8-hour shifts, which would require a larger number of campaign workers in proportion to the intercampaign workers. Secondly, between the years 1922 and 1924 a fall in the November campaign employment is shown concurrent with a rise in the May intercampaign employment and the average employment for the year. This is due to the fact that the November figure in this year fails to reflect a rise in the total campaign employment which is evident when the figures for the 4 campaign months are compared for the 2 years. (See table A-2.) Thirdly, although the average number of salaried employees is not available for 1931, the low figure for 1933 does not seem to reflect the upward movements of the other series in that year. It will be shown in chapter III that plant employment in the year 1933 rose both because of a tremendous increase in production, and because of a decrease in factory working hours. A decrease in office hours did not accompany a decrease in factory hours, however, and the increase in production does not appear to have affected the office employment. These differences are noted in order to pave the way for the use of a single yearly series when comparing employment and production in the next chapter. With the exception of the differences emphasized above, the fluctuations in the series showing average employment for the year are fairly representative of the fluctuations in the other series.

The trend in employment was steadily upward until 1918-20, after which time it declined somewhat irregularly until 1931. In 1933 a change was made in the length of the working day. Although one large company producing a third or more of the beet sugar had had three shifts of 8 hours each since 1919 and another company, since 1919-22, most factories had had two shifts of 12 hours each during the campaign period. They now changed to the uniform practice of three shifts of 8 hours each. Accompanying this change was the increase in employment for 1933, shown in figure 3, which, however, is in large part due to an increase in the number of tons of beets sliced that year.

The concentration of factory operations in 3 months of the year has meant that the industry has often been compelled to rely upon itinerant workers for part of its labor supply.² Figure 4 shows the pattern of the seasonal demand for labor in the industry. Monthly data secured from the *Census of Manufactures* were expressed as percentages of annual averages. An arithmetic mean of the percentages for each month was computed, and these average percentages for each of the 12 months were expressed as percentages of their average, as shown in table 4.

**Table 4.- INDEX OF SEASONAL EMPLOYMENT IN BEET-SUGAR FACTORIES
1903-33^a**

(Average = 100)

| Month | Index | Month | Index |
|----------|-------|-----------|-------|
| January | 68.6 | July | 53.6 |
| February | 32.4 | August | 74.4 |
| March | 32.8 | September | 99.3 |
| April | 38.2 | October | 254.2 |
| May | 42.9 | November | 258.7 |
| June | 46.8 | December | 198.1 |

^aBased on table A-2.

The average length of the campaign has decreased from 77 days in 1917-19 to 65 days for the period 1933-35.³ Although the am-

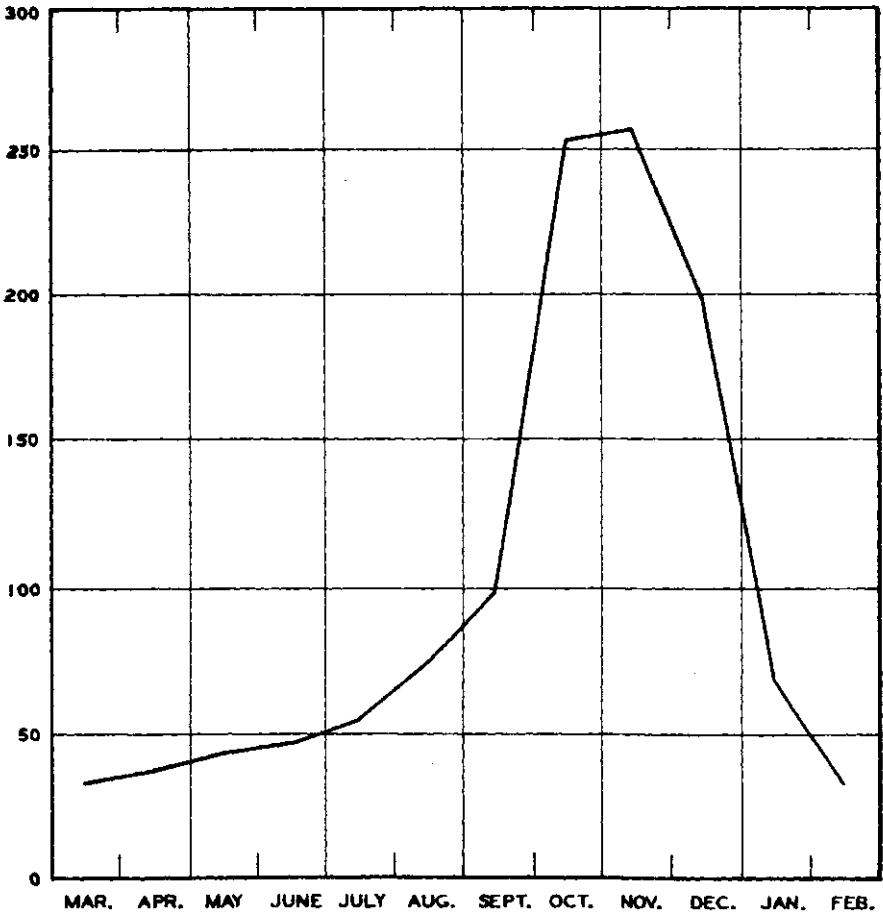
²The superintendent of a plant in the Central States said that previous to 1930 the beet-sugar industry was able to secure only the poorest grades of labor during the campaign season. Many of the laborers employed were transients. Since the depression of 1930, however, the industry has been increasingly able to secure its labor supply from local areas because more farmers are anxious to earn an additional income and because unemployed workers from other occupations have become available.

³See table B-16.

Figure 4.- SEASONAL PATTERN OF EMPLOYMENT IN BEET-SUGAR FACTORIES, 1903-33

(Average = 100)

INDEX



Based on table 4

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plitude of the seasonal change in employment has probably not been much reduced, the speeding up of the processes has made possible a shorter campaign, thus reducing the man-hours of employment per person for those engaged during the campaign period only.

The lowest seasonal demand for labor was in the months of February and March. It is a customary practice for the beet-sugar processor to retain superintendents, chief foremen, chief electricians, mechanics, chemists, workers in the plant office, etc., on the pay roll throughout the year. These workers prepare sugar

for shipment, keep the factory equipment in repair, and get the factory in readiness for the campaign.

**VOLUME OF EMPLOYMENT IN ALLIED VERTICAL SEGMENTS
OF THE INDUSTRY**

Growing and Transporting Sugar Beets

Data available concerning the number of workers in the allied vertical segments of the industry are meager and do not permit precise computations.

Another study published by the National Research Project provides the data from which an estimate is made of the average amount of labor engaged in the production and transportation of sugar beets.⁴ In this study it is estimated that in order to plant the country's sugar-beet crop and to cultivate, harvest, and transport it to the factory an average of 68 million man-hours per year were expended in raising and transporting sugar beets in the United States in the years 1913-17, 83 million in the period 1920-24, 71 million in the period 1928-32, and 73 million in the period 1934-36.⁵ Data concerning typical number of hours per day and per year worked in sugar-beet fields show a great variation in the number of working hours and days. The total beet-raising season, from plowing to final delivery of beets to the factory, encompasses some 6 months. The work on an acre of beets over the 6-month period is intermittent, however, and it should be remembered that the labor of plowing, planting, cultivating, and lifting is usually done by a different group of individuals than that of blocking, thinning, hoeing, pulling, and topping. All of these unknown variables make any estimates of the number of persons engaged in the production of sugar beets exceedingly hypothetical if based only on the total number of man-hours expended per year. If emphasis is placed upon the amount of work done rather than upon numbers of men employed, an estimate of man-years of work done is significant. If a man-year is assumed to be 3,000 hours (300 days at 10 hours per day), roughly 23 thousand man-years of work were required per year, on the average, to produce sugar beets for the years 1913-17, 28 thousand for the years 1920-24, and 24 thousand for the other

⁴Loring K. Macy and Others, *Changes in Technology and Labor Requirements in Crop Production: Sugar Beets* (Works Progress Administration, National Research Project, Report No. A-1, Aug. 1937).

⁵*Ibid.*, p. 41.

periods. The computations used in estimating the labor required in sugar-beet raising are brought together in table 5.

Table 5.- EMPLOYMENT IN PRODUCTION OF SUGAR BEETS, 1913-36^a

| Period | Average number of - | | Estimated number of - | |
|---------|---------------------|-------------------|-----------------------|-----------------------------------|
| | Hours per acre | Acres (thousands) | Man-hours (millions) | Man-years (thousands) (3) ÷ 3,000 |
| | (1) | (2) | (3) | (4) |
| 1913-17 | 113 | 601 | 68 | 23 |
| 1920-24 | 112 | 738 | 83 | 28 |
| 1928-32 | 99 | 717 | 71 | 24 |
| 1934-36 | 94 | 773 | 73 | 24 |

^aDerived from Loring K. Macy and Others, *Changes in Technology and Labor Requirements in Crop Production: Sugar Beets* (Works Progress Administration, National Research Project, Report No. A-1, Aug. 1937), p. 41.

It has been estimated that in 1933 there were 159,394 hired laborers in the beet fields, of whom 110,354 were contract laborers, 80,393 men, 15,228 women, and 14,743 children.⁶ The number of growers of sugar beets was 70,709. These estimates are for the largest acreage in the history of the industry. The 983 thousand acres harvested in 1933 exceeded by over 100 thousand acres the acreage in any year before or after. Estimates for earlier years placed the number of contract laborers at 67,680 in 1922 and 78,594 in 1926; the total number of laborers required on the 1926 crop was placed at 100,000 adult laborers, or a working force of adults and children equivalent to that number.⁷

The large apparent differences between the estimate of employment in table 5 and the estimated number of persons as quoted from other sources may be explained in part, at least, by the different purposes for which the estimates are made. As explained earlier, one is an attempt to answer the question of how much labor time is used, measuring that time in man-years. The other is an attempt to count all the persons who have found employment in the sugar-beet fields and the transportation of beets to the

⁶William T. Ham, "Regulation of Labour Conditions in Sugar Cultivation Under the Agricultural Adjustment Act," *International Labour Review*, 33, No. 1 (Jan. 1936), 76.

⁷*Costs of Producing Sugar Beets*, Part X: "Summary of Costs of Production of Sugar Beets in the United States, and an Economic Analysis of the Sugar Beet Industry, 1921, 1922, and 1923" (U. S. Tariff Commission, Misc. Series, 1928), pp. 16-7.

factories. Since some may work only a few days during the rush season of harvesting the beets, while others may work several months, it is quite possible that estimates with such extreme differences may both be reasonable. For example, if, of the estimated 100,000 adult laborers in 1926, 75,000 worked on the average of 50 days each while the remaining 25,000 worked 150 days, there would be 7,500,000 man-days of work utilized or the equivalent of the work of 25,000 men working 300 days each, or 25,000 man-years of work.

The difficulties in making these estimates are inherent in the very nature of agricultural production. For example: There is little uniformity in the length of working days; the same agricultural laborer often works on one or more kinds of crops; and the farmer-employer himself often works in the beet fields. It is obvious, however, that a much larger number of persons are employed and more labor is expended in growing beets than in working in the beet-sugar factory and that since 1920-24 the labor time expended has decreased approximately 12 percent.

Producing Fuel for Beet-Sugar Factories

The estimates of the labor required to produce the fuel consumed in beet-sugar factories are based upon the amount of fuel used in plants included in our sample and upon data prepared by Nicholas Yaworski of the National Research Project dealing with the volume of labor required per ton of coal in coal mining.

The lime rock burned in the lime kiln is usually burned with coke, whereas various types of fuel are used in the boilerhouse. For the plants for which we have collected fuel data, the natural gas, fuel oil, and other fuels reported were converted into bituminous-coal equivalents which were added to the tons of bituminous coal used. It was then found that the tonnage of fuel (in terms of bituminous-coal equivalents) required in the sample plants for the years 1927 to 1935 was roughly 15 percent of the tonnage of beets sliced in those plants.⁸ The average of the years 1927 to 1935 was used for the years 1913-26. This assumes that the average plant was as efficient in its use of fuel in these earlier years as in the period 1927-35. This probably underestimates the amount of fuel used during this period. From what is known of technological changes in the factories, it is

⁸The ratios of bituminous coal (or equivalents) to beets sliced are shown in table A-3.

likely that significant increases in the efficiency with which fuel was utilized took place at some time between 1913 and 1927. This would correspond also to what was taking place in other industries, as shown by another National Research Project report.⁹

The ratio of tons of bituminous coal to tons of beets sliced was multiplied by the total tons of beets sliced in the country for each year, 1913-35, to obtain total tons of bituminous-coal equivalents required.¹⁰

Calculation of the number of men required each year to produce fuel was accomplished with the aid of material on labor productivity in coal mining prepared by Mr. Yaworski.¹¹ This report furnished calculations of tons of coal produced per man-day in coal mining and the average number of days worked in each year. With the aid of these figures in conjunction with tons of bituminous coal required, the total man-days of labor required to produce coal for the beet-sugar industry and the total number of men were calculated for each year since 1913. The number of men is shown in table 6.

The year-to-year fluctuations in the average number of men required to produce fuel are not in close accord with the fluctuations in employment in the beet-sugar factories because the average number of days worked per year in coal mining fluctuates widely from year to year. Hence total man-days or man-hours are better measures of the labor used in producing the fuel. Whereas the number of tons of coal produced per man-hour has increased 50 percent or more since 1913, bringing about a marked reduction in the labor used per ton of coal, the increase in the production of beet sugar has required increasing amounts of coal, and hence there is no pronounced trend in the total labor requirements for the production of fuel.¹²

⁹Nicholas Yaworski and Others, *Fuel Efficiency in Cement Manufacture, 1909-1935* (Works Progress Administration, National Research Project in cooperation with Department of the Interior, Bureau of Mines, Report No. E-5, Apr. 1936).

¹⁰Approximately 75 to 80 percent of the fuel energy used in the factories is bituminous coal. This estimate is based on *Census of Manufactures* data for the years 1909, 1914, 1919, and 1929.

¹¹On the basis of material published by the U. S. Bureau of Mines, bituminous-coal production in the United States was divided by employment in bituminous mines. The employment series was calculated by the multiplication of the total average number of men in one active pay-roll period working in bituminous-coal mining by the number of mine-days the mines were operating. Mr. Yaworski emphasizes that this procedure is subject to errors in estimation and he has elaborated carefully the factors tending toward underestimation and overestimation of employment inherent in the method, his final conclusion being that the factors tending to overestimation and underestimation cancel out during periods when production is not rising or falling rapidly.

¹²See table A-3 for the series of man-hours per ton of bituminous coal, tons of coal equivalents used in the beet-sugar factories, and other series used in these computations.

Table 8.- NUMBER OF MEN REQUIRED TO PRODUCE FUEL FOR
BEET-SUGAR FACTORIES, 1913-35^a

| Year | Average number of men | Year | Average number of men |
|------|-----------------------------|------|-----------------------------|
| 1913 | 1,007 | 1925 | 1,180 |
| 1914 | 1,089 | 1926 | 1,047 |
| 1915 | 1,154 | 1927 | 1,248 |
| 1916 | 986 | 1928 | 1,120 |
| 1917 | 917 | 1929 | 996 |
| 1918 | 883 | 1930 | 1,353 |
| 1919 | 1,172 | 1931 | 1,328 |
| 1920 | 1,340 | 1932 | 1,708 |
| 1921 | 1,761 | 1933 | 1,985 |
| 1922 | 1,205 | 1934 | 1,450 |
| 1923 | 1,224 | 1935 | 1,452 |
| 1924 | 1,349 | | |

^aTable A-3, col. (7).

Producing Machinery for Beet-Sugar Factories

Data are available from the *Census of Manufactures* for companies making sugar-mill machinery, but, since most machinery used in a beet-sugar factory is also used in a cane-sugar refinery, it is not possible to ascertain the sugar machinery manufactured for beet-sugar mills alone from that source. By rough methods, however, it is possible to estimate the number of men required in the production of beet-sugar machinery on the basis of data collected in the NRP-NBER field survey.

The annual dollar expenditures of 31 plants for new equipment to maintain and improve plant facilities in the years 1917-35 were computed from data obtained in the NRP-NBER field study. There are also available yearly ratios of man-hours of labor required for the production of a dollar value of machinery.¹³ The total man-hours required in the production of machinery for the 31 plants were obtained by multiplying the expenditures by the ratios. This total for 31 plants was then used as the basis for estimating the total man-hours required in the production of machinery for the years 1917-35 for the whole industry. The

¹³These ratios were computed by the "Studies in Equipment Changes and Industrial Techniques" section of the National Research Project and are shown in table A-4, column (2).

31 plants for which machinery man-hours were obtained were found to represent 38 percent of the total daily slicing capacity of the industry in 1934, and this figure was used as the basis for the estimate of the industry total.¹⁴ The estimated number of men required each year to produce machinery for beet-sugar factories was calculated from man-hours on the assumption that each man works 2,400 hours per year. The number of men required to produce machinery is shown in table 7 and figure 5. This number in no sense represents the number of individuals engaged in the making of beet-sugar machinery but rather the number of man-years of labor utilized in its production.¹⁵

Table 7.- NUMBER OF MEN REQUIRED TO PRODUCE MACHINERY FOR BEET-SUGAR FACTORIES, 1917-35^a

| Year | Average number of men | Year | Average number of men |
|------|-----------------------|------|-----------------------|
| 1917 | 2,054 | 1927 | 134 |
| 1918 | 1,537 | 1928 | 383 |
| 1919 | 743 | 1929 | 651 |
| 1920 | 625 | 1930 | 597 |
| 1921 | 1,066 | 1931 | 257 |
| 1922 | 153 | 1932 | 373 |
| 1923 | 440 | 1933 | 1,110 |
| 1924 | 823 | 1934 | 585 |
| 1925 | 1,115 | 1935 | 310 |
| 1926 | 475 | | |

^aTable A-4, col. (5).

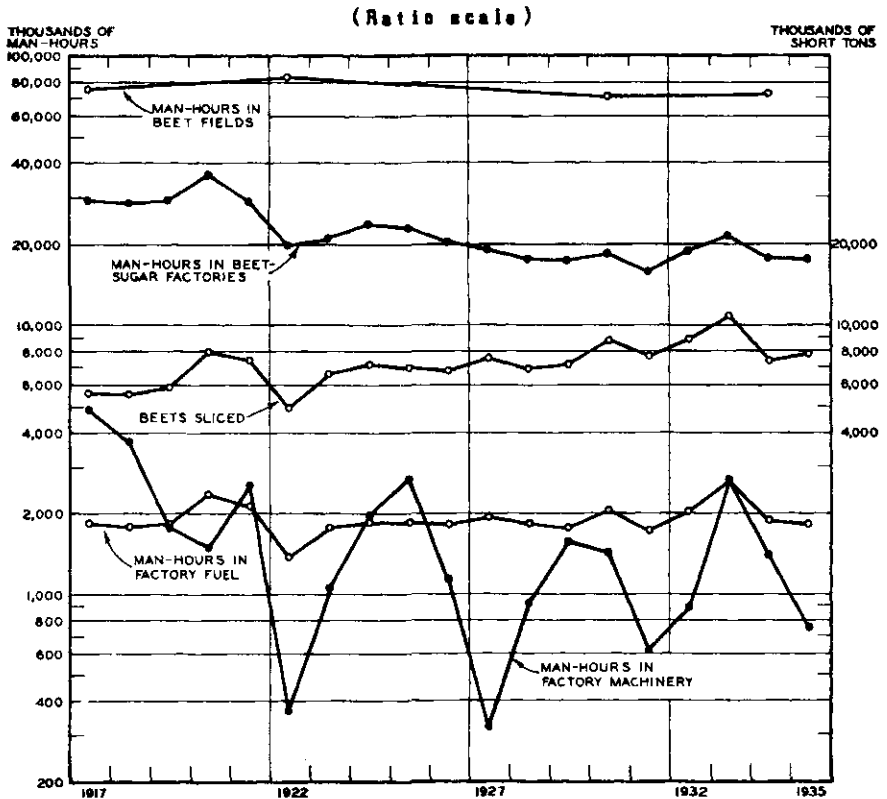
Transporting and Distributing Sugar

Data upon which could be based an estimate of the number of men required each year in the wholesale and retail distribution

¹⁴These calculations are shown in table A-4 and are based on the following assumptions: In 1934 the expenditures in the nonrepresented part of the industry bear the same ratio to daily slicing capacity as they do in the 31 plants, and the slicing capacity of the 31 plants is .38 of the total slicing capacity throughout the period. It is recognized that more reliable estimates might have been made if the ratio of the total daily slicing capacity of the 31 plants to the total of the industry had been obtained for other years. The estimate may be too high with respect to the remainder of the plants in the earlier years because of the fact that the 31 plants probably had a daily capacity somewhat large in relation to that of the industry in the years previous to 1934. On the other hand, the new plants which came into the industry during this period may have had more installation of new machinery than the average for other plants.

¹⁵The average number of men shown in the table is an average similar to that used customarily in the phrase "average number of men employed during the year" except that the man-year in this phrase is understood to be 12 months in length, leaving the number of hours per month undefined, whereas the man-year in the table is defined as 2,400 man-hours.

Figure 5.- MAN-HOURS IN FOUR VERTICAL SEGMENTS OF THE BEET-SUGAR INDUSTRY, 1917-35



Based on tables A-1 and A-5

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of beet sugar are not available. Likewise, adequate data upon which an estimate of the volume of employment required for the transportation of beet sugar might be made are not available. The statistics concerning the employment required in the transportation and wholesale distribution of sugar that do exist do not distinguish between beet sugar and cane sugar. There is no reason to think that beet sugar is being transported shorter or longer distances today than 20 or 30 years ago, since there has been no marked change in the location of the plants or markets. But it is known that the number of men required to ship a ton of freight has been decreasing over a period of 10 to 15 years. Whether this tendency toward decreased employment has offset the tendency toward increased employment resulting from the larger production of sugar, it is impossible to say.

Other Segments

Attention should be called to other obvious omissions in the estimates of employment in the segments which makeup the vertical structure of the industry. While an attempt has been made to estimate the number of man-hours of labor utilized from year to year in manufacturing machinery, no corresponding attempt has been made to estimate the employment in the building and repairing of the structures which house this machinery. The difficulties involved in making these estimates, coupled with the fact that most of the structures for which financial data are available were built previous to 1917, made it seem unwise to make these estimates. Moreover, because of the large amount of building in the years 1915-19 and the long life of structures there has been relatively little building since then.

Also, no attempt has been made to estimate the man-hours employed in the production of materials other than fuel and beets nor those used in the transportation of fuel and of these materials.

TOTAL VOLUME OF EMPLOYMENT

The average annual volume of employment measured in man-hours in all of the vertical segments for which employment could be estimated is shown in table 8. Since agricultural employment was

**Table 8.- AVERAGE YEARLY MAN-HOURS OF EMPLOYMENT
IN FOUR VERTICAL SEGMENTS OF THE BEET-SUGAR
INDUSTRY, 1917-35^a**

(Thousands)

| Year | Total | Growing and trans- portation of beets | Process- ing | Fuel for factories | Machinery for factories |
|---------|---------|--|-----------------|-----------------------|-------------------------------|
| | (1) | (2) | (3) | (4) | (5) |
| 1917 | 111,130 | 75,145 | 29,210 | 1,846 | 4,929 |
| 1920-24 | 111,977 | 82,656 | 25,931 | 1,899 | 1,491 |
| 1928-32 | 91,541 | 70,983 | 17,596 | 1,877 | 1,085 |
| 1934-35 | 92,531 | 72,004 | 17,601 | 1,851 | 1,075 |

^aBased on table A-5.

obtained as an average annual figure based upon average acreages harvested and yields for the periods 1913-17, 1920-24, 1928-32,

and 1934-36, the estimates of employment for the other vertical segments of the industry were also expressed as annual averages for the same periods, except that the year 1917 was substituted for the first period and the years 1934 and 1935 for the last period because of lack of data for 1913-16 and 1936 in other segments of the industry.

Comparison of the changes in the man-hours of employment in the four segments of the industry with the changes in production (beets sliced) is shown in figure 5. Except during the initial period, the growing and transportation of beets has required about 74 to 78 percent of all the labor in the measured segments of the industry. It might be remarked that much of this labor was the least skilled and poorest paid, being in part that of transient agricultural workers and including that of women and children. The labor in the factories declined from 26 percent of the total in the earlier years to 19 percent in 1934-35. The labor for fuel was approximately 2 percent of the total throughout the period and about 10 percent of the labor in the factories in the later years, while since 1920 the labor used in the machinery industry has been about 1 percent of the total and 6 percent of that in the factories. There has been a decline in the labor used in the industry amounting to 20 percent if only the end periods are compared and this in face of an increased production of 26 percent in terms of beets sliced. Increased use of machinery in the growing of the beets, the use of trucks to transport them to market, improved seed and agricultural methods, improvements in the factories, and increased efficiency in the extraction of coal and in the machinery industries have all combined to bring this about.

The number of persons dependent upon the functioning of the beet-sugar industry for a part of their income from employment in 1933 was approximately 30,000 in the factories, 70,000 sugar-beet growers, 159,000 hired laborers in the beet fields, 2,000 in the production of fuel, 1,000 in the machinery industries, and several thousand more in the transportation of fuel and sugar and in the wholesale and retail distribution of the sugar. The estimated total might, therefore, range anywhere from 262,000 to 270,000 or more in this year of peak production. But some of those working in the beet fields received pay for only a few weeks' work; many farmers depended upon the industry for a substantial portion of their cash income; the bulk of the workers

in the factories averaged not more than 72 days of work; and in the machinery and fuel industries it is likely that a number equal to that included in the estimate depended upon the industry for their entire employment.

SUMMARY

The outstanding characteristic of the employment in this industry is the fact that of the large number of persons, some 260 thousand or more, who receive income from employment not more than a few thousand have employment for the year. In fact the employment period tends to be considerably less than 100 days for most of them, and in the beet-sugar factories the average period of employment during the campaign has been decreasing. This, combined with the type of work required, has created problems of transient labor. Laborers have been drawn into some communities for employment during a short period but have remained to be taken care of on relief rolls for the rest of the year.¹⁶

Largely because of greater efficiency in all segments, the number of people who find employment in the industry has remained fairly stable in the face of a steady increase in the volume of production. This factor affecting the demand for labor will receive more detailed consideration in chapter IV.

There are, however, year-to-year fluctuations, sometimes of considerable magnitude, in the numbers employed or in the length of the period of employment, due to fluctuations in the amount of production. The natural and economic causes which bring about these fluctuations will be discussed in chapter III, together with the causes which have determined the level of production and its upward trend.

¹⁶W. Lewis Abbott, *Report for the Committee on Labor Conditions in the Growing of Sugar Beets* (Washington, D. C.: mimeo., Mar. 1934); Walter Quinn in an unpublished report on *The Conditions of Sugar Beet Workers in Colorado in 1937* (Works Progress Administration, Section of Labor Research, Division of Research, Statistics and Records); Elizabeth S. Johnson, "Wages, Employment Conditions, and Welfare of Sugar-Beet Laborers," *Monthly Labor Review*, 46, No. 2 (Feb. 1938), 331, 337-8.

CHAPTER III

CHANGING PRODUCTION AS A FACTOR AFFECTING THE VOLUME OF EMPLOYMENT

RELATIONSHIP OF PRODUCTION AND EMPLOYMENT CHANGES

That change in the volume of production is the major determining factor of change in the volume of employment is self-evident, but the year-to-year changes in production may not bring about proportional changes in employment because of the influences of other factors. Likewise, over a period of years an increase or decrease in production may not be accompanied by a proportional increase or decrease in employment. In fact, employment may fall off while production is increasing.

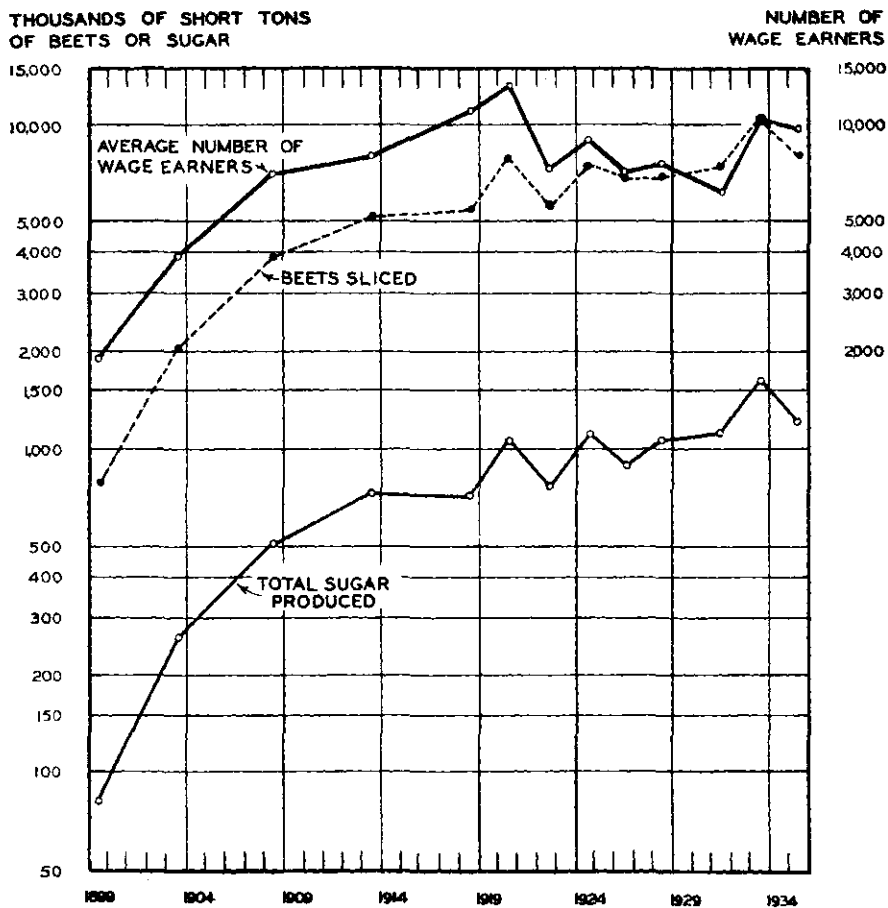
For the purpose of comparing changes in the volume of employment with changes in production, two types of measures may be used which have been presented in chapter II, either the average number of persons employed during the year, which is a rough attempt to measure employment in man-years (the man-years representing a changing number of man-hours) or the number of man-hours. If measured in terms of average number of persons employed, changes in the number of hours worked per person during the period may cause the movement of the employment series to be different from that of the production series for the corresponding years.

The main purpose in this chapter is to explain the movements in production which have affected the volume of employment. Hence a comparison of the changes in the average number of persons employed in the beet-sugar factories with the changes in production may serve as an introduction to this chapter and the one which follows by pointing out the differences in the movements of the two series which remain to be explained. Figure 6 presents on a ratio scale the changes in the amount of beet sugar produced, in tons of beets sliced, and in the average number of wage earners from 1899 to 1935. The first two series are shown in table 9 also.

The rising trend of sugar production throughout the period is partly attributable to an increase in the sugar content of the beets and to an increase in the percentage of available sugar extracted. Since these influences have little if any effect upon

Figure 6.- PRODUCTION AND EMPLOYMENT IN BEET-SUGAR FACTORIES
1899-1935

(Ratio scale)



Based on tables 3 and 9

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labor requirements in the factory, the quantities of beets sliced have been placed on the chart for comparison with employment. Employment fluctuates much more closely with total tons of beets sliced than with total sugar produced, and the dependence of employment upon the extent of operations is thus more clearly revealed.

It will be observed that while the trends of the series for sugar produced and beets sliced continued upward throughout the period, that for the average number of wage earners, after increasing at a somewhat slower rate than the other two up to 1920, changed to a declining trend. The differences between the trends

**Table 9.- SUGAR BEETS SLICED AND BEET SUGAR PRODUCED
1899-1935^a**

(Thousands of short tons)

| Year | Beets sliced | Sugar produced ^b |
|------|---------------------|-----------------------------|
| 1899 | 795 | 82 |
| 1903 | 2,175 | 254 |
| 1908 | 3,965 | 502 |
| 1913 | 5,639 | 743 |
| 1918 | 5,649 | 722 |
| 1920 | 7,873 | 1,030 |
| 1922 | 5,786 | 754 |
| 1924 | 7,423 | 1,083 |
| 1926 | 6,711 | 899 |
| 1928 | 6,951 | 1,086 |
| 1931 | 7,620 | 1,165 |
| 1933 | 10,778 ^c | 1,636 |
| 1935 | 7,745 | 1,186 |

^aCensus of Manufactures data.

^bFigures represent total sugar produced; they include a small quantity of raw sugar, and differ slightly from those for granulated sugar given in table A-1. 1899 is the only year when a considerable portion of the sugar was raw.

^cAgricultural Statistics, 1936 (U. S. Dept. Agr., 1936), p. 91.

in production and in employment can be explained in large part by the changes in the number of man-hours required to produce a bag of sugar, a factor which will be given detailed consideration in chapter IV.

Relative differences in the year-to-year fluctuations in the average number of wage earners as compared with the year-to-year changes in production are in part due to the fact that the average number of wage earners is a very imperfect measure of the employment of labor in an industry in which the operating season is short and of a varying length from year to year.

Changes in the length of the campaign plant shift which took place during the period from 1918 to 1935 also affected the average number of persons employed, although they probably had little effect upon the number of man-hours worked. Two large companies in the year 1919 changed campaign plant shifts from two 12-hour to three 8-hour shifts per 24-hour day thus necessitating an increase in the number of men, but one of these companies returned to two 12-hour shifts in 1922. Since 1933, when an 8-hour working

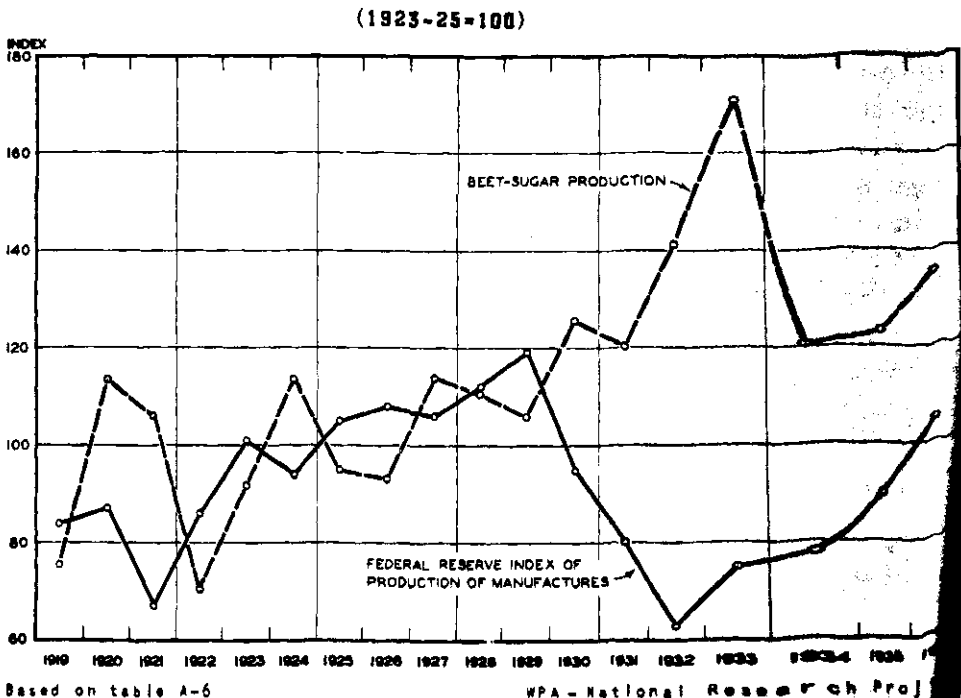
CHANGES IN PRODUCTION

day was established for the industry under the National Industrial Recovery Act, all companies have been operating with three 8-hour shifts during the campaign period. This necessitated a larger proportional increase in the number of men in 1933 than in the number of hours worked.¹

ABSENCE OF CORRELATION WITH BUSINESS CYCLES

Employment in the beet-sugar industry has not exhibited the same cyclical behavior shown by general indexes of employment because beet-sugar production has not followed the fluctuations of general business cycles. The relative year-to-year changes in the production of beet sugar and in the Federal Reserve Board's index of all industrial production for the period 1919-35 are shown in figure 7. In 10 of the years the two series move inversely to

Figure 7.- INDEXES OF PRODUCTION OF BEET SUGAR AND ALL MANUFACTURES, 1919-35



¹Intercampaign hours per shift and per week were not changed. However, figure 3 reveals an increase in the intercampaign employment comparable to the increase in campaign employment for that year probably due to increased intercampaign activity in anticipation of the largest campaign in the history of the industry.

each other, but the movements are in the same direction in the remaining 6 years. While industrial activity fell to an extremely low point in 1932, beet-sugar production was moving to an all-time high in 1933. The failure of beet-sugar production to reflect the general swings in industrial activity is due to the peculiar economic milieu of governmental protection and control within which the industry operates, on the one hand, and to the dependence of the industry upon the production of an agricultural commodity, sugar beets, on the other, as will be shown in the discussion which follows.

FACTORS INFLUENCING PRODUCTION OF BEET SUGAR

The importance of governmental action and the industry's relationship to agriculture will be brought to the front as the answers to the following questions are being sought. What economic circumstances, on the one hand, permitted or are responsible for the great rise in the production of beet sugar from 1899 to the end of the war? Why, on the other hand, did the previously rapid rate of increase of beet-sugar production decline following the end of the war? What economic circumstances are responsible for the increase in production to the highest point in the history of the industry in 1933 when the other manufacturing industries were suffering from a serious depression? What economic circumstances acted as retarding influences on the trend of beet-sugar production, and what circumstances are responsible for the erratic year-to-year fluctuations of production within the general trend of growth? Finally, what forces today are operative in promoting or retarding an expansion of beet-sugar production, and what is the outlook for the future?

Fluctuations in Consumption

In order to understand better the interplay of various factors determining the volume of production of beet sugar in the United States, it is necessary to understand the nature and extent of the demand for sugar and of the competitive conditions under which the beet-sugar industry operates.

Practically all the sugar now produced is used either in the home or in the manufacture of foodstuffs such as candy and bakery goods. Since sugar is a relatively small item in the household

budget and is habitually used as the chief sweetening food, housewives are wont to continue their customary purchases of sugar regardless of minor fluctuations in its retail price.²

The rising consumption of sugar in the United States is shown in figure 8. There are also shown on the chart the wholesale prices of refined sugar at New York and the annual per-capita consumption of sugar. By 1936 the consumption of sugar had increased to 264 percent of that in 1899.³ The rise in per-capita consumption indicates that this increase in the consumption of sugar was only partly due to population growth and that sugar had become an increasingly important item in the household budget. Between 1899 and 1913, when the price of sugar fluctuated between 4 and 5½ cents per pound, total and per-capita consumption showed a steady rise.

The steady rise in total consumption of sugar was interrupted by the disturbances in supply and demand which accompanied the Great War only to resume its earlier trend line later after regaining what it had lost during the war. The trend upward was again interrupted from 1929 to 1932 by the sudden falling off in incomes which accompanied the depression. An examination of the year-to-year fluctuations in the per-capita consumption of sugar seems to indicate a certain correlation with year-to-year changes in incomes. In other words, it is probable that the demand for sugar in the form of various luxury foods falls off with the decline in incomes.⁴ These fluctuations in per-capita

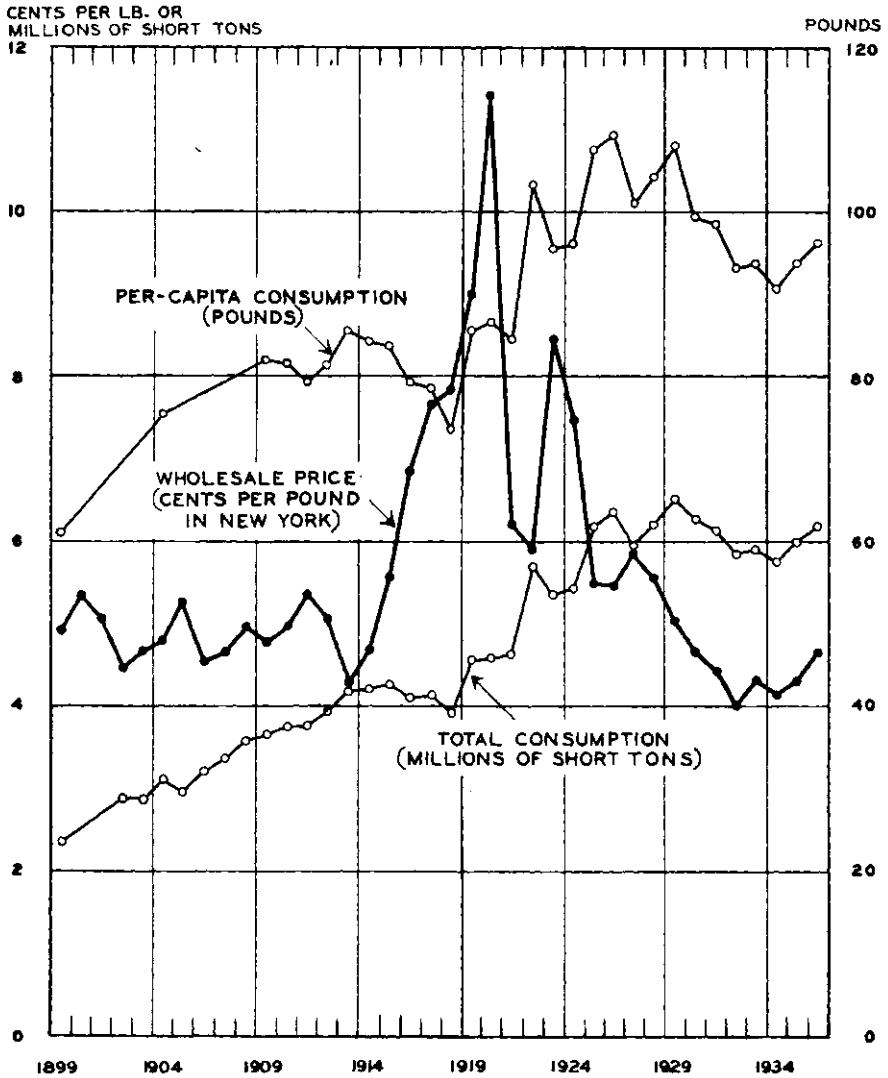
²It has been estimated that the average cost of sugar per family in 1931 was \$17.33, as compared with \$25.31 for eggs, \$54.82 for beef, and \$105.41 for milk. See Sugar Institute, *Study of Sugar Used by Manufacturers and for Household Consumption, 1929 and 1931* (New York: Sugar Institute, 1934), Statistical Report No. 23, p. 6.

Henry Schultz, in his statistical analysis of demand and supply curves for sugar, states that "the elasticity of the United States' demand [for sugar] has been found, by four different methods, to be approximately equal to -0.5 under 'normal' conditions. That is to say, based on the experience of 1890 to 1914, an increase in the price of sugar of 1 percent will reduce consumption by 1/2 of 1 percent under normal conditions." *Statistical Laws of Demand and Supply* (Chicago, Ill.: The University of Chicago Press, 1928), p. 200. Mr. Schultz emphasizes the fact that the results of his methods cannot be separated from the methods themselves and that if other methods were to be used, identical results would not be obtained.

³Lippert S. Ellis in *The Tariff on Sugar* (Freeport, Ill.: The Rawleigh Foundation, 1933) states (p. 25) that observations in the United States for 108 years previous to 1933 show that consumption has made an annual average increase of a little more than 5 percent.

⁴See Sugar Institute, *op. cit.*, p. 5, which states "that the average amount of sugar used by each person in the United States, in the form of sugar or of home-made desserts, remained practically constant during the first two years of the depression, and that the loss in total consumption was due to decreased purchases of factory-made jams, candy, soft drinks, etc., and a smaller consumption of pies, cakes and cookies, from the bake shop. The conclusion may be drawn from these figures that sugar as sugar is not regarded as a luxury food, but is considered necessary and economical by the American housewife. On the other hand, it would appear that the feeling is different when it comes to candy, ice-cream, beverages, chewing gum, etc."

Figure 8.- TOTAL AND PER-CAPITA CONSUMPTION
AND WHOLESALE PRICES OF REFINED SUGAR
1899-1936



Based on table A-7

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consumption are reflected in the curve of total consumption but with lessened amplitudes because of the fact that the steady increase in population tends to offset to some extent the factor of decline in per-capita consumption.

The use of sugar as the chief sweetening food is very likely to continue, for sugar has no serious competitors. Edible, noncrystallizable sirups compete with sugar as a sweetening food

for some purposes, namely, in the manufacture of ice cream and bakery products in the food industry and in the home where these sirups may be used in the preparation of certain foods. However, most edible sirups sold as sweetening foods, with the exception of maple sirups and corn sirups, are byproducts of beet-sugar and cane-sugar manufacture. As compared with the huge quantities of sugar consumed, the exceedingly small amounts of other sweetening foods used are of no great importance.

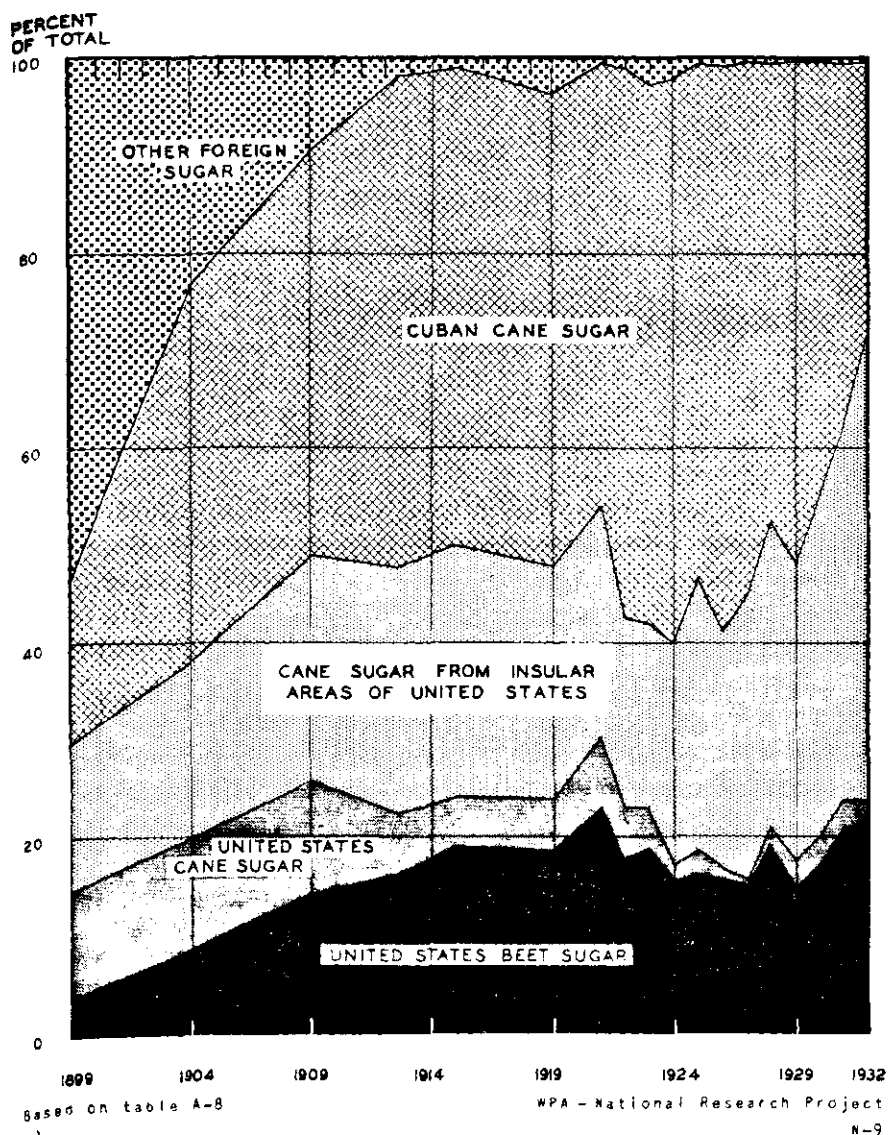
Per-capita and total consumption of sugar declined during the depression, reached their low points in the period 1932-34, and thereafter turned upward. Although the consumption of sugar has been rising since 1934, it is impossible at this date to predict what average rate of increase in consumption we may expect during the next decade. That consumption of sugar will keep pace with increase in population seems highly probable, and from the behavior of the curve showing per-capita consumption there is also a high degree of probability that total consumption will proceed at even a faster rate than population, but that this rate of increase will gradually slow down.

Sources of Sugar Consumed in the United States

As pointed out in chapter I, beet sugar competes with an identical product, cane sugar, in supplying the total demand for sugar in the United States. Cane sugar and beet sugar are not exactly identical from the point of view of the market, however, as is revealed by the usual price differential in favor of cane sugar.

The United States has always depended on outside sources for a large part of its supply of sugar. For a number of years the chief sources of the sugar coming into this country have been the Philippine Islands, Hawaii, Puerto Rico, and Cuba. Louisiana and Florida cane sugar also compete in the national sugar market, furnishing about 2½ percent of the total amount of sugar consumed in this country. A tariff upon the sugar imported has been in existence in the United States since 1789 except for a short period between 1890 and 1894 when a direct bounty of 2 cents per pound was paid upon all sugars domestically produced. Prior to 1890 the tariff had been primarily a revenue measure serving only incidentally as a protection for the relatively unimportant Louisiana cane-sugar industry. Since 1890 greater emphasis has

Figure 9.- DISTRIBUTION BY SOURCE OF SUGAR CONSUMED
IN CONTINENTAL UNITED STATES, 1899-1932



been placed on the protective feature of the tariff. It has afforded protection for the producers of sugar in certain islands from which the United States obtains its supply, as well as for domestic beet-sugar producers and domestic cane-sugar producers. Hawaiian producers since 1876, Puerto Rican producers since 1901, and Philippine producers since 1909 have enjoyed the

protection given by the tariff.⁵ The percentages of the total sugar consumed in the United States from the different sources are graphically shown in figure 9.⁶

Effect of United States Tariffs Upon Domestic Production of Beet Sugar

From 1899 to 1914 the production of beet sugar in the United States increased at a rapid rate, but after this the rate of increase declined. The production of cane sugar in Cuba during this period was increasing at a slower percentage rate, but the absolute rate of increase was much greater, while at the same time the production in the island possessions was also being built up, at a somewhat slower rate, so that by 1913 the other foreign competitors had been practically driven from the American market. After the war, production in Cuba took a spurt upward bringing her production in 1922 to a new level of 57 percent of the total sugar consumed in the United States. This was followed in 1924 by a marked increase in the upward trend in production in the island areas until in 1932 they were producing 48 percent of the total sugar consumed in the United States. In the meantime production in Cuba began to fall off, taking a decided turn downward in 1929 both relative to the total and absolutely. The production of domestic beet sugar, after rising to a new level in 1921 when the beet-sugar industry supplied 23 percent of the market, tended to decline both relative to the total sugar supplied to the market and absolutely.⁷ After fluctuating about a level for several years, production in the beet-sugar industry seemed to resume an upward trend around 1928, interrupted somewhat by year-to-year fluctuations, until in 1932 it had regained its relative position as a producer in the American market, with 21 percent of the production to its credit. After 1929 neither the production of beet sugar in the United States nor of cane sugar in the islands reflected the decline which characterized the consumption of sugar. In fact both of them made marked increases in their production during this period.

⁵After 1903 the Philippine Islands were permitted to export sugar to us at a 25-percent reduction from the full import duty on sugar; after 1909 they were permitted to export 300,000 tons of sugar to this country free of duty; and after 1913 the Philippines were permitted complete freedom of access to our market.

⁶Table A-8 shows these data in absolute terms and in more detail.

⁷1921 is the market year, not campaign year, and hence corresponds for the most part to the 1920 campaign year. Market years, not campaign years, will be used in the following discussion.

In the tariff policy of the United States Government is to be found in part the explanation of the peculiar characteristics of the growth of production of beet sugar in the United States, as well as a partial explanation of the fluctuations about the line of growth. Before the World War the trend of the production of beet sugar was much steeper than that of the total consumption of sugar in the United States, but since the war the trends, though not so clearly defined, have run more nearly parallel. The fluctuations of the two curves about these trends show little correlation, however. It is these differences in the changes in the two series that require explanation. Why does the production of beet sugar fail to reflect the fluctuations in the demand for sugar?

Allocation of Production Under Free-Trade Conditions.- Under conditions of free trade the amount of sugar produced in each of the world's principal producing areas would become so adjusted to the world price as to result in all the areas arriving at marginal costs which are approximately equal after adjustments have been made for transportation costs to the principal markets. Whether any one district would find it profitable to participate in the industrial activity at the world price would depend, of course, upon whether in that district any producers could operate at costs not in excess of the marginal costs established under the conditions of competition in competing areas.

Whether the United States would produce any sugar under the conditions of free trade is, therefore, a question of relative costs which would be incurred to produce varying supplies of sugar. These costs, in turn, are determined by the suitability of the natural resources for the undertaking, the nearness to the markets, and the alternative uses to which those resources and the labor and capital supply of the economy can be put. Under a competitive international-trade situation the opportunity cost resulting from the alternative uses of resources may well be so high as to remove certain industries which exist under governmental protection from the economy altogether.

In order to determine whether there would be any considerable production of sugar within the boundaries of continental United States under these circumstances, an analysis of the costs of production of the various mills would be required, together with the construction of a supply curve showing the production which

would be called forth by a variety of supply prices. As to what the magnitude of this production would be in the United States, estimates reveal that efficient parts of the beet-sugar industry could continue to operate profitably in the absence of protection. A calculation of the percentages of the domestic beet-sugar industry that would have survived free trade in sugar in 1916-17 and 1917-18 was made by the United States Tariff Commission on the basis of its early cost studies.⁸ It was estimated that 56.8 percent of the beet-sugar industry would have survived if the tariff on sugar had been removed in 1916 as was originally contemplated by Congress in the Tariff Act of 1913. However, the competitive position of the industry was found by the Commission to have been much improved by 1918; at this time it was estimated that 82 percent of the industry could survive free trade.⁹ It should be noted that in making these estimates the Commission did not take into account interest on investment as an element in cost, hence the estimates would be lower if interest was added to costs. It should also be noted that the estimates are based on the assumption that only that part of the industry which was producing at a cost equal to or below the world price could survive in any one year. The possibility of survival must therefore be interpreted in this very limited sense. Also, the difference in estimates between 1916 and 1918 may be in large part due to a rise in the price of sugar not reflected in the costs of production of beet sugar. Actual survival of any portion of the industry after the removal of the tariff is a function of several variables, some of which are highly indeterminate. After taking into consideration average Cuban costs for 1921 and 1922, freight differentials, the above-normal price that existed at that time, and the increase in Cuban production that could be expected as a result of the price, Mr. Philip G. Wright has estimated that in 1923, 66 percent of the domestic beet-sugar industry could have survived free trade.¹⁰

The most recent study made by the Commission of the costs of producers in the various supply areas of the United States sugar system shows that a considerable portion of the domestic beet-sugar industry still requires government protection for its ex-

⁸*Costs of Production in the Sugar Industry* (U. S. Tariff Commission, Tariff Information Series No. 9, 1919), pp. 41-2.

⁹*Ibid.*, p. 44.

¹⁰Philip G. Wright, *Sugar in Relation to the Tariff* (New York: McGraw-Hill Book Co., Inc., 1924), pp. 135-6.

istence. Table 10 gives the average cost of producing beet sugar f. o. b. factory as contrasted with the costs of producing cane sugar from the various cane areas f. o. b. American seaboard refineries.¹¹ The costs shown are average costs for the 3 campaign years 1929-31. They indicate that the average costs of refined Cuban cane sugar f. o. b. refineries on the Atlantic coast were less by 1.19 cents per pound than the average costs of beet sugar f. o. b. factories.

Table 10.- COMPARATIVE AVERAGE TOTAL COSTS OF REFINED SUGARS
COMPETING IN THE UNITED STATES, 1929-31^a

(Cents per pound)

| Source | Average cost, campaign years 1929-31 | Competitive advantage (+) or disadvantage (-) of beet sugar |
|---|--------------------------------------|---|
| Domestic beet at factories | 3.93 | - |
| Louisiana cane at New Orleans | 5.46 | +1.53 |
| Hawaiian cane at Pacific and Atlantic refineries | 4.11 | +0.18 |
| Puerto Rican cane at Atlantic refineries | 4.10 | +0.17 |
| Philippine cane at Atlantic refineries | 3.54 | -0.39 |
| Cuban cane at Atlantic and Gulf Coast refineries ^b | 2.74 | -1.19 |

^aBased on *Report to the President on Sugar* (U. S. Tariff Commission, Report No. 73, Second Series, 1934), pp. 88, 132-3. Figures refer to cost of production of cane and beets, not price. Imputed interest on total investment at 6 percent is included in cost. Cane-sugar costs include cost of refining in the United States.

^bThese costs are not normal but a result of the low prices of sugar (*Report to the President on Sugar*, p. 21).

Growth of the Industry Under Protection, 1890-1919.- The growth of the industry in the United States since 1899 and its present scale of operations must, in view of the facts stated above, be

¹¹Cane sugar enters the markets of the United States through ports on the Atlantic and Pacific coasts and on the Gulf of Mexico, while beet sugar is produced in the dairy States of the Middle West, in the range and plains States west of the Mississippi, and in California. As a result of these facts, cane-sugar producers pay smaller freight rates within this country to consuming centers in the East and South. Beet-sugar producers pay smaller freight rates to areas west and north of the Missouri River. Cane and beet sugars produced in the West pay approximately equal freight rates in California and States of the upper Mississippi Valley, and, of course, the beet-sugar producers of the central dairy States have a considerable freight advantage in that area.

explained in part in terms of the protection it has received which has resulted in the establishment of a domestic price for sugar substantially and uniformly above the world price. The Federal Government provided a twofold impetus to the development of the beet-sugar industry in this country when the industry was first emerging from its experimental stages. On the one hand, the McKinley Tariff Act of 1890 substituted for the previous duty a direct bounty of 2 cents per pound on all sugar domestically produced, and this resulted in a decided stimulus to the infant industry. Also, the United States Department of Agriculture was active during the decade of the nineties in advertising and encouraging the expansion of sugar-beet growing. Special and regular reports of the Department devoted much space to the methods of sugar-beet culture and argued the advantages of sugar-beet growing both from the point of view of the farmer and of the nation as a method of producing a part of the domestic sugar requirements at home.¹²

The tariff protection provided by Congress since 1897 for domestically produced sugars is summarized in table 11. Previous to 1913 the production of sugar within the United States, in the insular areas, and in Cuba was not sufficient to satisfy the demand for sugar in this country, so considerable amounts of sugar were imported from foreign countries other than Cuba. The result was that the American consumer paid the world price of sugar plus the full rate of duty but the Cuban producers received the 20-percent Cuban tariff differential. By 1914, however, domestic, insular, and Cuban production had expanded to such an extent that the combined production was greater than the amount of sugar consumed in the United States. Imports from foreign countries other than Cuba became negligible, and Cuba began exporting her surpluses, over and above the needs of the United States, to other markets. In general, then, by 1914 the American consumer paid the world price plus only the Cuban tariff rate, and Cuban producers received only the world price.

The fact that the American price was maintained above the world price resulted, of course, in the exploitation of less-productive economic opportunities in this industry than would have been possible had the world price prevailed. In other words, by maintaining a supply price in the United States which was appreciably

¹²Frank W. Taussig, *Some Aspects of the Tariff Question* (Cambridge, Mass.: Harvard University Press, 1915), pp. 80-1, 95.

Table 11.- RATES OF DUTY ON SUGAR IN UNITED STATES TARIFF ACTS 1897-1936^a

(Cents per pound)

| Tariff rate effective | 96 ^o centrifugal | | Refined, Cuban rate |
|-----------------------|-----------------------------|-------------------------|---------------------|
| | Full rate ^b | Cuban rate ^c | |
| | (1) | (2) | (3) |
| July 24, 1897 | 1.685 | 1.6850 | - |
| Aug. 6, 1909 | 1.685 | 1.3480 | 1.5200 |
| Mar. 1, 1914 | 1.256 | 1.0048 | 1.0880 |
| May 28, 1921 | 2.000 | 1.6000 | 1.7280 |
| Sept. 22, 1922 | 2.206 | 1.7648 | 1.9120 |
| June 18, 1930 | 2.500 | 2.0000 | 2.1200 |
| June 8, 1934 | 1.875 | 1.5000 | 1.9875 |
| Sept. 4, 1934 | 1.875 | 0.9000 | 0.9540 |

^aData in: cols. (1) and (2), July 24, 1897 to June 18, 1930, from Lippert S. Ellis, *The tariff on Sugar* (Freeport, Ill.: The Rawleigh Foundation, 1933), p. 48; col. (3), August 6, 1909 through June 18, 1930, from *Report to the President on Sugar* (U. S. Tariff Commission, Report No. 73, Second Series, 1934), p. 35. Rates effective June 8, 1934 were established by Presidential proclamation of June 8, 1934 under the flexible provisions of the Tariff Act of 1921; those effective September 4, 1934 were established under the terms of the Reciprocity Trade Agreement of August 1934. No rate for refined Cuban sugar was in effect on July 24, 1897.

^bSugar from Hawaii admitted free since September 9, 1876; from Puerto Rico, admitted free since July 25, 1901; and from the Philippine Islands, admitted free since August 6, 1909.

^cUnder the terms of the reciprocity treaty effective December 27, 1903, Cuba was given a 20-percent preference.

above the world supply price, a larger production was forthcoming from producers within the United States than would have been forthcoming had the world price prevailed in the United States. Philippine, Hawaiian, and Puerto Rican cane producers also enjoyed the protection of the American tariff, so that a larger production was forthcoming from these areas than would have been forthcoming under the world price, and Cuba enjoyed a preferential duty which stimulated production facilities there. Indeed, as has been seen, production in the islands expanded appreciably under the tariff protection received.¹³

By increasing the production of sugar within the jurisdictional limits of the United States, the tariff has drawn a substantial labor force into the industry to produce this additional output. This observation must not be interpreted as supporting the thesis that a protective tariff creates employment in industry as a whole. No attempt is made to estimate the additional cost of

¹³See figure 9 and table A-8.

sugar and the consequent reduction in purchasing power of American consumers because of this policy, nor are we in a position to state the loss of employment opportunities in other industries with comparative advantages in trade whose costs have been increased or markets restricted by the expansion of the beet-sugar industry.

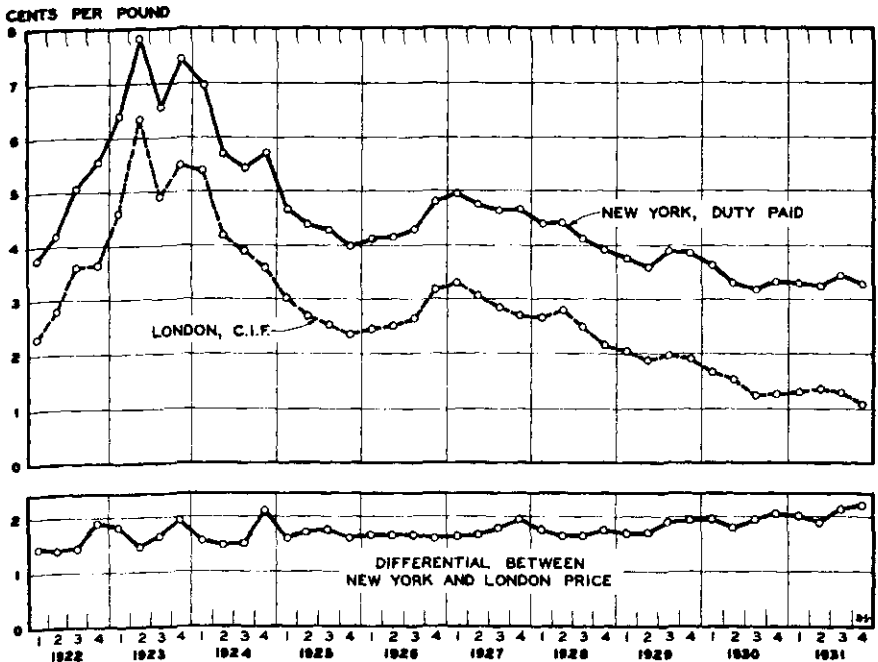
Thus it is generally agreed that the tariff was responsible not only for the rapid development of the beet-sugar industry in the United States but also for the development of the cane-sugar industry in the island areas in the period from 1900 to 1914. Moreover, the preference given to Cuban sugar was sufficient to bring about its rapid development at the same time. All of these sources of supply were being developed at a time when the consumption of sugar was expanding at a fairly rapid rate. Advances in technology in the beet-sugar industry during this period, both in the growing of beets and in the processing in the factories, made it possible for the industry to expand within the limits afforded by protection until by 1914 it was producing 18 percent of the sugar offered on the American market. Under the protection of the tariff the margins of utilization of resources in the United States, Cuba, and the islands were adjusted relative to the margins of utilization which were established in other districts by the world price. Just why the tariff was so placed that under the existing conditions of supply and demand factors there resulted a production of domestic beet sugar that totaled about 18 percent of the sugar domestically consumed is a question of public policy which was controlled by a multiplicity of factors.

Competition for the American Market, 1914-1933.— During and immediately after the World War an expansion took place in the land devoted to the production of sugarcane and in the capital equipment in the sugar industry in all areas, so that by 1919 a greatly increased capacity for production of sugar existed. The dislocations of production associated with the war period called into existence in this industry, as in many others, capital equipment beyond that warranted by the rate of increase in consumption. Thus, there appears after 1919 a competitive condition which is different from that preceding this period. Whether the World War did more than hasten the period when the increase in capacity for production, brought about by expansion of sugarcane acreage in Cuba and the islands and of sugar-beet acreage in the United

States, would outrun the increase in demand, it is impossible to say. At any rate, after 1919 competition between these three producing areas appears to be more keen than before.

The competition due to the increase in the supplies of sugar coming from the duty-free island areas resulted in the Cuban producers' sacrificing the 20-percent tariff differential after 1913, and the effective rate of duty in this country after that date became the Cuban rate of duty. That the price of sugar to the American consumer has been above the world price by virtually the effective Cuban tariff rate from 1922 to 1930 is demonstrated by figure 10. The average quarterly prices of Cuban sugar, duty

Figure 10.- PRICE DIFFERENTIALS OF RAW CUBAN SUGAR AT NEW YORK AND LONDON, QUARTERLY 1922-31



Based on table A-9

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M-10

paid New York and c. i. f. price London (includes cost, insurance, and freight but not duty) are shown there for the period 1922-31. The average difference in the two sets of prices from 1922 to 1929 was 1.695 cents per pound.¹⁴ When the average excess transportation costs from Cuba to London over the costs from Cuba to New

¹⁴Ellis, *op. cit.*, p. 125.

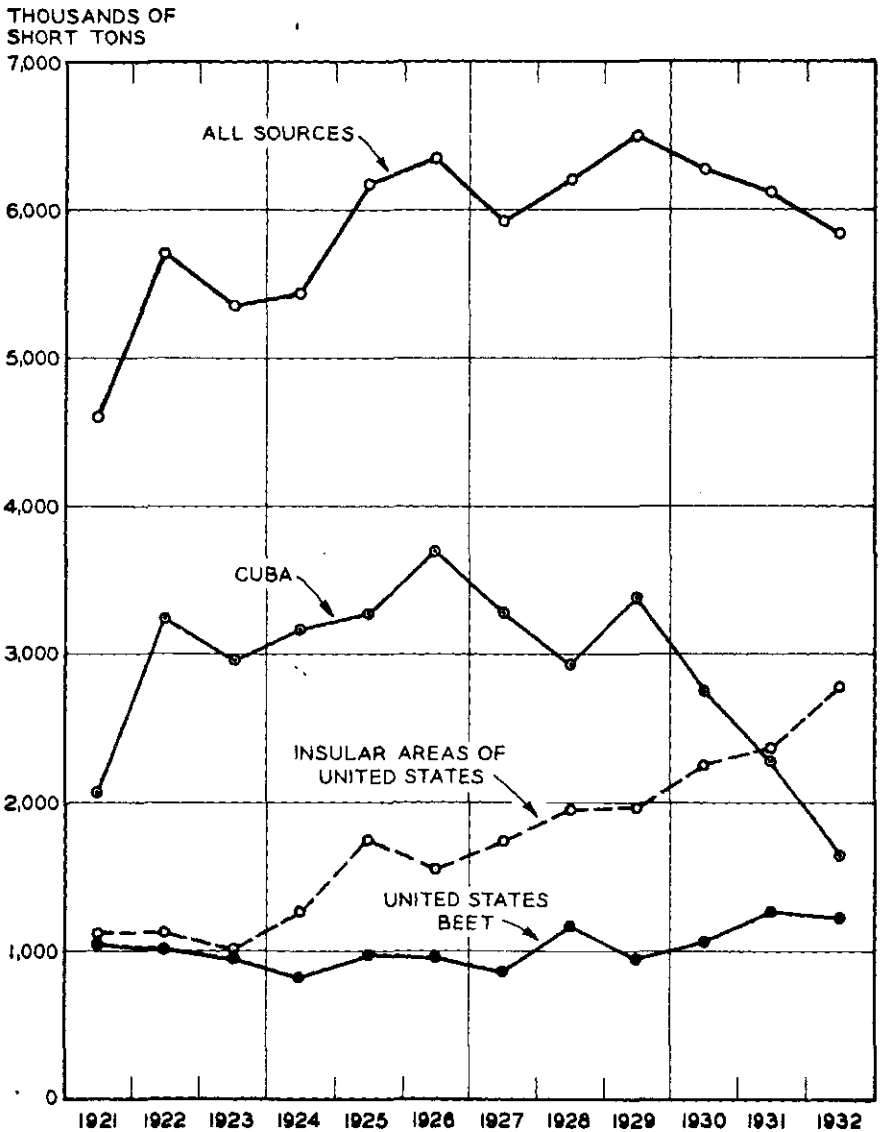
York are considered, the average difference between the two series of prices is practically equal to the Cuban duty of 1.7648 cents per pound levied by this country. The average freight differential between Cuba and the two cities was between 4 and 7 cents per 100 pounds, which, added to the average differential of 1.695 cents, gives between 1.739 and 1.765 cents per pound respectively.¹⁵

A comparison of the changes in rates of duty, noted in table 11, which occurred in 1921, 1922, and 1930 with the changing proportions of production supplied by the different areas, as shown in figures 9 and 11, brings out the fact that from 1922 to 1926 Cuba was gaining a larger share of the increasing market at the expense, for the most part, of the beet-sugar industry and that increase in tariff rates in 1921 and 1922 were not sufficient to check this. After 1930, Cuba's advantage of lower costs was sufficiently offset by the increased tariff so that, coupled with other factors, among which were legislative and other measures reducing the amount of her production and of her exports to the United States, the supply that she could offer on the market was materially reduced. What Cuba lost in advantage between 1926 and 1930 seems to have been transferred in large part to the cane sugar produced in the islands. Only after 1929 was the beet-sugar industry able to compete successfully and regain the portion of the market which it had lost.

The different characteristics of the cane-sugar and beet-sugar industries explain in part the reasons for the advantages of cane sugar over beet sugar during these years. Once sugarcane is planted, it bears for several years, so that if enough can be obtained from the crop to pay for the labor of harvesting it and of transporting it, it will be put on the market. Also, the cost of labor is kept to a bare minimum because of the fact that cane-sugar areas are usually one-crop areas, and this crop offers the only opportunity for employment. This, coupled with the tropical nature of the countries where cane is grown, makes the price of labor low. Sugar beets, on the other hand, are a crop which must be planted every year and planted on land which is well adapted for other uses. The decisions of the farmers in regard to planting beets will be affected by the opportunities offered by other crops compared with the beet crop. Moreover, the large amount of hand labor required in the growing of beets makes the labor cost of beets high. This only accentuates the competitive disadvantage

¹⁵ *Ibid.*

Figure 11.- SOURCES OF REFINED SUGAR CONSUMED IN CONTINENTAL UNITED STATES, 1921-32



of beet sugar due to the differences between the rates of wages in island cane-producing areas and those in sugar-beet areas. The cost of beets is such a large part of the cost of beet sugar that the price of beets may be the limiting factor determining to a great extent the ability of the marginal part of the industry to enter the market in a given year.

It should be pointed out here that revolutionary changes in the production and processing of sugarcane during this period were reducing costs, especially in the Philippines, and were thus enabling this area to increase its production at the expense of other parts of the American sugar system.¹⁶

The increase of beet-sugar production from 1929 to 1933 seems to be due to two factors, the relatively greater decline in prices of other agricultural products, which made it advantageous for farmers to raise sugar beets, and the fact that the tariff of 1930 was instrumental in decreasing the imports of Cuban cane sugar. It is also possible that because of technological improvements the manufacturing costs had decreased so that by 1929-33 beet sugar had a competitive advantage, possibly not previously enjoyed, with respect to average costs of Louisianian, Hawaiian, Puerto Rican, and Cuban cane sugar when the duty on Cuban cane is taken into consideration.¹⁷

In summary, it may be stated that the spread which was maintained between the world price and the domestic price of sugar, coupled with the preference given to the Cuban cane sugar, brought about the growth of the sugar industry in the protected areas and in Cuba to the point at which practically all other foreign competitors were excluded from the American market. The proportions of the market which were apportioned to different parts of the American sugar system were determined by the adjustments of the margin of cultivation and utilization of resources in the various areas to the higher American price. By 1914 as a result of competitive forces within this system the beet-sugar industry was supplying 18 percent of the market, but since then there have been marked fluctuations in the proportion of the market supplied by beet sugar. The peculiar and changing nature of the competitive conditions existing after the war accounts for the fluctuations which took place in the utilization of the resources in the American sugar system at that time. With an overexpansion of the world's sugar resources, as well as of those supplying the American market, competition for the American market became severe. Associated with this is the peculiar phenomenon present in the international sugar system of a renewed nationalism on a world-wide scale in which sugar production is often stimulated

¹⁶ John E. Dalton, *Sugar, A Case Study of Government Control* (New York: The Macmillan Co., 1937), pp. 291-2.

¹⁷ See table 10.

in regions least favorable for its production and thus curtailed in regions with the greatest natural producing advantages, resulting in excessive tariffs, bounties, and import quotas.

Fluctuations in the World Price of Sugar

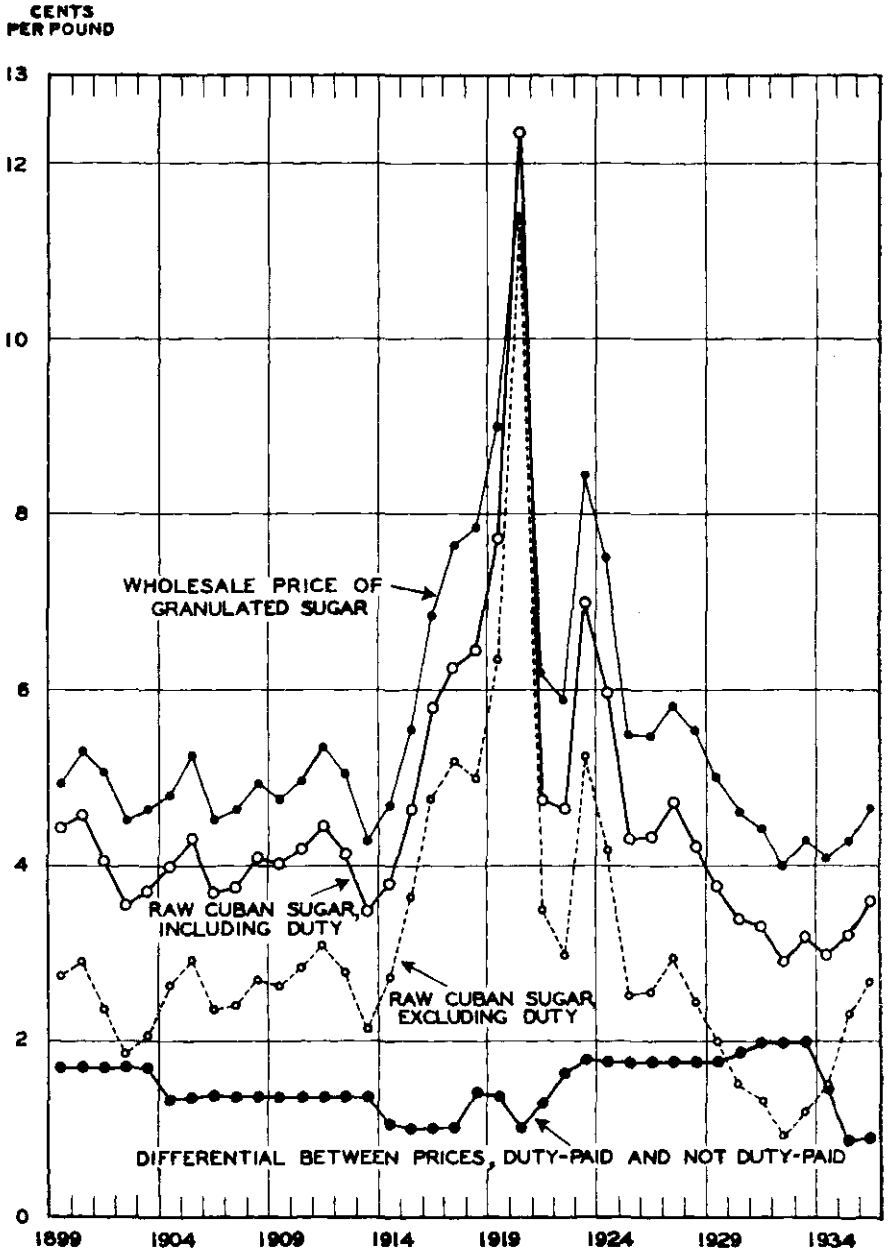
Although the presence of the tariff resulted in a reapportionment of the resources of the nation and thus in a greater employment of labor and capital in the sugar industry than would otherwise have occurred, it nevertheless left the domestic price of sugar sensitive to variations in the world price. Figure 10 illustrates the close relationship that existed between the New York duty-paid price of raw Cuban sugar and the London c. i. f. price of raw Cuban sugar. Beet sugar, however, is usually produced in refined granulated form and, of course, sells at refined-sugar prices. Figure 12 reveals the close relationship that exists between raw-sugar prices, duty-paid, and the prices of c. and f. raw sugar and wholesale refined sugar, all at New York for the period 1899 to 1936. As was stated above, the difference between the raw-sugar prices over the period has been substantially equal to the effective rate of duty upon the importation of foreign sugars.

The function and result of the tariff was to maintain a spread between the world price and the domestic price of sugar, but it did not, in any sense, result in the stabilization of either the world or domestic price. If the world price went down, the domestic price, prior to the establishment of the quota system in 1934, followed the course of the world price. The result of such a price behavior was a tendency to curtail production both at home and abroad, whereas an increase in the world price raised the domestic price and tended to increase production both at home and in Cuba. But while the behavior in general tended to follow this pattern, that of any one area might be the opposite. This is most marked in the period from 1929 to 1933 when the fall in the price of sugar was accompanied by a drastic reduction of production in Cuba and an increase in production in the United States and the islands.

The question naturally arises: What influence did a rise or fall of world price have upon the relative proportions of the domestic consumption that were supplied by the islands, the domestic beet-sugar industry, and Cuba as contrasted with the

influences upon those relative proportions of the *spread* between domestic and world prices? The answer to this question would require an examination of the supply (cost) curves for each area

Figure 12.- AVERAGE NEW YORK SUGAR PRICES, 1899-1936



Based on table A-10

and an analysis of the exact amounts that could be produced in each region at given prices. Transportation rates and the opportunity costs in each region arising out of the possibilities of the alternative uses of resources would have to be examined and taken into consideration. Of course these data are not in our hands.

An alternative procedure might be a statistical examination of the actual proportions of the increasing domestic consumption that have been supplied by the various areas at different world prices. This would be difficult, however, because other influences have not remained constant so as to permit the measurement of the influence of the magnitude of world price. Tariff rates have been changed, and the rates of improvement in technology in the sugar-beet and various cane areas have not been uniform. Agricultural development in the United States, on the one hand, is highly diversified so that the opportunity costs of raising sugar beets are high, while Cuba, on the other hand, is relatively a one-crop country where costs are as much a resultant of prices as prices are of costs.¹⁸ The agriculture of the protected islands, Hawaii, the Philippines, and Puerto Rico, is also less diversified than that of the continent.

The great fluctuations which have taken place in the whole price structure since 1914 have been accompanied by changes in the relative competitive positions of the different sugar-producing areas with the result that at times the competitive advantage was with one group of producers and at times with another. The drastic fall in the price level which took place after 1929 supplemented the tariff structure in taking away the advantage which Cuba had had over the other areas since the fixed rate of duty of 2 cents offered a relatively greater protection for the industry when its nominal costs had been lowered. Receiving the benefit of the American tariff, insular producers met the challenge of low depression prices by increasing production with the resultant partial displacement of Cuban sugar in the American market during the years 1930-34. So long as the costs of domestic production were sustained by the higher price level as they were until 1928, Cuba and the islands tended to have a competitive advantage over the beet-sugar producers so that, despite the fact of a rapidly increasing consumption, the beet-sugar section of the industry could not expand.

¹⁸Report to the President on Sugar (U. S. Tariff Commission, Report No. 73, Second Series, 1934), p. 21.

In addition to the changes in price of sugar due to the changes in the general price level, year-to-year fluctuations in the world price of sugar due to changes in world conditions of supply and demand tended to bring about year-to-year shifts in competitive advantage which might be the limiting factors in determining the supply offered on the market by a given region in any one year. The disastrous effects of these rather frequent shifts of production from one area to another, which are revealed in figure 11, brought about the report of the United States Tariff Commission¹⁹ which resulted in the quota system.

The Quota System

Since the enactment of the recent quota system, the price of sugar in the United States has been effectively divorced from and raised above the world price. The Smoot-Hawley Tariff Act of 1930, raising the duty on Cuban sugar to 2 cents per pound, did not succeed in alleviating the reduced incomes of domestic producers and refiners because of the unusually drastic fall in world sugar prices. In 1933 the United States Tariff Commission, after a thorough examination of the tariff system, recommended to the President a complete change in our governmental policy toward sugar. The views of the Commission were summarized in a letter to the President from Robert L. O'Brien, Chairman, dated April 11, 1933.

In view of the possibility of early action by our Government in regard to tariff bargaining, I venture to send you certain conclusions that have been reached by the Tariff Commission from our study of the sugar industry. . . .

It is evident from our study that the duty on sugar cannot justly be based on a difference between domestic and foreign costs of production. The situation in Cuba, which is the chief competing foreign country, is such that the higher the American tariff may be the lower are the costs of producing sugar in Cuba.

Cuba must fix the price at which she sells sugar at a point which will enable her product to enter the American market. The result is that the price has gone down to a point which is disastrous both for American and for Cuban producers. It is evident that no increase of the American tariff can relieve the resulting situation in this country or in Cuba.

For the reinstatement of the comparative prosperity in the domestic industry, and also to such an extent

¹⁹ *Ibid.*

in Cuba as may enable her again to become a customer on a considerable scale for American exports, it is necessary that the price of sugar should be somewhat higher than has prevailed recently.

To raise the price it will be necessary to limit the supplies of sugar offered for sale in the United States. This cannot be done by an increase of the tariff, but must be done by limiting imports to this country. Such limitations should be imposed not only upon Cuba but likewise upon the Philippine Islands, and it might be extended, under the powers conferred upon the administration through the Farm Relief Act, to the production of sugar in Hawaii, in Puerto Rico, and, if necessary, in the continental United States.

Should some such quota system meet with the approval of the administration, the duty on Cuban sugar might be reduced on a limited importation by such amount as the Government might find expedient, with a view partly to revenue and partly to the restoration of the purchasing power of Cuba.²⁰

Thus the Commission pointed out that the theory of equalizing costs between domestic and foreign producers by means of the tariff was not workable for sugar since Cuba, as a one-crop country, must sell that crop at any price. Secondly, the Commission suggested that since the price of sugar could not satisfactorily be raised by the tariff, imports of sugar into the United States from the various islands and possibly domestic production should be limited by direct action. Finally, it was suggested that the Administration's sugar policy be devoted to a satisfactory solution of the problems prevailing in the United States sugar system as a whole through a more direct government control than had hitherto been exercised.

The President incorporated the Commission's suggestion of limited marketing in his sugar message to Congress in February 1934, following which the sugar act, known as the Jones-Costigan Act, was passed as an amendment to the Agricultural Adjustment Act of 1933 and approved May 9, 1934. By the terms of this sugar act, sugar beets and sugarcane were made basic agricultural commodities, and the estimated United States consumption of sugar was to be allotted among the domestic producers of beet sugar and cane sugar, the insular producers, and Cuba. Congress, in the act, set the quota of domestic beet sugar at 1,550,000 short tons, and of continental cane sugar at 260,000 short tons. The remainder of the United States consumption was to be allotted to the

²⁰*ibid.*, p. 25.

island producers and Cuba by the Secretary of Agriculture, the basis of the allotment in each instance to be determined by the actual production in any 3 representative years between 1925 and 1933, as the Secretary in his judgment should choose. The Secretary was empowered to enforce the quotas for the various areas by the issuance of Federal licenses to processors, refiners, importers, and wholesalers. To further strengthen the enforcement of the marketing quotas, the Secretary was to enter into contracts with beet-sugar and cane-sugar producers for the restriction of acreage in consideration of benefit payments by the Government. In January 1936 the Supreme Court decision, testing the validity of the Agricultural Adjustment Act, held the restriction of production through benefit-payment contracts unconstitutional. However, the Supreme Court did not pass upon the constitutionality of the marketing quotas of the various areas. On June 19, 1936, the President approved the Jones-O'Mahoney Sugar Resolution which provided that the quotas which had been decided upon by the Secretary of Agriculture for the various insular areas and Cuba, coupled with the congressional quotas for the various areas, should be extended through the year 1937. By this resolution Congress attempted to guard the constitutionality of the sugar quotas until new legislation could be enacted.

The regulation of the marketing of sugar through quotas has completely divorced the price of sugar in the United States from the world price. The quotas for 1934 were not established until after the acreage for the crop year 1933-34 had been harvested. Hence, the production in many areas was in excess of the 1934 quotas as established by Congress and the Secretary of Agriculture. These surpluses were withheld from the market, and the quota for the various areas in 1935 was reduced in proportion to the 1934 excess; thus the excessive supplies of the 1933-34 campaign which would have normally come onto the market in 1934 were prevented from entering the channels of distribution and were stored for consumption in 1935.²¹ The revised quotas for the various areas for the years 1934 to 1936 are shown in table 12. As long as the surpluses of 1934 were hanging over the market, the prices remained depressed.

In fact, the price of sugar in February 1935, after the close of the first quota year, was 2.80 cents per

²¹Dalton, *op. cit.*, p. 127.

pound, only slightly higher than the extreme low of 1932. When it became apparent to the trade in the summer of 1935 that effective readjustment of production had taken place in the Philippine Islands and Puerto Rico, and that the then existing drought would reduce the beet crop, the price of sugar rose until it reached the high level for the year of over 3.80 cents per pound.²²

In the year 1936 the average price of raw Cuban sugar was 3.595 cents per pound duty-paid in New York. At the same period the world price of raw sugar was approximately 1 cent. The Cuban rate of duty was \$0.009. Thus the American price during 1936 was 1½ cents above the world price plus the Cuban rate of duty.

Table 12.- SUGAR-MARKETING QUOTAS, 1934-36^a

(Thousands of short tons, raw value)

| Area | 1934 | 1935 | 1936 |
|--------------------|-------|-------|--------------------|
| Total | 6,476 | 6,359 | 6,813 |
| United States beet | 1,556 | 1,550 | 1,342 ^b |
| United States cane | 281 | 260 | 392 |
| Cuba | 1,866 | 1,823 | 2,103 |
| Philippines | 1,005 | 962 | 1,001 |
| Hawaii | 948 | 928 | 1,033 |
| Puerto Rico | 807 | 788 | 909 |
| Virgin Islands | 5 | 5 | 4 |
| Other, foreign | 26 | 25 | 29 |

^a Adapted from Farr & Co., *Manual of Sugar Companies, 1937* (15th ed.; New York: Farr & Co., 1937), p. 111. Quotas are final revised ones. Revisions have been made at intervals throughout each year to take care of consumption requirements greater than estimated at the beginning of the year and to transfer to other areas the portions of the original allotments which certain areas have relinquished because of inability to fill them.

^b Although the Government circulars retained the quota for U. S. beet sugar as 1,550,000 tons, fixed by law, the figure shown represents the net amount after deducting the deficiency of 207,821 tons, which was reallocated.

The quota system has had a stabilizing effect upon production by removing the effects of the interplay of the competitive forces which determine from year to year the relative competitive advantages in the American market of the different groups of producers. During the period of steadily increasing production before the war, with its comparative stability in the price of sugar and its lack of sudden changes, changes in the quantities

²² *Ibid.*, pp. 141-2.

of sugar produced took place slowly in all the areas, and all increased production together. The overexpansion of productive capacities during and after the war shattered this comparative stability of development and brought about a condition in which an expansion in one area due to a temporary shifting in competitive advantage was accompanied by a reduction in production in some of the other areas. Under the quota system the price of sugar in the United States is divorced from the world price and hence from the fluctuations in supply which are caused by changes in that price. To the extent that the quotas are adjusted to a steadily increasing demand for sugar the supply and price should be less subject to year-to-year fluctuations, and this should be reflected in more stable employment conditions in the beet-sugar industry.

Agricultural Conditions

An important limiting factor in determining the amount of beet sugar that will be produced in this country at any given price is the quantities of beets that factory managements can induce the individual grower-farmers to raise each year. Figure 1, chapter I, presents a comparison of the yearly series of acreage harvested, beets sliced, and sugar produced. The relationship between production and acreage is evident at once. The differences in the percentage fluctuations of acreage harvested and beets sliced are explained by changes in yields of sugar beets per acre due to weather, disease, and pest conditions, and by differences between the tonnage of beets harvested and the tonnage of beets sliced due to evaporation, shrinkage, or wastage. Differences between slicing and production are largely due to yearly changes in sugar content and improved factory extraction of sugar.

Since the mechanical equipment of the beet-sugar factory is highly specialized for the processing of sugar beets, the factory cannot be operated for any purpose other than the production of beet sugar. Factory management is therefore anxious to secure a large production over which to distribute overhead costs. On the other hand, much of the equipment which the farmer uses for raising sugar beets can be used to grow other crops, and capital investment in specialized equipment in this part of the industry is relatively small. However, two of the most important considerations in determining the supply of sugar beets are the limited

amount of land available for profitable sugar-beet culture in this country and the competition of other crops for that land.

Sugar beets are raised in a strip of land across the country, 200 miles wide, within which the mean temperature for the growing season is about 70° F., but some of this land is the most fertile land in the country and is devoted to many other crops. Indeed, the competition of other crops has been one of the chief influences bearing upon the establishment of the industry in the range States of the West where the competition of other crops has not been so keen. The industry has also been built up in the central dairy States, chiefly in Michigan, but that area does not have the natural growing advantages of controlled moisture and ideal temperature that the western States have, and the competition of other crops has been so severe that a substantial reduction in the acreage harvested has come about since the war.²³ Sugar beets have a further serious disadvantage in competition with other crops because of the large amount of labor required in their culture.

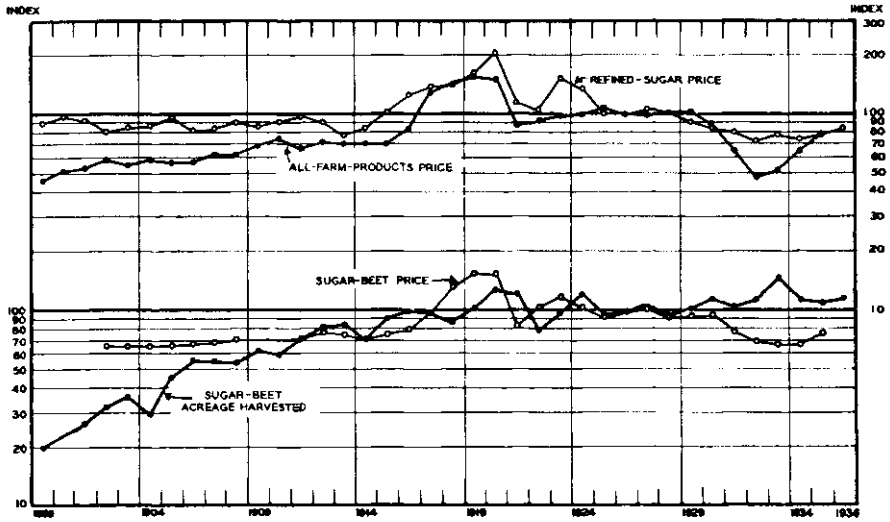
In view of what has been stated above it is apparent that the production of sugar beets (and hence beet sugar) is dependent upon fluctuations of sugar-beet prices as compared with the costs involved in and the fluctuations of returns from the production of alternative farm products. The price of beets is the price received by the farmers for the beets delivered to the factory and is calculated on the basis of sliding scales in the contract between farmer and factory as explained in chapter I. It was there shown how the sliding scales in the contracts are dependent upon the wholesale price of refined sugar. The relationship between refined-sugar prices and sugar-beet prices is shown in figure 13. An index of prices of all farm products and an index of acreage of sugar beets harvested in this country since 1899 are also shown on the chart.

Inasmuch as the protection provided the industry did not change between 1899 and 1914, and inasmuch as the world price of sugar exhibited no trend during this period, the fourfold increase in acreage between the years 1899 and 1914 must be explained by the "artificial" maintenance of a favorable price. To the price factor was added a more rapid progress made in production technique in this area than in competing cane-sugar areas. That the

²³Ellis, *op. cit.*, p. 82.

Figure 13.- INDEXES OF WHOLESALE PRICES OF ALL FARM PRODUCTS, REFINED SUGAR, AND SUGAR BEETS, AND OF SUGAR-BEET ACREAGE HARVESTED, 1899-1936

(Ratio scale; 1926=100)



Based on table A-11

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growth of the industry was gradual and steady during this period must be attributed to one or both of the following factors, the slowness of labor and capital in shifting into a new area of economic activity and the time needed for the experimentation required both in the culture of beets and in the development of the manufacturing organization and technology.

Alternative Crops.- A more important analysis from the standpoint of the present employment opportunities in the beet-sugar industry revolves around the question of why the rate of expansion of the industry declined after 1919. In view of the behavior of the acreage series from 1919-32, as shown in figure 13, theoretical considerations justify the assumption that the expansion of the beet-sugar industry in the United States had been pushed to the maximum point justified by the spread between domestic and world prices and by the existing state of technology and the relative prices and production costs of alternative crops. In other words, the returns to the marginal producers have been since 1919 only sufficient to justify their operations without further expansion. As has been emphasized above, this present scale of operations would necessarily be reduced if governmental

protection were removed or if there were a decided rise in the prices of other farm products relative to the price of sugar beets.

It was pointed out in chapter I that many of the sugar-beet growers were so dependent economically upon the sugar companies that they were not free to abandon the growing of beets, even if other crops appeared to be more profitable. It might seem from this that prices of agricultural products would have little effect upon the supply of sugar beets. That there exists a margin of really independent farmers who will take advantage of changes in relative prices to increase or diminish their acreage of sugar beets, according to what seems to them the more profitable enterprise, seems evident from the effect of prices upon the supply of beets. It is the action of these farmers which determines the total supply available to the sugar companies. In this connection, it should be noticed that sugar-beet acreage leveled off when the prices of farm commodities rose faster than the prices of sugar beets at the beginning of the war, but when sugar-beet prices caught up toward the end of the war, acreage again increased. When sugar-beet prices rose more rapidly than those of other farm products in 1922 and 1923, sugar-beet acreage again increased. The reverse situation is noticed in 1925. All agricultural prices fell during the great depression, but, whereas the prices of other agricultural commodities fell to drastically low levels, the tariff on sugar provided irreducible minimum prices for sugar and sugar beets with the result that the fall in the price of sugar beets was much less drastic than the fall of other agricultural prices and that sugar-beet acreage in 1933 rose to the highest point in the history of the industry. It exceeded by over 200 thousand the 764 thousand acres harvested in 1932.

Natural and Other Conditions Affecting Supply of Beets.— The movements of the various series in figure 13 indicate that price considerations are not the only factors determining the acreage of sugar beets harvested in this country. This is indeed true. The movements in the acreage harvested in the various regions in which the industry is localized show widely varying fluctuations over the period and do not necessarily follow the fluctuations in total acreage in all of the years. This is explainable upon two grounds: The economic development of various regions has not permitted uniform and proportional expansion of the

beet-sugar industry in the various areas, and local agricultural conditions such as moisture, disease, and pest conditions strongly influence the acreage harvested in the local areas. It was shown in chapter I that the relatively unfavorable agricultural conditions in the Michigan area as compared with the agricultural conditions in the West, coupled with the severe competition of other crops, has resulted in a decrease in acreage in that area since the war. The drought in 1934 and 1935 was responsible for a considerable reduction in acreage during those years. In California, sugar-beet production declined after 1921 because of severe sugar-beet diseases, competition of other crops, and the development of oil fields and suburban-residence properties in sugar-beet areas.²⁴ With the extension of sugar-beet culture into new and fertile California lands in 1929, however, production has since increased in that region.²⁵ Lastly, personal relationships also have had an important bearing upon the number of acres harvested. It is essential that the companies maintain satisfactory business relations with the farmers with whom they deal, or the acreages which farmers will be willing to plant will not be at a maximum. It is difficult during the period of the campaign to prevent disagreements that arise over the weight of beets, the physical condition of beets, the sugar content, the time of delivery, etc. A word should also be said concerning the influence upon acreage harvested of hauling by truck. In former years, when beets were hauled by horse and wagon, average hauls of longer than 5 miles were not feasible, but the introduction of trucks for hauling in all areas has now made possible hauls of 30 miles.²⁶ The increase in acreage in California, noted above, is partly attributable to the introduction of trucks for hauling.

SUMMARY

Since the plan of this study has been to isolate the factors affecting the volume of employment in the beet-sugar industry,

²⁴Loring K. Macy and Others, *Changes in Technology and Labor Requirements in Crop Production: Sugar Beets* (Works Progress Administration, National Research Project, Report No. A-1, Aug. 1937), p. 8.

²⁵The destruction wrought by diseases and plant pests has been the cause and stimulus for unremitting emphasis upon the search for effective methods in combating these nuisances. And, in view of the serious problems to be solved in this respect, it is reasonable to assume that there will be a continuation of the improvements which have been made in the development of disease- and insect-resistant varieties of sugar beets. Increased sugar content and greater quantities of beets may, of course, be the accompaniments of these new strains.

²⁶Macy and Others, *op. cit.*, p. 8.

it has been emphasized that volume of employment is dependent upon volume of production and labor requirements per unit of output. An analysis of the demand for employment in the beet-sugar industry, therefore, required first an analysis of the factors affecting the trend and fluctuations in production in the industry.

A comparison of an index of beet-sugar production with the Federal Reserve adjusted index of manufactures revealed that beet-sugar production does not follow the general cyclical swings of manufacturing production. The failure of activity in the beet-sugar industry to respond to general cyclical swings is explained by the agricultural nature of the industry on the one hand and by the competitive conditions existing under governmental protection on the other.

The relatively low costs of producing sugar in cane-sugar-producing islands, the high labor costs in growing sugar beets, and the opportunities existing in the United States for alternative profitable uses of land for the raising of many staple agricultural commodities necessitated governmental protection for the industry if it was public policy to develop the industry to present levels of production.

The industry has received the benefit of a tariff since 1894 and of governmental quotas since 1934 with the result that more land and capital have been devoted to the beet-sugar industry in this country than would have been devoted to it in the absence of governmental protection. The net result of the tariff has been to adjust the cost margins in the various sugar-producing areas in the United States sugar system so that 15-23 percent of the total annual quantity of sugar consumed in the United States was furnished by the domestic beet-sugar industry from 1913 to 1932. Under the influence of governmental protection the manufacturers of sugar have received higher prices for their product, which in turn have been partly passed on by the sugar processors to the sugar-beet growers.

It has been pointed out that protection increased the spread between the world price of sugar and the price to the United States consumers, while leaving the price of sugar in the United States sensitive to changes in the world price and domestic production therefore sensitive to the effects of changes in the world conditions of supply and demand. With the expansion of production facilities for both cane sugar and beet sugar which

took place during and after the war in all areas, competitive conditions existing between cane sugar produced in the insular possessions and Cuba and domestic beet sugar resulted in a leveling off of the upward trend in beet-sugar production and also subjected it to temporary fluctuations.

Finally, the quota system allotted to the beet-sugar industry a quota of 1,556 thousands of short tons (raw value) in 1934, which is larger than the domestic production in any year except 1933-34, and which was equal to 24 percent of the total of all quotas. It has also established a certain degree of stabilization in production of beet sugar by removing some of the factors making for instability.

An important limiting factor in the production of beet sugar has been the supply of sugar beets that the processors have been able to induce beet growers to raise. While, in the long run, the total supply of sugar beets produced is dependent upon the relative price of sugar beets and other farm products, year-to-year fluctuations are also the result of natural conditions, such as drought and plant diseases.

The extent of the production of beet sugar, although an important factor in explaining the fluctuations of employment in the beet-sugar industry, must be supplemented by an examination of changing labor requirements per unit of output since fluctuations of employment are also due to the efficiency of labor utilization in the industry. The analysis of the latter factor is made in chapter IV.

CHAPTER IV

CHANGING UNIT LABOR REQUIREMENTS AS A FACTOR AFFECTING THE VOLUME OF EMPLOYMENT

THE PROBLEM OF ANALYSIS

An examination of the curves of employment and production has made clear that increasing production in the beet-sugar industry has been accompanied by decreasing unit labor requirements. In this chapter an attempt will be made to measure the changes which have taken place in productivity by measuring the changes in the man-hours of labor required to produce 100 pounds of sugar or the man-hours required to produce the sugar manufactured from a ton of sliced beets. The measurement of labor requirements in the factories has been made possible by a field survey of plants in three regions in the United States which produce beet sugar.

Not only is it possible to present a picture of fluctuations in labor requirements for the factories from year to year and the changes taking place over a period of years, but it is also possible to investigate some of the factors which enter into these changes. An industry may reduce its demand for labor by transferring a larger proportion of its production to the more efficient plants without any marked change in efficiency in any one plant. At the same time the inefficient plants may close their doors. Thus, without any technological changes in any plants the requirements for labor may be reduced. The type of changes described above would tend to bring about displacement of labor in certain plants, with an increase in other plants. Ordinarily, the increase would be smaller than the displacement and might be in a different locality so that while the displacement would be numerically offset to some extent, in reality there would be no absorption since the increase would take place in a different locality.

A decrease in labor requirements per unit of output may be brought about by the building of new and more efficient plants and either (a) increasing the total production or (b) producing with the result of lowering the production of other plants or (c) a combination of these two results. In the second case there would

naturally be some tendency toward displacement of labor. Or, technological improvements may take place in the existing plants and thus bring about a general reduction in labor-requirement ratios. If this is accompanied by increased production, there may be no displacement of labor, but a certain stability in the demand for labor may accompany the general technological improvement in the industry.

In order to understand further the effects of technological changes upon the demand for labor it becomes necessary to determine which of these movements accompanies the downward trends in the average labor-requirement ratio for the beet-sugar factories and also to relate the changes in man-hour ratios to the changes in technology which are known to have taken place.

As has been pointed out, there are in addition natural causes associated with conditions of weather, agricultural pests, and the like which may cause certain factories to close down for one or more campaigns because of lack of raw materials. This will have its effect upon the average labor-requirement ratios and the demand for labor in the region of those factories. An examination of the idle plants will throw light on these causes and their effects. Migration of the industry may result from a combination of natural causes and other changing conditions, among which are the relative shifts in agricultural prices and in the supply of labor for the beet fields, which have been previously mentioned. This in turn may bring about changes in the labor requirements as well as a shift in the demand for labor from one section of the country to another.

Some of these changes may be accompanied by a more stable demand for labor, while others may be factors making for greater irregularity in demand. A migration from unirrigated areas to irrigated might be expected to be reflected in less irregularity due to the factor of rain. In some regions a longer campaign might be possible than in others. The results of the NRP-NBER field survey throw some light on all of these questions. In what way and how, when, and where, do changing technology and changing labor requirements affect the demand for labor in the beet-sugar industry? What are the factors tending to bring about these changes, and through what channels do they work themselves out? These are the questions which should be answered in this chapter. The field survey of plants is the first step toward answering these questions; the measurement of the labor requirements per

unit of output for the plants, for the different regions, and for the industry over a period of time is the second step; the analysis of the fluctuations in these ratios and of the correlation of changes in order to isolate the factors making for change is the third step.

RELATIONSHIP OF THE SAMPLE TO THE INDUSTRY AS A WHOLE

An analysis has been made of the number of plants which are included in the field survey and of their production, in an effort to determine the extent to which they represent the industry. Table 13 summarizes the results of this analysis.¹ The sample included at least 47 percent of the plants reported by the census from 1918 through 1935, rising to approximately 77 percent in 2 of these years. The coverage of production was higher, fluctuating between 58 percent and 79 percent. From this it is evident that the average yearly production for the plants in the sample tended to be larger than the average for the United States. This is more marked in the earlier years than in the years after 1922, when there is less difference between the two averages. In 1928 the average of beets sliced per plant was only 2.4 percent higher in the sample than in the universe, and sugar produced was only 1.6 percent higher.²

Since age as well as size of plants may show some degree of correlation with labor requirements, an examination of the sample was made to see to what extent it was representative of the industry in this respect. There were 100 plants reported by the United States Beet Sugar Association as in existence in 1934-35, 78 of which were included in the field survey. With the exception of the 11 factories which had been built during 1910-14, of which there were only 6 in the survey, every age group has a coverage of two-thirds or more in the sample.³

Region II, which is the western irrigated area, is the largest producing district and is the district in which our coverage is most complete. In this district the sample includes not fewer than 61 percent of the plants and the percent included runs as high as 80 in 1931. Again the proportion of the total production

¹For more detailed analysis see tables B-1 to B-5.

²See table B-4.

³See table B-5.

Table 13.- SUMMARY OF ANALYSIS OF SAMPLE OF BEET-SUGAR FACTORIES^a

| Year | Number of factories | | | Production of granulated sugar | | | Percent by which average production per factory in sample exceeds universe |
|------|---------------------|----------|-------------------------------|--------------------------------|----------|-------------------------------|--|
| | Sample | Universe | Sample as percent of universe | Short tons (thousands) | | Sample as percent of universe | |
| | | | | Sample | Universe | | |
| 1918 | 40 | 85 | 47.1 | 419 | 719 | 58.2 | 23.8 |
| 1920 | 44 | 92 | 47.8 | 616 | 1,023 | 60.2 | 25.9 |
| 1922 | 42 | 84 | 50.0 | 437 | 749 | 58.3 | 16.6 |
| 1924 | 52 | 89 | 58.4 | 680 | 1,076 | 63.2 | 8.2 |
| 1926 | 56 | 79 | 70.9 | 707 | 893 | 79.1 | 11.6 |
| 1928 | 63 | 82 | 76.8 | 834 | 1,068 | 78.1 | 1.6 |
| 1931 | 46 | 67 | 68.7 | 825 | 1,156 | 71.4 | 3.9 |
| 1933 | 58 | 84 | 69.0 | 1,253 | 1,626 | 77.1 | 11.6 |
| 1935 | 59 | 77 | 76.6 | 887 | 1,178 | 75.3 | -1.7 |

^aBased on tables B-1 and B-4.

included in the sample is greater than the proportion of the plants included.⁴

In region III, the eastern one, which is second in importance as a producing area, the coverage on a plant basis fluctuates between approximately 26 percent in 1920 and 84 percent in 1928. In this region also, the percentage of the production included in the field study is the same as, or greater than, the percentage of the plants included.

In region I, which is the State of California, is produced not over 18 percent of the beet sugar made in the United States. Our coverage in this relatively unimportant region is less satisfactory than the percentages of plants and production included indicate, for the reason that there were in the entire period no more than 10 plants reported by the census and for 5 of the 9 years there were 6 plants or less. One plant operating in this district and included in the sample in 1926, for instance, represents 20 percent of the operating plants and 18 percent of the production. Not until 1933, when three of the six plants in the State are included in the sample, can it be said that we have a meaningful sample of the operations in this district.

In figure 14 and table B-6 a comparison is made of the fluctuations in production in the universe with fluctuations in the sample as represented by a chained index of production based on comparison between identical plants for paired years. It will be noticed that the sample reflects not only the general upward trend of the total production in the United States from 1918 to 1935 but also, to a marked degree, the year-to-year fluctuations from this trend. The three exceptions are the years 1926, 1932, and 1935 in which the sample and the universe move in opposite directions. These differences are probably due to changes in production which resulted from changes in the number of plants operating. Between 1924 and 1926 there was a decrease in the number of plants in the western region as reported by the census,⁵ and in 1932 there was an increase in the number of plants operating in the eastern region.⁶ Because of the manner of its construction the chained index of production fails to reflect changes in production due to plants coming in or going out. This is unfortunate since an error once introduced imparts a bias to the

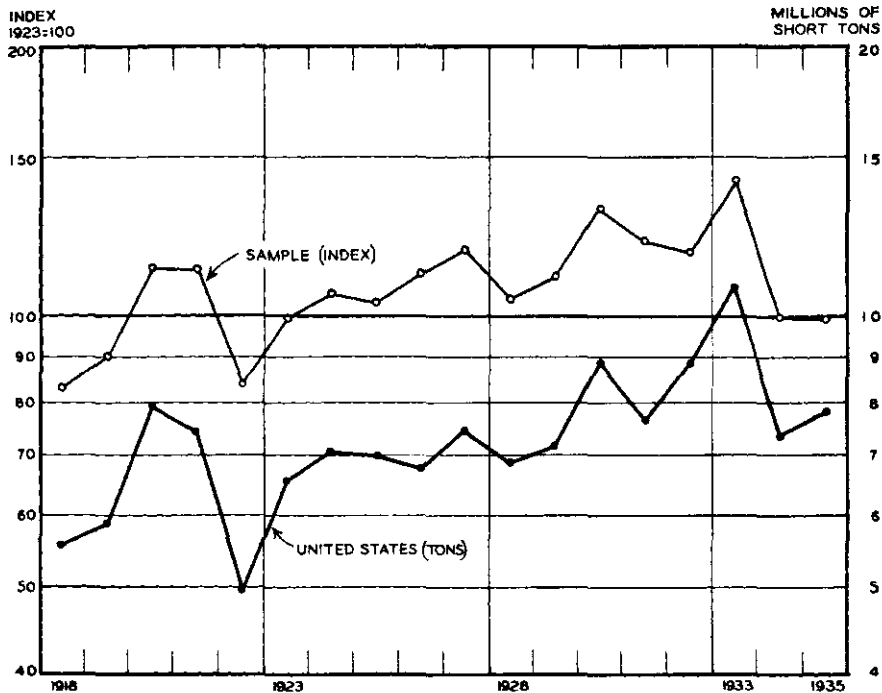
⁴See table B-1.

⁵See table B-1.

⁶See table B-17.

Figure 14.- TOTAL BEETS SLICED, AND INDEX OF BEETS SLICED BY SAMPLE FACTORIES, 1918-35

(Ratio scale)



Based on table B-6

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index. Thus, compared with previous years, the index numbers for 1932-35 are too low.

The figures for production on which this index is based, combined with comparable man-hour figures, furnish the data for measuring the fluctuations in the average labor-requirement ratio for the industry over the period of years from 1916 to 1935. As far as the resulting chained index of man-hour ratios is concerned, it is unaffected by the bias in the production index since a corresponding bias would be present in the man-hours index, but it may be affected by plants coming in and going out of the sample to the extent that these plants differ in efficiency from the average. The relatively large size of the sample and its representative character with respect to size and age of plants and with respect to fluctuations in production make it highly probable that the sample reflects, with a fair degree of accuracy, the behavior of the industry in the United States.

Care must be taken, however, to make allowance for bias which may enter because of shifts in regional distribution not characteristic of the universe, differences in the average size of plants, and other differences which seem to be apparent in the years since 1932.

STATISTICAL PROBLEMS OF MEASUREMENT

The Man-hour Ratio

Changes in the efficiency of labor utilization in a plant are evidenced by changes in the relation of the volume of output to the quantity of labor employed in its production. This relation may be expressed either in terms of the output per man-hour or, inversely, in terms of the man-hours per unit of output, whichever is most appropriate for a particular purpose. For the purposes of this study the latter method has been selected, and all comparisons between the labor employed and the output are in terms of man-hour ratios indicating the number of hours of labor required per unit of output.

Labor Requirements per 100-Pound Bag of Sugar and per Ton of Beets Sliced

In the beet-sugar industry the unit of finished product is the 100-pound bag of sugar, but the scale and magnitude of operations may also be represented by the quantity of raw materials consumed, that is, by the tons of beets sliced. Indeed, for some purposes the ratio "man-hours per ton of beets sliced" is more illuminating than the ratio "man-hours per 100 pounds of sugar produced." This is true because the quantity of sugar produced is partly influenced by the sugar content of the beets processed, with the result that the labor actually expended in a plant bears a closer relationship to the quantity of beets sliced than to the tonnage of sugar produced by that plant. By using the ratio "man-hours per ton of beets sliced" in conjunction with the ratio "man-hours per 100 pounds of sugar produced" we are able to isolate those changes in productivity that are due entirely to fluctuations in the sugar content of beets.

Weighted mean man-hours per ton of beets sliced and per bag of sugar produced for 31 identical plants are shown on figure 15 and table 14, and for all reporting plants on figure 16 and table 15.

Table 14.- CAMPAIGN MAN-HOUR RATIOS AND PERCENTAGE OF SUGAR CONTENT AND YIELD, 31 IDENTICAL FACTORIES 1917-35

| Year | Number of factories operating | Man-hours per - | | Percent | |
|------|-------------------------------|----------------------------------|---------------------------------|----------------------------|--------------------------|
| | | Ton of beets sliced ^a | 100-pound bag of sugar produced | Sugar content ^b | Sugar yield ^c |
| | (1) | (2) | (3) | (4) | (5) |
| 1917 | 30 | 2.78 | 1.02 | 16.3 | 13.6 |
| 1918 | 30 | 3.11 | 1.09 | 16.2 | 14.2 |
| 1919 | 29 | 2.76 | 1.13 | 14.5 | 12.2 |
| 1920 | 31 | 2.61 | 0.93 | 16.0 | 14.1 |
| 1921 | 30 | 2.10 | 0.73 | 15.8 | 14.3 |
| 1922 | 29 | 2.08 | 0.76 | 15.4 | 13.6 |
| 1923 | 31 | 2.05 | 0.76 | 15.3 | 13.5 |
| 1924 | 30 | 1.95 | 0.64 | 17.2 | 15.3 |
| 1925 | 30 | 2.00 | 0.74 | 14.9 | 13.4 |
| 1926 | 26 | 1.70 | 0.63 | 14.9 | 13.5 |
| 1927 | 29 | 1.65 | 0.57 | 16.1 | 14.6 |
| 1928 | 30 | 1.62 | 0.51 | 16.7 | 15.9 |
| 1929 | 30 | 1.55 | 0.55 | 15.6 | 14.2 |
| 1930 | 29 | 1.40 | 0.51 | 15.2 | 13.6 |
| 1931 | 26 | 1.35 | 0.45 | 16.2 | 15.0 |
| 1932 | 29 | 1.46 | 0.47 | 16.4 | 15.5 |
| 1933 | 30 | 1.31 | 0.43 | 16.6 | 15.3 |
| 1934 | 26 | 1.42 | 0.45 | 17.0 | 15.7 |
| 1935 | 29 | 1.35 | 0.44 | 16.5 | 15.5 |

^aTable B-10, col. (6).

^bTable A-12, col. (2). Figures are for entire industry.

^cTons of sugar produced as a percentage of tons of beets sliced.

It will be noticed that the year-to-year fluctuations in man-hours per ton of beets sliced are considerably different from the fluctuations of man-hours per bag of sugar produced. The numerators of the two labor-requirement ratios shown on figure 15 are the same series of man-hours. Hence, fluctuations between the two series are explained by differences in the denominators, bags of sugar and tons of beets. The differences between the relative fluctuations in these two ratios are due to a changing amount of sugar within the beets, and a changing percentage of the sugar within the beets which is actually obtained as a final product.

Table 15.- CAMPAIGN MAN-HOUR RATIOS AND PERCENTAGE OF SUGAR CONTENT AND YIELD, ALL REPORTING FACTORIES 1915-35

| Year | Number of factories operating ^a | Man-hours per - | | Percent | |
|------|--|----------------------------------|---------------------------------|----------------------------|--------------------------|
| | | Ton of beets sliced ^a | 100-pound bag of sugar produced | Sugar content ^b | Sugar yield ^c |
| | (1) | (2) | (3) | (4) | (5) |
| 1916 | 20 | 2.61 | 0.90 | 16.3 | 12.1 |
| 1917 | 42 | 2.86 | 1.06 | 16.3 | 13.4 |
| 1918 | 41 | 3.07 | 1.11 | 16.2 | 13.7 |
| 1919 | 39 | 2.86 | 1.18 | 14.5 | 12.1 |
| 1920 | 44 | 2.66 | 0.96 | 16.0 | 13.9 |
| 1921 | 47 | 2.22 | 0.80 | 15.8 | 13.9 |
| 1922 | 42 | 2.18 | 0.81 | 15.4 | 13.5 |
| 1923 | 47 | 2.16 | 0.81 | 15.3 | 13.3 |
| 1924 | 52 | 2.14 | 0.70 | 17.2 | 15.3 |
| 1925 | 57 | 2.20 | 0.85 | 14.9 | 12.9 |
| 1926 | 57 | 1.97 | 0.75 | 14.9 | 13.1 |
| 1927 | 61 | 1.82 | 0.84 | 16.1 | 14.3 |
| 1928 | 64 | 1.76 | 0.58 | 16.7 | 15.3 |
| 1929 | 53 | 1.62 | 0.58 | 15.6 | 14.0 |
| 1930 | 54 | 1.46 | 0.55 | 15.2 | 13.3 |
| 1931 | 46 | 1.37 | 0.47 | 16.2 | 14.7 |
| 1932 | 50 | 1.46 | 0.49 | 16.4 | 15.0 |
| 1933 | 58 | 1.46 | 0.49 | 16.6 | 15.1 |
| 1934 | 58 | 1.59 | 0.52 | 17.0 | 15.3 |
| 1935 | 59 | 1.52 | 0.50 | 16.5 | 15.1 |

^aTable B-9. The number of operating factories and the campaign man-hours per ton of beets sliced are: For 1912, 6 and 3.96; for 1913, 7 and 3.36; for 1914, 7 and 3.21; and for 1915, 7 and 3.10. (NRP-NBER field-survey data.)

^bTable A-12, col. (2). Figures are for entire industry.

^cTons of sugar produced as a percentage of tons of beets sliced.

The average sugar content of sugar-beet crops in the United States has been placed on the charts to aid in the interpretation of the differences in fluctuations between the two labor-requirement series. A high sugar content results in a greater production of sugar relative to a given tonnage of beets and a given labor expenditure. Hence, man-hours per bag of sugar produced varies relative to man-hours per ton of beets sliced inversely to the movements of sugar content. Not all differences in the percentage fluctuations of the two labor-requirement series, however, are accounted for by an inverse percentage change

of sugar content.⁷ If bags of sugar are expressed in tons, and if these figures are expressed as ratios to tons of beets sliced, the result will be the percentage of the weight of the beets sliced obtained as the final product, sugar. This yield of sugar per ton of beets sliced has been plotted along with sugar content on the chart. The difference between the sugar content and yield represents the amount of the sugar available in the beets that was lost or rather not secured as a final product. This difference between the sugar content and the yield of sugar per ton, it must be remembered, is a percentage based upon the total weight of the beets.

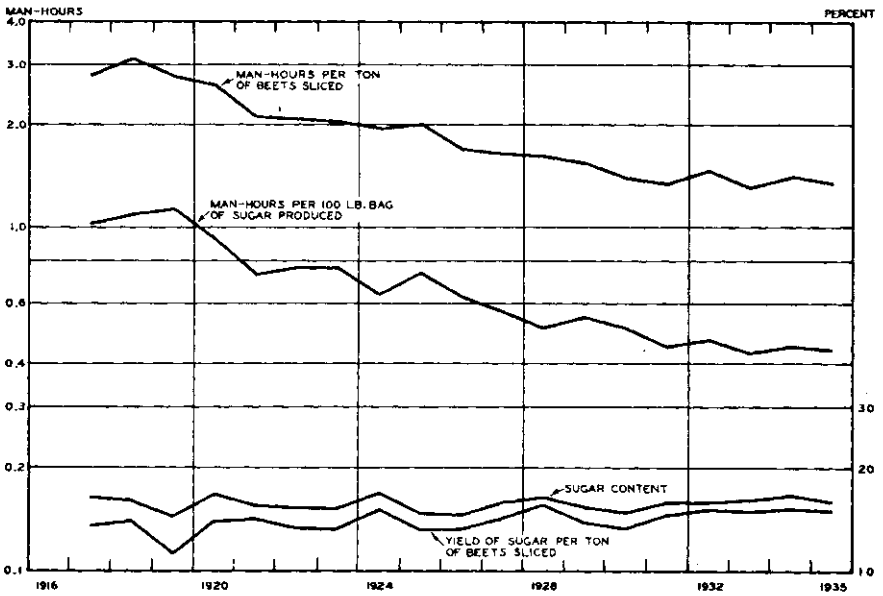
There are several reasons for the changing amounts of the sugar available that are actually extracted from year to year, among them being the physical and chemical conditions of the beets. Unusually tough and fibrous beets are harder to slice and treat than other beets. Furthermore, if the solid matter dissolved in the juices of the beets is chiefly sugar, extraction is relatively simple, but if large quantities of mineral salts and other foreign substances also are present in the beet juices, extraction presents many difficulties. Other factors of importance in the explanation of efficiency of extraction are the mechanical efficiency of the plant and the skill of the labor employed. Modern plants employing efficient labor are able to prevent wastage of sugar that in less efficient plants occurs in many places throughout the operations. One of the chief duties of the chemist in a beet-sugar factory is to control the handling of the beet-sugar juices in such a manner as to prevent, as much as possible, inversion of sucrose to noncrystallizable sugars. Most important of all in this respect is the influence of the Steffens process (described in chapter I) as a factor tending to secure an increased amount of the sugar available in the beets.⁸ Among these factors making for the extraction of a higher percentage of sugar the use of the Steffens operation alone increases the labor requirements per 100-pound bag of sugar, this of course being justified by reduction in other costs, especially the reduction in the cost of beets per 100-pound bag of sugar. When the Steffens process is used, centrifugal molasses is further treated in order to obtain an additional yield of sugar, and thus more of the

⁷The sugar-content series is taken from the *Yearbook of Agriculture* and represents the average sugar content of all beets produced in the United States. Thus we are comparing labor-requirement ratios based upon beets sliced and sugar produced from 31 NRP-NBER sample plants with sugar content for the universe, and some error may be introduced on this account.

⁸See appendix D.

Figure 15.- CAMPAIGN MAN-HOUR RATIOS AND PERCENTAGE OF SUGAR CONTENT AND YIELD, 31 IDENTICAL FACTORIES, 1917-35

(Ratio scale)



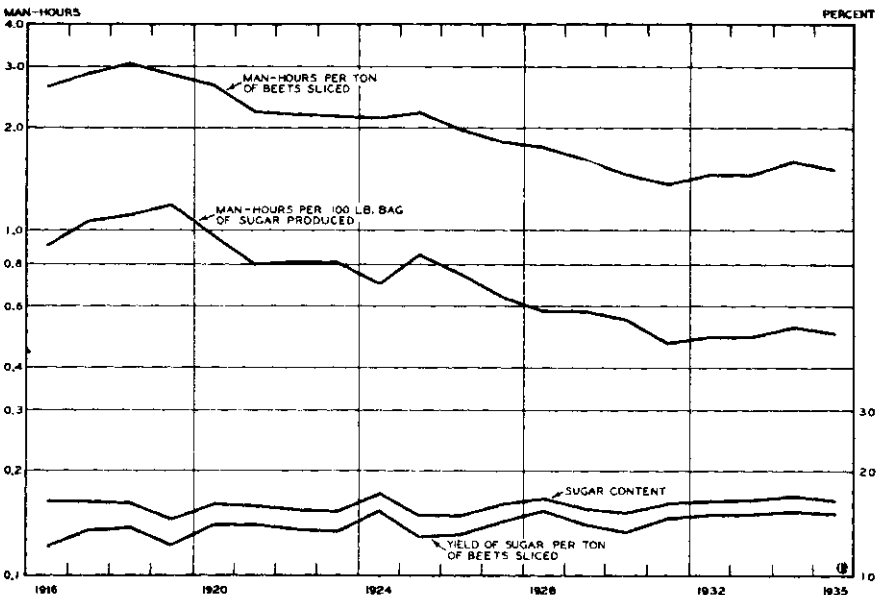
Based on table 14

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Figure 16.- CAMPAIGN MAN-HOUR RATIOS AND PERCENTAGE OF SUGAR CONTENT AND YIELD, ALL REPORTING FACTORIES, 1916-35

(Ratio scale)



Based on table 15

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available sugar in the sugar-beet crop of the country will be secured in proportion to the extent of total Steffens operations. It should be remembered that even though a given plant does not have a Steffens operation, the molasses of that plant may be worked in the Steffens house of another factory.

The yield of sugar per ton of beets sliced, as shown on figures 15 and 16, approaches the available sugar content more closely in later years than in the earlier years. This is because of a number of factors among which are increasing use of the Steffens operations in the industry and improvements and refinements of the processes coming about in part through their more scientific regulation by means of electrical control mechanisms, which reduce the amount of waste, and possibly through a better condition of the beets. Although the trend has been upward in respect to the percentage of the sugar content which is recovered from the beets, there are year-to-year fluctuations in this yield which may be due to the effect of weather upon the condition of the beets when they are harvested, rendering the sugar more difficult to obtain, or which may be due to the shifting of the proportions of the production from one region to another.

Over the period from 1916 to 1935, man-hour ratios show a somewhat greater decrease in terms of sugar produced than in terms of beets sliced. Man-hours per ton of sugar produced is the actual labor requirement per unit of output in the industry, but both the declining trend and the yearly fluctuations in this ratio are partially due to a changing amount of sugar in the raw materials. In the ratio of man-hours to beets sliced changes due to quality of raw materials are eliminated, and this ratio has been chosen, therefore, as the basis of an examination of changing efficiency of labor utilization resulting from changes in plant facilities and their utilization.

Problems of Comparability and of Byproducts

The analysis of changing labor requirements in this industry is not complicated by significant changes in the quality of the product. The earliest data obtained in the individual plant surveys are for the year 1912, and over the entire period from 1912 to 1935 the output of the beet-sugar industry has been refined sugar, that is, sugar almost 100-percent pure. The refined sugar produced today is substantially the same as the refined sugar produced in 1912.

Nor is the measurement of output seriously complicated by the byproducts. Beet pulp and molasses are the two major byproducts of the beet-sugar plants, but their value is relatively insignificant compared with the value of sugar. Hence, unit labor requirements are computed in terms of beets sliced or sugar produced. Labor devoted to the preparation of pulp for sale is eliminated in computing the man-hour ratios.⁹ The labor required in the handling of molasses, however, is not so easily eliminated, mainly because the labor of handling molasses is largely the same labor that is expended in the production of the main product, sugar, and because some plants subject molasses to additional treatment in Steffens houses while others do not. These difficulties, coupled with the smallness of the degree of error introduced by noncomparability, made it seem unwise to attempt any correction for these differences.¹⁰

The Standard Man-hour Ratio

In order to make an analysis of the differences in the efficiency of plants which are attributable to differences in the characteristics of the plants selected for comparison, or, in other words, to correlate differences in man-hour ratios per ton of beets sliced with other characteristics, such as age or size, it was necessary to compute for each plant a man-hour ratio which would be free from the erratic factors present in certain plants in any year which might be selected for purposes of comparison. Hence, an unweighted mean of the ratios for 3 years was chosen, thus eliminating in part, at least, the influence of short-time fluctuations in the ratio of any one plant. These ratios are called the standard man-hour ratios and are given the date of the middle year.¹¹

Capacity or Size of Plant

In order to determine whether size is a factor in the unit labor requirements of a plant, it has been necessary to decide upon some measurement of size. It has been pointed out that the supply of beets available seems to be the determining factor

⁹See appendix E for explanation of the method.

¹⁰See appendix D for further explanation.

¹¹For a few plants, standard man-hour ratios are based upon an average of the ratios for 2 of the years, or on the ratio of 1 of the years when ratios for these 3 years are not available.

in the yearly production of a given plant, and the length of the campaign in any given year is adjusted to this supply of beets. It is conceivable that two plants of widely different size might process the same amount of beets in a given year since the number of days in the campaign may vary from 20 days to 100 days or more. For this reason annual production was not used as a measure of size. Rather, the average daily slicing measured in tons of beets washed was taken as the measure of size or capacity of the plants for the year in question. This measure makes possible not only a comparison of the behavior of plants of different size but also a comparison of the changing size of plants from year to year and the trend in size. This measure of size is based on the practice of the plants in the industry to utilize the available capacity to its fullest extent as long as the supply of beets lasts. Hence, the behavior of a plant is the best possible measure of size. It is obvious that capacity is dependent upon the physical size of the plant structure, the amount and type of equipment, and the efficiency of management and organization. It must be remembered that a given number of large plants will not necessarily process more beets than the same number of small plants. In other words, if the plants are divided into two groups, the large and the small, it will not necessarily follow that the large plants produce more than the small ones in a given year: they may only operate a shorter length of time.

UNIT LABOR REQUIREMENTS FOR THE CAMPAIGN

Fluctuations in the Man-hour Ratio

The seasonality of the volume of employment in the beet-sugar factories was emphasized in chapter II, where it was shown that a large number of workers must be added in the fall, at the beginning of the annual campaign. Man-hour data for the intercampaign employment of those workers in the plants that work the year round were not obtained for the years prior to 1927. As a result it has been necessary to analyze unit labor requirements based upon intercampaign man-hours and those based upon campaign man-hours separately. The distinction between the man-hours expended in the two periods of the year also provides a much more illuminating analysis.

The campaign operating and indirect¹² man-hours per ton of beets sliced calculated from aggregates of man-hours and tons of beets sliced of all plants for which data have been collected for each year since 1912 are shown in table 15.

Since the sample from 1916 through 1923 contains plants with capacity larger than the average by from 11 to 17 percent, measured in terms of beets sliced, it is probable that the man-hour ratios for these years are lower than the average for the industry.¹³ According to the sample analysis, however, man-hour ratios for the years 1928, 1931, and 1935 should reflect rather accurately the average for the country. The fluctuation in the

**Table 16.- CHAIN INDEXES OF CAMPAIGN MAN-HOUR RATIOS
AND BEETS SLICED, 1917-35^a**

(1917=100)

| Year | Man-hour ratio | Average daily slicing | Total beets sliced |
|------|----------------|-----------------------|--------------------|
| 1917 | 100.0 | 100.0 | 100.0 |
| 1918 | 107.4 | 96.9 | 105.0 |
| 1919 | 100.1 | 102.7 | 113.5 |
| 1920 | 93.6 | 111.3 | 142.9 |
| 1921 | 76.4 | 126.8 | 142.2 |
| 1922 | 75.2 | 133.3 | 105.6 |
| 1923 | 74.1 | 135.7 | 126.0 |
| 1924 | 71.5 | 150.2 | 132.7 |
| 1925 | 70.4 | 139.5 | 131.1 |
| 1926 | 60.6 | 154.5 | 141.3 |
| 1927 | 56.8 | 157.4 | 149.4 |
| 1928 | 54.6 | 161.2 | 131.6 |
| 1929 | 52.1 | 170.7 | 140.0 |
| 1930 | 47.2 | 171.4 | 166.1 |
| 1931 | 45.6 | 178.6 | 152.8 |
| 1932 | 47.2 | 168.1 | 148.3 |
| 1933 | 43.8 | 177.3 | 178.3 |
| 1934 | 45.2 | 175.5 | 126.0 |
| 1935 | 42.9 | 176.9 | 125.3 |

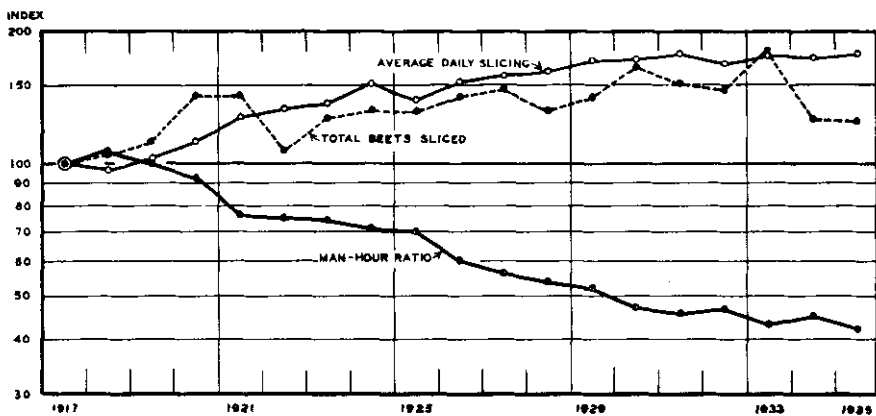
^aBased on table B-12, col. (5); table B-13, col. (5); and table B-14, col. (5).

¹²Operating and indirect man-hours include the man-hours worked by all plant employees exclusive of office employees, executives, salesmen, and agricultural fieldmen. This includes superintendents, maintenance men and repairmen, and all employees connected with the factory. It excludes men working on new construction and machinery installations, men working on workmen's cottages, and all workers not working at the factory.

¹³See table B-4.

man-hour ratios in table 16 is affected not only by changes in the average man-hour ratio for the industry but also by changes in the composition of the sample, so that the series cannot be used to measure either year-to-year fluctuations or the declining trend in labor requirements, although in general it reflects these movements. For the purpose of measuring the changes in the labor requirements within the limits of a changing sample, recourse has been had to an index of labor requirements obtained by chaining links computed from man-hour ratios for identical groups of plants for each successive set of paired years. This has been presented on a ratio scale in figure 17 and table 16 for comparison with the chained indexes of the tons of beets sliced and of the average daily slicing.¹⁴

Figure 17.- INDEXES OF MAN-HOUR RATIOS AND BEETS SLICED
1917-35
(Ratio scale; 1917=100)



Based on table 16

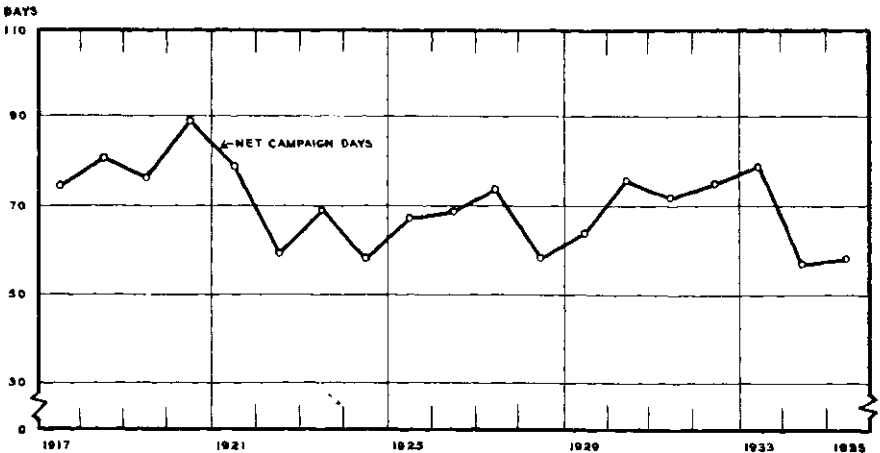
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It will be observed that the trend of man-hour ratios is downward while the trend of beets sliced is upward; this corresponds to what was observed in regard to employment. The improvement in the man-hour ratio seems to take place in the years from 1918 to 1921 and again in the years 1925 to 1930. Each one of these periods of improvement is followed by a period of 3 years or more in which there is relatively little change. The average annual decrease in the ratio was 5.8 percent during the period

¹⁴For other types of indexes of man-hour ratios see table B-15.

1917-19 to 1924-26 and was 5.5 percent during the period 1924-26 to 1931-33.¹⁵ A comparison of this curve with the chained index of average daily slicing for plants in the sample shows an inverse relationship. Production increases by increasing the capacity of the plants, and as this capacity increases, the number of beets sliced per campaign man-hour increases. It will be noticed that the year-to-year fluctuations in beets sliced are not reflected in the curve of average daily slicing. A decrease in production is taken care of by a shorter campaign period and a temporary increase by a longer campaign.¹⁶

Figure 18. - LENGTH OF CAMPAIGN, 1917-35



Based on table B-16, col. (2)

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Correlation of Technological Changes With Changes in Productivity¹⁷

The increase in average daily slicing corresponds with the changes in technology which took place during the period 1913-35. The revolutionary period of mechanization in the beet-sugar industry coincides with its period of rapid growth from 1900 to 1913. By the end of that period the flow of the materials beginning with the washing of the beets and ending with the flow of the sugar into bags and their removal for shipment and storage was

¹⁵This is the geometric average rate of change based on the man-hour ratios for the terminal periods.

¹⁶See figure 18 and table B-18.

¹⁷Data on technological changes in this section are based in part on a report on Mechanization in the Beet Sugar Industry prepared by the "Studies in Equipment Changes and Industrial Techniques" section of National Research Project.

continuous and mechanical. The manual workers were concerned only with the beets at the beginning of the operation and the bags of sugar at the end. The other workers in the plants were machinists, operators of machines and their assistants, technicians, chemists, and the like. The important concern of management was to slice as fast as possible to avoid any waste, since the crop flowing into any one plant was all harvested at approximately the same time, and to extract as much sugar as was economically possible. The bottle necks which prevented the speeding up of the slicing operations were the diffusion battery and the evaporators. Improvements in this equipment during the period 1913-35 materially reduced the time required for processing. Wherever possible, automatic control of processes was perfected, such as control of mixture and heat in the process of evaporation and carbonation. This improved the quality of the sugar and displaced operators. Throughout this period the capacity of the units in the various processes was increased, with slight change in size or cost, by improved design and regulation and by shortening the machine time required for given operations. This had the effect of reducing the campaign man-hours required per ton of beets sliced since it either increased slicing capacity, and therefore daily production, without any increase in man-hours, or substituted automatic control for operators of machines. A survey of the field reports on installations of machines reveals that of those which displaced labor, 83 percent or 50 installations affected skilled operators, while 17 percent or 10 installations affected unskilled or hand labor.¹⁸ This reflects the change from personal control of processes to the more scientific mechanical control which tends to eliminate losses due to errors in personal judgment and also to produce a more perfect product.

Accompanying this mechanization, and a necessary part of it, was the transformation of the power systems from steam to electricity. In 1914, 23 percent of the power installed in the industry was electric, while by 1929 it had been increased to 58 percent.¹⁹ Electrification offered greater reliability and freedom from shut-down with its consequent loss from fermentation and idle labor, as well as the possibility of more automatic control of processes.

¹⁸ See chapter V, discussion of "Effect of Machinery Installations."

¹⁹ *Census of Manufactures: 1929* (U. S. Dept. Com., Bur. Census, 1933), II, 209.

Mechanical handling also received attention, eliminating some unskilled manual labor. Conveyors and elevators came into use for the beets at the beginning of the process and the sugar at the other end. Traveling cranes equipped with grab buckets were installed for handling the beets, and revolving screens, for cleaning. Also, in many plants the loose sugar was conveyed mechanically to bins or silos instead of being run into bags as under the old system, thus eliminating unskilled labor at this end.

Attention has been called to the fact that there were two periods of marked decrease in the man-hour ratio, the first from 1918 to 1921 and the second from 1925 to 1930. Activity in building new plants and in improving the machinery and equipment of plants already built preceded and accompanied each of these periods of increased productivity.²⁰ Not only was the period 1918 to 1920 one of great activity in the building of new plants, but the expenditures for improvements during the 5 years 1917-21 for 31 identical plants in the sample was more than twice that for any following 5-year period.

After 3 years of comparatively little construction activity, the second period of improvement in productivity was initiated by an increase in expenditures for machinery in 1924 followed by renewed building activity during the years 1925-27. This period was brought to a close by another increase in expenditures for improvements during the years 1929-30. In the following years building construction fell off; so did expenditures for new machinery and equipment except during the year 1933, when it was necessary to prepare for the largest campaign in the history of the industry.

The improvements during these two periods have made possible a steady increase in the average daily slicing capacity of the plants and a decrease in the man-hour ratios.

A possible partial explanation of the behavior revealed by this analysis may be as follows. Trucks have been displacing the horse-drawn vehicle in the transportation of the beets to the factories. With the improvements in roads and the increase in transportation by trucks the agricultural area which one beet-sugar plant can adequately serve has increased.²¹ Since it is

²⁰See tables A-4 and B-5.

²¹Loring K. Macy and Others, *Changes in Technology and Labor Requirements in Crop Production: Sugar Beets* (Works Progress Administration, National Research Project, Report No. A-1, Aug. 1937), p. 26.

the practice in the industry to run the plants continuously 24 hours per day until all beets are disposed of, the increase in the supply of beets would at first cause an increase in the number of days in the campaign period. This tends to bring with it a certain amount of wastage due to the spoilage of beets from standing and the deterioration in their condition for the processing later. Hence, the supply available to a given plant exerts a pressure to increase the slicing capacity by reducing the bottle necks wherever they exist. This increase of slicing capacity automatically results in a shorter campaign and tends to reduce the man-hours per ton of beets sliced.

It will be noticed that the fluctuations in the length of the campaign which are shown on figure 18 tend to correlate with fluctuations in total tons of beets sliced. The peak years in both series are 1920, 1927, 1930, and 1933, but the trend in the length of the campaign is downward. Temporary fluctuations in production are taken care of principally by an increase or decrease in the length of the campaign, but the increase in daily slicing which has been occurring steadily since 1918 has tended at the same time to decrease the average length of the campaign.²²

The same pressure which would lead to increased capacity of the plants in operation might also impel companies to establish new plants. Of the 100 plants in existence in 1934-35, 37 had been built between 1916 and 1930. Of these, 24 had been built during the years 1916-20, and 11 in the years 1925-30, leaving only 2 that had been built in the 4 intervening years.²³ That there were other and more important factors which increased the number of plants and the supply of sugar produced cannot be denied. Some of these factors have been discussed in part in chapter III and do not require further elaboration here, while others will receive attention later. Five out of the 31 identical beet-sugar plants were idle in 1926, yet in this year 3 newly built plants came into the sample, the slicing capacity and the total tonnage of beets sliced increased, and the man-hour ratio decreased. It is possible that the same forces brought about the abandonment of certain plants, the building of new ones, and the increased capacity of others. This was the period of severe competition in which the domestic beet-sugar industry lost ground in the

²²See tables B-13 and B-16.

²³See table B-5 and the pamphlet *American Beet Sugar Companies, 1934-35* (Washington, D. C.: The United States Beet Sugar Association).

American market. It seems clear that many inefficient, less favorably located plants would fall by the wayside in such a period and that others would tend to increase their efficiency in order to stay in the market.

Analysis of Fluctuations in Unit Labor Requirements

One of the objectives in the field study was to analyze differences in the labor-requirement ratios as between different processing plants and also to ascertain the conditions and relative rates of change in the several elements of the industry in order to understand better how changes in the industry as a whole came about. The attempt was made to single out the forces tending to accelerate or retard improvement in efficiency of labor utilization in order to understand better the conditions affecting the industry's demand for labor.

The general procedure of analysis was to isolate changes in unit labor requirements that were due respectively to (a) improvements in efficiency in the utilization of labor within individual plants, and (b) improvements in efficiency in the utilization of labor in the industry as a whole due to shifts in the plants which were operating and in the proportions of output produced by relatively more- or less-efficient plants. This analysis should show whether the decrease in unit labor requirements for the industry was due to one or more of the following factors: (a) the opening of new, efficient plants or the abandonment of old, inefficient plants; (b) the changing proportions of output produced by the more efficient plants; or (c) the changing efficiency of labor utilization within given plants.

Before proceeding with the analysis outlined above, however, it was necessary to examine the extent to which labor-requirement ratios differed between individual plants and also to ascertain what types of plants were most efficient in labor utilization.

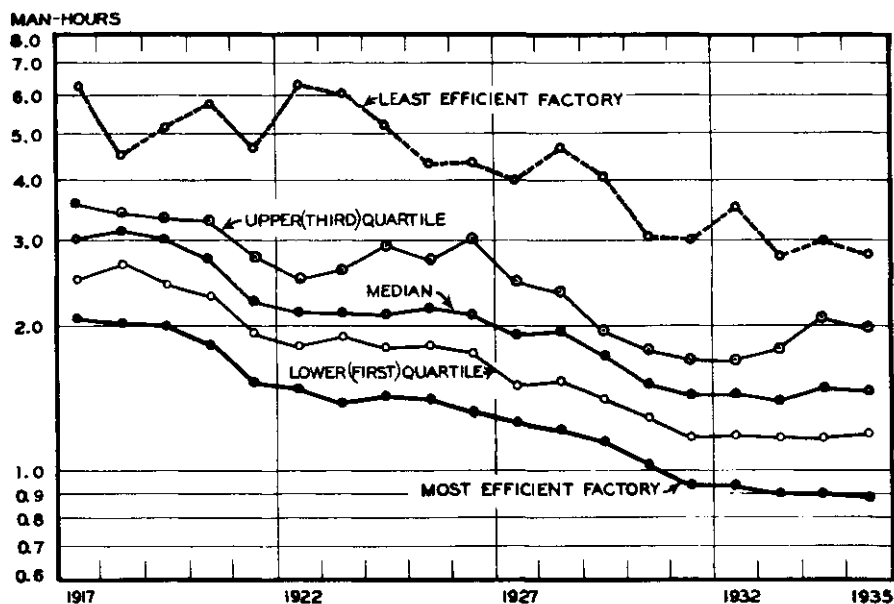
The chief interest in an analysis of differences in labor-requirement ratios centers upon changing unit labor requirements over time. However, an examination of differences in unit labor requirements among various types of plants is illuminating in explaining these changes. A knowledge of the types of plants that are relatively more efficient or less efficient in the utilization of labor is important in ascertaining the causes of changes in the labor requirements over time for the industry as a whole.

For example, if large plants are more efficient than small plants, a reduction in the over-all man-hour ratio over a period of time may merely mean that there are more large plants or that the large plants are more active than the small ones. Geographical differences, differences in age, and other differences may be important in this connection.

Increasing Productivity in Individual Plants.— The outstanding common characteristic of the various series of man-hour ratios for individual plants is their marked tendency to decline throughout the period from 1918 to 1931. This is revealed by even a cursory examination of the series of man-hour ratios for individual plants²⁴ and confirmed by a comparison of the measures of dispersion for the series for all reporting plants with those for the 31 identical plants. Figure 19 presents the quartile measures of labor-requirement ratios for all reporting plants together with those of the most-efficient and the least-efficient plants in each of the years 1917 through 1935. It is evident from this

Figure 19.- CAMPAIGN MAN-HOURS PER TON OF BEETS SLICED, ALL REPORTING FACTORIES, 1917-35

(Ratio scale)



Based on table B-9

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²⁴ See tables B-7 and B-8.

chart that while there is a relatively wide range between the most-efficient and the least-efficient plant, the measures are for the most part rather closely grouped about the median.

The average deviations of the arrays fall throughout the period, the average deviation for 1916 being .74 man-hours and for 1935, .38 man-hours; but the ratios of the average deviations to the median do not drop perceptibly, the coefficient of dispersion being .28 for 1916 and .26 for 1935.²⁵ In other words, the decrease in the absolute dispersion has so paralleled the decrease in the medians of campaign man-hour ratios that the relative dispersion measures for the yearly arrays have undergone little change over the period. It is evident that the decrease in the typical man-hour ratios has been accompanied by corresponding proportional decreases in the quartiles.

The question naturally arises: Do the observed proportional decreases in the median and quartile man-hour ratios come about because of new plants coming in and because of old plants being abandoned, or is the decrease in labor requirements the typical behavior of the individual plants in the series? In order to answer this question an analysis was made of the yearly arrays of campaign man-hours per ton of beets sliced for 31 identical plants for the years 1917-35. An examination of figure 20 reveals a decrease of all the quartiles proportional to the decreases exhibited by the medians of the arrays.²⁶ The average deviations of the ratios fall from .65 man-hours per ton of beets sliced in 1917 to .24 man-hours per ton in 1935. The ratios of the average deviations to the medians of the yearly arrays, however, exhibit no discernible trend. The dispersion characteristics of yearly arrays of ratios for identical plants are not dissimilar to the dispersion characteristics of arrays of ratios for all reporting plants over the period.

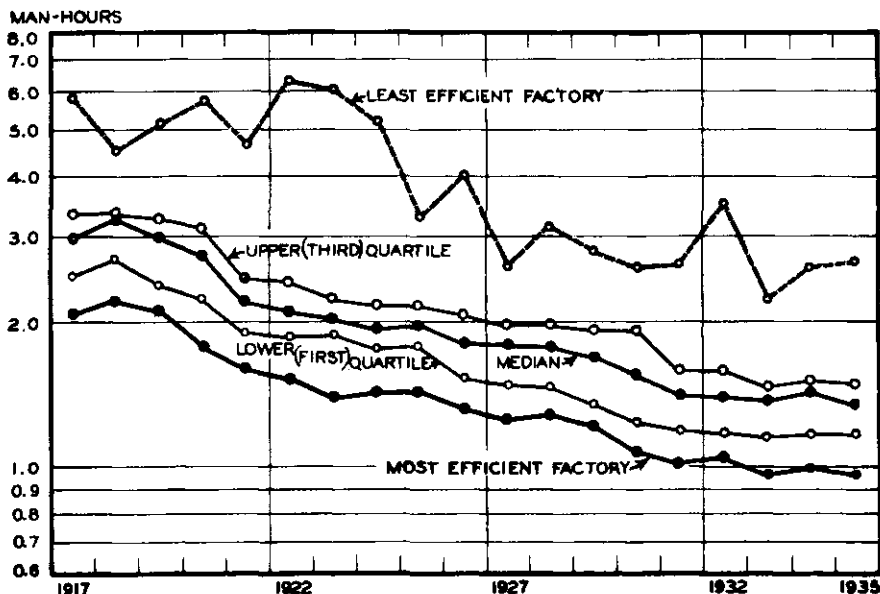
A further analysis was made of the arrays of the 31 identical plants to determine whether the decrease in the man-hour ratio was due to a general improvement in all plants or to improvement in a few of the plants producing a large proportion of the output. It was assumed that if improvement took place by a gradual and uniform improvement of all plants in all portions of the arrays, there would be relatively little change in the constituency of

²⁵The measures computed from the arrays for all reporting factories are shown in table B-9.

²⁶The measures computed from the yearly arrays for 31 identical factories are shown in table B-10.

Figure 20.- CAMPAIGN MAN-HOURS PER TON OF BEETS SLICED, 31 IDENTICAL FACTORIES, 1917-35

(Ratio scale)



Based on table 8-10

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the two halves of the arrays over the period. In 1935, of the 30 plants which were operating in 1917 (1 plant in the group was idle in 1917), 21 were in the same half in which they had started, 1 was idle, and the remaining 8 had shifted from one half to the other; 4 had stayed continuously in the upper half of the array and 3 had stayed continuously in the lower half. An examination of the arrays reveals even more stability than is shown by these figures. The shifting about in positions seems to be due more to the differences in timing and rate of speed in improvements than to permanent shifts so that while one plant may get ahead in one year it may lose out in some later year.²⁷

A further confirmation of this general improvement is found in the examination of the series of average daily slicing of beets for individual plants. The common characteristic of each of these series is a continued increase throughout the period. Figure 21 and table 17 show the trend in these two characteristics and the inverse relationship for the 31 identical plants. The

²⁷ See table B-10 for a series of array-stability measures for the 31 identical factories for the years 1917-35.

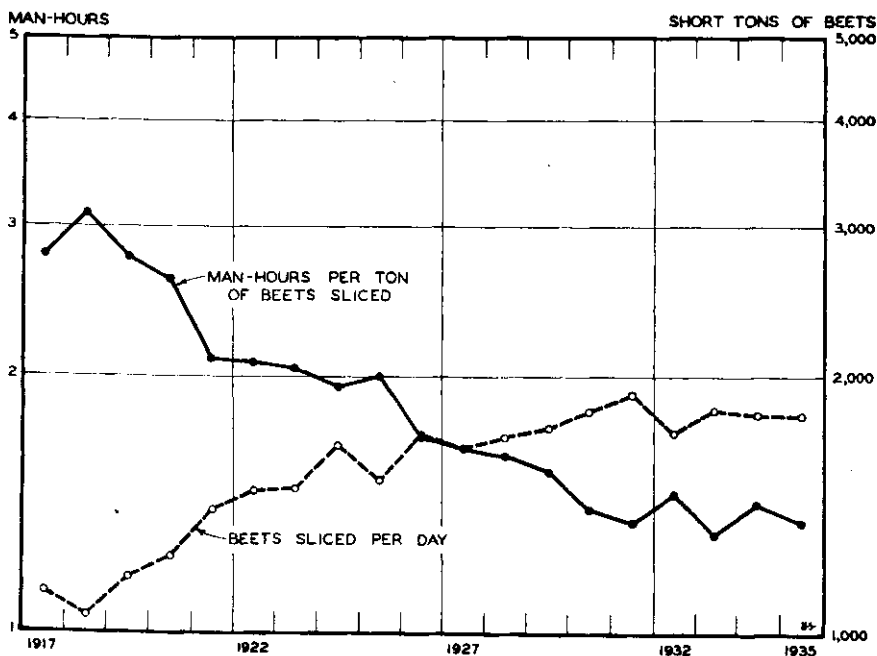
Table 17.- CAMPAIGN MAN-HOURS PER TON OF BEETS SLICED AND AVERAGE DAILY SLICING, 31 IDENTICAL FACTORIES 1917-35

| Year | Man-hour ratios ^a | Average daily slicing (short tons) | Year | Man-hour ratios ^a | Average daily slicing (short tons) |
|------|------------------------------|------------------------------------|------|------------------------------|------------------------------------|
| 1917 | 2.78 | 1,117 | 1927 | 1.65 | 1,651 |
| 1918 | 3.11 | 1,044 | 1928 | 1.62 | 1,702 |
| 1919 | 2.76 | 1,160 | 1929 | 1.55 | 1,743 |
| 1920 | 2.61 | 1,231 | 1930 | 1.40 | 1,822 |
| 1921 | 2.10 | 1,393 | 1931 | 1.35 | 1,907 |
| 1922 | 2.08 | 1,465 | 1932 | 1.46 | 1,722 |
| 1923 | 2.05 | 1,478 | 1933 | 1.31 | 1,833 |
| 1924 | 1.95 | 1,661 | 1934 | 1.42 | 1,805 |
| 1925 | 2.00 | 1,510 | 1935 | 1.35 | 1,806 |
| 1926 | 1.70 | 1,716 | | | |

^aTable B-10, col. (6).

Figure 21.- CAMPAIGN MAN-HOURS PER TON OF BEETS SLICED AND AVERAGE DAILY SLICING, 31 IDENTICAL FACTORIES, 1917-35

(Ratio scale)



Based on table 17

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upward trend of the average daily slicing per plant is reflected in the downward trend of the man-hour ratio, thus indicating that decreasing campaign labor requirements have to some extent resulted from an increasing capacity with the same labor force. In this respect the 31 plants show the same characteristic that has been noted for all the plants in the sample.

The analysis of the behavior of the 31 plants and the similarity of their behavior to that of all plants in the sample would seem to indicate that the decrease in labor requirements over the period is neither due in the main to new and efficient plants coming in nor to old and inefficient plants falling out, but rather to the general improvement of all plants.

Rates of Change and Contingent Labor-Reduction Ratios.- The speed at which the change in unit-labor-requirement ratios in the 31 identical plants took place may be expressed in two ways: first, in terms of the annual geometric rate of decline in the median man-hour ratio; then in terms of shifts in the entire distribution of man-hour ratios.

By the first method, man-hours per ton of beets sliced declined 4.17 percent a year from the period 1917-19 to 1933-35, the decline being relatively rapid from 1917-19 to 1927-29 (5.34 percent per year) and relatively slow (3.19 percent per year) from 1927-29 to 1933-35.

The second method of expressing the rate of change in unit labor requirements is a new device and hence will be explained in somewhat more detail. We have seen that there are substantial differences in the unit labor requirements of the individual plants in the 31-plant series and also that these differences maintain about the same relative dispersion throughout the period. This suggests that an instructive approach to the analysis of rates of change may be to conceive of the progress of efficiency in an industry as consisting of the shifting of the entire distribution of man-hour ratios, without substantial change in form, toward the more-efficient (lower man-hour ratios) end of the scale. The existence of substantial differences in the unit labor requirements of the several plants in a group is evidence of the possibility, if not the inevitability, of further reductions in the average man-hour ratio. Under such conditions, there obviously is room for improvement in efficiency even without major technological innovations, and the passage of time may

reasonably be expected to bring a lowering of the man-hour ratios of at least the less-efficient plants.

A convenient way of measuring the labor reductions contingent upon specified possible shifts in the distribution is based upon the ratios between selected pairs of the various man-hour ratios which represent the efficiency of plants at selected points in the array, such as the ratio between the most-efficient (smallest) man-hour ratio and the least-efficient (largest) man-hour ratio, or the ratio between the first-quartile man-hour ratio (with one-quarter of the ratios smaller) and the median. Selecting the ratio between the first quartile and the median to illustrate the procedure, we may frame the problem thus: What will be the reduction in unit labor requirements if the array shifts toward the more-efficient end of the scale sufficiently so that the median man-hour ratio becomes as low as the first-quartile ratio at the initial date and, on the average, the other elements of the array undergo proportionate shifts; and how long has it ordinarily taken to accomplish this "median-to-first-quartile shift"?²⁸

The corresponding contingent labor-reduction ratio indicates how much unit labor requirements will be reduced if the specified shift takes place. For example, for the median-to-first-quartile shift, the computation procedure may be expressed by the formula $C = 1 - \frac{Q_1}{Q_2}$ where C is the reduction in the unit-labor-requirement ratio contingent upon the specified shift. For the 31-plant series this ratio ranged from 9 to 21 percent in the period 1917-35, the median contingent reduction being 16 percent.

The time required for the median-to-first-quartile shift ranged from 1 to 6 years, the median interval being between 3 and 4 years, or about the length of the average business cycle. Consequently, if we base our judgment upon the observed stability in the relative dispersion of the man-hour ratios and on the average time interval required in the past for the median-to-first-quartile shift, it would appear that on the average we

²⁸ Obviously, such comparisons might be made between any 2 positions in the array, and the choice of the median-to-first-quartile shift may appear somewhat arbitrary. In fact, computations by 4 methods have been made and recorded in tables B-9 and B-10 for all reporting plants and for the 31-plant series respectively. These tables show the contingent reduction ratios and the shift intervals, with each year in turn considered as the initial year. The median-to-first-quartile shift appears most useful for an analysis of changes likely to take place within the span of a few years. The comparison between the most- and least-efficient plants (the "range-ratio" method) rests upon only 2 plants in each year and suggests a degree of improvement which will ordinarily require a long span of years. Never in the 18-year period covered by the 31-plant series did the man-hour ratio for the least-efficient plant become so low as that of the most-efficient plant in the initial year (1917).

may reasonably expect a reduction in unit labor requirements of about 16 percent in a period of 3 to 4 years. This estimate agrees roughly with the 4.17 percent geometric rate of decrease experienced in the median man-hour ratio for the 31 plants during the 1917-35 period. It should be noted, however, that the time interval required for the median-to-first-quartile shift appears to be lengthening in recent years. This corresponds to the slowing down of the rate of increase which was noted in the geometric rate of change in the median after the period 1927-29. With 1929 as an initial year, it required 6 years for the median to become as low as the 1929 first quartile, and in the succeeding years the shift from median to quartile did not take place within the time interval covered by the data, that is, before 1936.

The use of contingent labor-reduction ratios based upon the dispersion of the array of man-hour ratios is, of course, a new approach to the measurement of rates of change and is feasible only when individual-plant data are at hand. It is a useful supplement to the usual method of computing trends and rates of change in that it lays stress upon the potentialities of improvement arising from the existing differences in efficiency. These potentialities would be exaggerated if a comparison were made between the most-efficient and the least-efficient plants (the "range-ratio" method).

Characteristics of Individual Plants Correlated With Productivity

An analysis of yearly arrays of labor-requirement ratios indicates wide ranges between the most-efficient and least-efficient plants, but a moderate dispersion of most of the plants about the central tendencies. The following paragraphs are devoted to answering the question: What characteristics of plants are responsible for their relative efficiency in the utilization of labor, that is, for their position in these arrays? Comparison between groups of plants will be made on the basis of unweighted averages of the standard man-hour ratios for the individual plants.

Influence of Size and Age of Plants.- The man-hour ratios of the plants surveyed indicate that newer plants are more efficient in the utilization of labor than older plants and that larger plants are more efficient than smaller. A cross-classification of the standard man-hour ratios for 1934 by size and age of

Table 18.- STANDARD MAN-HOUR RATIOS BY SIZE AND AGE OF FACTORIES, 1934^a

| Period in which factory was constructed | Total | | Capacity ^b (in short tons) | | | | | | | | | |
|---|---------------------|-----------------|---------------------------------------|-----------------|---------------------|-----------------|---------------------|-----------------|---------------------|-----------------|---------------------|-----------------|
| | | | Under 1,100 | | 1,100-1,399 | | 1,400-1,699 | | 1,700-1,999 | | 2,000 and over | |
| | Number of factories | Man-hour ratios | Number of factories | Man-hour ratios | Number of factories | Man-hour ratios | Number of factories | Man-hour ratios | Number of factories | Man-hour ratios | Number of factories | Man-hour ratios |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) |
| 1890-1929 | 66 | 1.62 | 10 | 2.28 | 17 | 1.77 | 20 | 1.48 | 10 | 1.34 | 9 | 1.24 |
| 1890-99 | 9 | 2.08 | 3 | 2.37 | 1 | 2.45 | 3 | 1.81 | 0 | - | 2 | 1.87 |
| 1900-09 | 29 | 1.74 | 4 | 2.65 | 7 | 2.07 | 12 | 1.49 | 1 | 2.20 | 5 | 1.06 |
| 1910-19 | 16 | 1.42 | 2 | 1.50 | 5 | 1.55 | 3 | 1.37 | 5 | 1.33 | 1 | 1.20 |
| 1920-29 ^c | 12 | 1.26 | 1 | 2.12 | 4 | 1.35 | 2 | 1.11 | 4 | 1.13 | 1 | 0.89 |

^aStandard man-hour ratios are averages of the ratios for 1933-35 (see p. 84). The man-hour ratios shown are unweighted means of the standard man-hour ratios for all factories in the respective size (capacity) classes.

^bMeasured by average daily slicing, 1933-35.

^cIncludes 1 factory constructed in 1930.

Table 19.- STANDARD MAN-HOUR RATIOS BY SIZE AND AGE OF FACTORIES, 1918^a

| Period in which factory was constructed | Total | | Capacity ^b (in short tons) | | | |
|---|---------------------|-----------------|---------------------------------------|-----------------|---------------------|-----------------|
| | | | Under 1,100 | | 1,100 and over | |
| | Number of factories | Man-hour ratios | Number of factories | Man-hour ratios | Number of factories | Man-hour ratios |
| 1890-1918 | 40 | 3.15 | 28 | 3.26 | 12 | 2.89 |
| 1890-1904 | 20 | 3.19 | 14 | 3.29 | 6 | 2.96 |
| 1905-1918 | 20 | 3.11 | 14 | 3.23 | 6 | 2.82 |

^aStandard man-hour ratios are averages of the ratios for 1917-19 (see p. 84). Man-hour ratios shown are unweighted means of the standard man-hour ratios for all factories in the respective size

(capacity) classes.

^bMeasured by average daily slicing, 1917-19.

plants is shown in table 18. The number of plants in each subgroup is shown together with the average standard man-hour ratio for the plants in that group. The table reveals that for the group as a whole the man-hour ratios of the larger plants are lower than those of the smaller and that the man-hour ratios of the newer plants are lower than those of the older, although within the subgroups of the cross-classification some exceptions do occur. These exceptions to this general principle are usually based upon samples of only one or two plants.

Table 19 presents a size and age cross-classification of average standard man-hour ratios for individual plants for the year 1918. The age classification segregates plants built in the period 1890-1904 from those built in the period 1905-18. The size classification segregates plants for which the average daily slicing is less than 1,100 tons from those slicing 1,100 tons and more. This table indicates that in this earlier period, as was shown to be true for the more recent period in table 18, the larger plants were the most efficient in the utilization of labor and that the newer plants were more efficient than the older.

Influence of Organization and Management.- Analysis of man-hour ratios for individual plants reveals that significant differences exist between plants of various companies, for when the average standard man-hour ratios for the plants of individual companies for 1934 are compared with each other, a considerable dispersion is shown. The average ratios for six companies ranged from 1.19 to 2.54. These companies were large, multiple-plant organizations operating 55 plants in the years 1933-35 with an average labor requirement of 1.54 man-hours per ton. Nine small companies operating 11 plants during the same period had an average standard man-hour ratio of 2.02 man-hours per ton.

The multiple-plant organization enables the improvements which are so characteristic of the industry to be carried out throughout the plants of one company. This, coupled with the strong trade association, may account in part for the remarkably uniform change throughout the industry. One large company owning several plants encourages improvements in organization and general efficiency by setting standards for each plant and then offering a prize of an extra week's holiday to all the yearly employees in the plant which makes the greatest improvement over the standard set. The officials of the company consider their scheme effective in reducing costs. If reduction of costs has as a corollary

greater production with the same labor force, then a corresponding reduction in unit labor requirements occurs.

Influence of Geographical Location.- In general, plants in the eastern region have higher man-hour ratios than plants in the West. The average standard man-hour ratio for the eastern plants for 1934 was 2.19, while for the western plants it was 1.38. It should be noted, however,²⁹ that factors other than geographical location are important in the explanation of these regional differences. For example, the western plants are newer and larger and are operated by large multiple-plant companies.

*Influence of the Degree of Mechanization*²⁹.- Plants with a greater investment in machinery and equipment per man-hour expended are more efficient in the utilization of labor than plants less highly mechanized. These facts were revealed when standard labor-requirement ratios were classified by the degree of mechanization of the plants. The measure chosen to represent mechanization was the gross investment in machinery and equipment per daily campaign man-hour. By gross investment is meant the total cost of all the machinery and equipment which the plant has installed, less the cost of the machinery and equipment which has been retired or scrapped or sold but without deduction for depreciation. Average daily man-hours were used rather than total campaign man-hours since the length of the campaign varies in different plants.

Average gross investment for individual plants for the years 1933-35 and 1927-29 was divided by average campaign man-hours per day for the same groups of years respectively. The individual plants were then subdivided into the following three groups:

- (a) All plants with a gross investment of less than \$600 per daily campaign man-hour.
- (b) All plants with a gross investment of \$600 or over but less than \$800 per daily campaign man-hour.
- (c) All plants with a gross investment of \$800 or over per daily campaign man-hour.

Standard campaign man-hours per ton of beets sliced for each of the years 1928 and 1934 for the individual plants falling under each of the three groupings above were averaged and the results are shown in table 20.

²⁹See appendix D for a discussion of the influence of Steffens operations upon man-hour requirements.

Table 20.- STANDARD MAN-HOUR RATIOS FOR FACTORIES CLASSIFIED BY GROSS INVESTMENT PER DAILY CAMPAIGN MAN-HOUR 1928 AND 1934^a

| Year | Under \$600 | | \$600 to \$799 | | \$800 or over | |
|------|------------------|-------|------------------|-------|------------------|-------|
| | Number of plants | Ratio | Number of plants | Ratio | Number of plants | Ratio |
| 1928 | 20 | 1.73 | 8 | 1.53 | 4 | 1.46 |
| 1934 | 14 | 1.40 | 13 | 1.26 | 6 | 1.12 |

^aNRP-NBER field-survey data. For definition of standard man-hour ratio see p. 84. Ratios are unweighted means of the standard man-hour ratios of the factories in the respective classes.

Evaluation of Factors Affecting Average Unit Labor Requirements

While the outstanding factor in the decrease in the man-hour ratios is a fairly uniform improvement in individual plants, there remains the problem of evaluating other factors. An examination of the characteristics of new plants coming into the series reveals the fact that of the 26 newly built plants which have come into the sample, 73 percent were below the average capacity during the first year of operation and 68 percent during the second year, showing therefore at least an average increase in capacity, which, as defined in this study, is identical with the average daily slicing. Reviewed with respect to productivity, 35 percent were below the weighted mean of man-hour requirements for all plants in the sample during the first year and 65 percent were above the weighted mean. In the second year of operation there was an equal division of plants above and below the mean of man-hour requirements. Therefore, these newly built plants showed a greater improvement in labor requirements than the average for the sample. This improvement in the second year of operation is of especial significance because of the use of the chained index to indicate the change in unit labor requirements. If new plants come into the index at an efficiency above the average and do not improve or increase their proportion of the output, the resulting improvement in the average man-hour ratio for all plants is not reflected in the index since it measures only changes in the man-hour ratios of the plants after they enter the sample. To that extent the index has an upward bias. But if the improvement

takes place after they come in, as tends to be the case in beet-sugar plants, then the chained index measures it.

Similarly, an examination was made of idle and abandoned plants. Of the 16 such plants, 62 percent were less efficient in the last year of operation than the weighted average for all plants, and all of them were below the average capacity in that year. The closing of plants would in general tend to lower the weighted mean of the man-hour ratios, but the first effect of new plants is to raise the weighted mean. Both of these tendencies are obscured in the index because of the necessity of comparing groups of identical plants for year-to-year changes, but fortunately they are in opposite directions and of relatively little importance in any one year. In the years 1925-30, 10 new plants were built while 8 were abandoned, so it is likely that the immediate net effect upon the average man-hour ratio in any year of the entrance and exit of plants was negligible, but that the swifter improvement of the new plants after they once enter the industry tends to decrease the ratio. Hence the chained index would tend to decline faster than the index for a group of identical plants for this period, but probably not faster than the average man-hour ratio for all the plants in the industry since the sample is probably fairly representative in respect to idle and abandoned plants as well as in respect to newly constructed plants.

When the changes in the index of weighted man-hour ratios for the 31 identical plants are compared with the changes in the chained index of comparable aggregates, small differences are noticeable which may be accounted for by the improvement in the new plants. The decline in the average labor-requirement ratio for the 31 identical plants over the period from 1917-19 to 1933-35 was 53 percent and in the aggregative chained index for the sample was 57 percent. During the first period of decline from 1917-19 to 1924-26 the decline in the two series is approximately the same, being 35 percent, while in the second period of decline the labor-requirement ratio for the identical plants declines 28 percent, and that for the series including the new plants coming in declines 35 percent.

It has been noted that large plants are more efficient than small plants. The 31 identical plants are larger than the average for the series of all reporting plants in every year, ranging from about 20 percent greater capacity to only 2 percent. Except

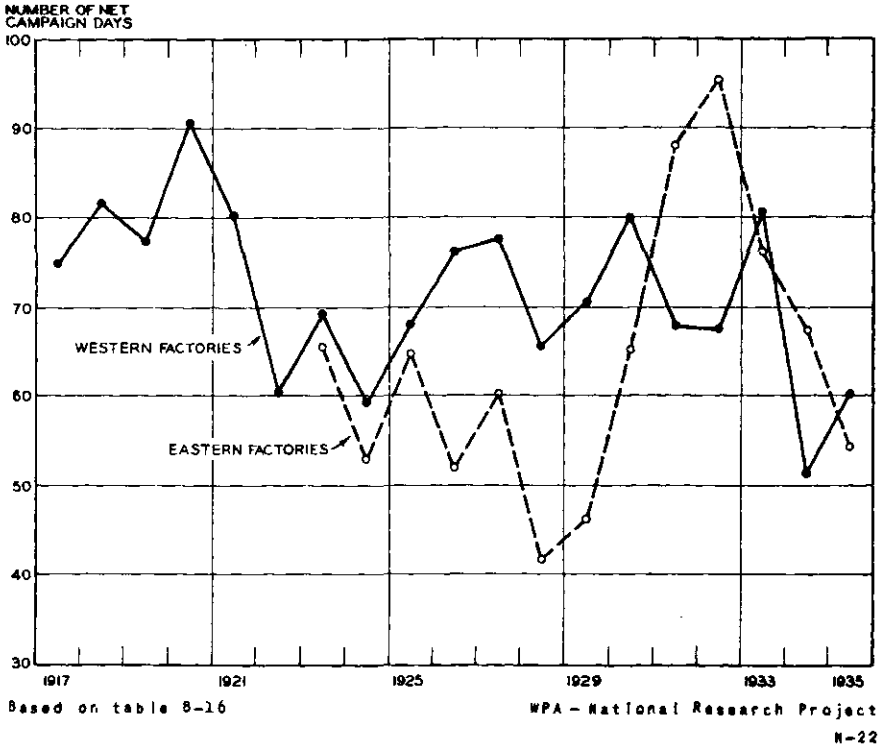
in 2 years the man-hour ratios of the 31 identical plants have been lower than those for all reporting plants. The increase in capacity has been about 62 percent for the 31 identical plants since 1917 and 77 percent for the plants in the sample as shown by the chained index. Hence, we may conclude that size is an important element in the average man-hour ratio and improvement in size is a general characteristic of the plants in the industry. The decrease in the man-hour ratio, as affected by size, is due not to a shift in the proportion of output from smaller to larger plants but to the general enlargement of capacity of operating plants.

Since there is a correlation between size and efficiency and since size is measured each year by the average daily slicing, it is to be expected that the production of plants having ratios below the median man-hour ratio would be greater than those with man-hour ratios above the median. This of course neglects the factor of the length of the campaign. The percentage of the yearly production, measured in terms of beets sliced, accounted for by this efficient half of the plants varies from 52 percent in 1918 and 49 percent in 1934 to 75 percent and 74 percent in 1916 and 1926 respectively. The median of the 20 yearly values is 63 percent. In 4 years it was above 70 percent and in 6 years it fell below 60 percent. The more-efficient half of all the plants, therefore, tends to slice 60 to 65 percent of the beets. Since there is no noticeable trend toward a larger or smaller percentage, there is little reason to believe that a changing proportion of the production going to the larger and more-efficient plants is a factor of any importance in the declining man-hour ratio.

However, year-to-year fluctuations in the average man-hour ratio may easily be caused by changes in this proportion. In recent years, that is, since 1931, the campaign has been considerably longer in the eastern plants, which are less efficient than the western plants, and in these years the percentage of the production in the inefficient half of the plants has ranged between 44 percent and 51 percent.³⁰ This accounts, in part, for the fact that during these years the average man-hour ratio has not only ceased to fall but in fact has tended to rise, falling slightly in 1935 when the percentage of production in the inefficient plants declined and the length of the campaign in the

³⁰See figure 22 and table B-16.

Figure 22.- LENGTH OF CAMPAIGN, EASTERN AND WESTERN FACTORIES, 1917-35



East fell again below that in the West. During the years 1931-34 the supply of beets in the eastern region evidently rose in proportion to that in the West.³¹

Attention should be called here to the effect of natural causes upon temporary fluctuations in the average man-hour ratios. When the supply of beets in a given locality fails, it becomes necessary to shut down plants in that locality. During 1934-35, plants were closed in some sections because of drought, and in a number of years insects and pests affecting sugar-beet crops have caused the closing of plants in certain areas. Coupled with these natural causes are the relative price fluctuations of farm products which are a factor in the choice of the farmer to devote his land to sugar beets or other crops. If the failure in the supply of beets, whether from one cause or another, tends to be concentrated in some one region, then there may take place a change in the average man-hour ratio due to the resulting changes in the distribution of production between regions. In some instances there

³¹See table B-17 for comparison of eastern and western areas.

are temporary fluctuations affecting only the man-hour ratios for years of abnormal weather, while in others there may be more permanent shifts in the proportional importance of different regions.

The eastern plants in the sample reached a high point in production of beet sugar in 1925. After this the trend of production in the East was downward, and the relative importance of this district declined for a number of years, while the western region increased in relative importance. This was a factor in the declining man-hour ratios from 1925 to 1931 since the plants in the West have a lower average labor-requirement ratio than those in the East. Since 1931 California has been increasing the number of its plants and its production, with a tendency toward lowering the ratio.

In summary, it may be said that all the facts in hand seem to point to one conclusion, that the main factor in the decline of the average labor-requirement ratio per ton of beets sliced in the beet-sugar factories during the campaign is the gradual improvement of all plants which has taken place as an accompaniment of the steady increase in the daily slicing of beets. All plants tend to increase their daily capacities and decrease their labor-requirement ratios. Although the average plants are larger today than they were 20 years ago, this increase in the average has come about in the main not by building larger plants but by increasing the capacity of the existing plants, and this in turn has come about not by revolutionary changes in equipment but by gradual improvement and changes where necessary to speed up or improve production and by improvement in general organization and flow of materials. The gradual and uniform improvement which has taken place in all plants has probably been made possible by the high degree of centralization of management, which was pointed out in chapter I. The five largest companies controlling 75 percent of the production have been able to make use of the improvements developed in their individual plants to increase the efficiency of their whole organization, and thus there has resulted a more rapid and uniform improvement than would be expected with less-centralized ownership. It has been pointed out that the average man-hour ratio for the plants owned by these large corporations is less than for the other plants. Moreover the five largest of these operate in California and the western area where the average man-hour ratios are lower than in the eastern area and where the plants are larger.

Interruptions in the general trend downward have occurred because of shifts in the proportions of the production supplied by the different areas or because of natural causes affecting the supply or the condition of the beets which were processed, but, at least until 1933, the trend of the man-hour ratios for the individual plants and for the plants as a whole declined from year to year while the capacity increased.

CHANGING UNIT LABOR REQUIREMENTS IN VERTICAL SEGMENTS OF THE BEET-SUGAR INDUSTRY

That the campaign labor is only a small part of the total labor utilized in the production of beet sugar was pointed out in chapter II. A study of changes in the demand for labor in the industry should consider also the changes in the labor utilized in other parts of the industry even though data are not at hand to make so detailed a study as was made of the campaign labor. In the following section an attempt will be made to estimate the number of man-hours per ton of beets sliced that are used in producing and harvesting the beets and bringing them to the factories, that are used in the factories and in the central offices of the beet-sugar companies, and that are used in producing the fuel and machinery for the processing of the beets in the factories. An attempt will also be made to determine the nature of the trend of the man-hour requirements per ton of beets sliced in each of these segments and in the industry.

Total Factory Labor Requirements per Ton of Beets Sliced

In the previous section the discussion has centered entirely upon the analysis of changes in the campaign labor necessary to extract the sugar from a ton of beets. This is, however, only part of the labor expended in the beet-sugar factories. In the first place there is the intercampaign labor which is performed by all factory employees who work about the plant in the interval between the closing down of operations in the winter and the opening up in the fall. Some of these workers must clean and repair the machinery, get the plant ready for the next operating season, and take care of the shipping of the sugar during the year. In addition, there are chemists, and technicians, and office workers who are employed for the entire year. For the purposes of this analysis the labor of these workers has necessarily been separated

into the two parts, campaign and intercampaign labor. The labor which they performed during the campaign period has been included in the campaign labor. It now remains to consider the amount of labor which they performed during the remainder of the year. The other workers who have been omitted are those who worked in the plant offices during the campaign and in the central offices of the companies operating several plants.

Intercampaign and Campaign Man-hour Ratios.- Data for intercampaign man-hours were secured for the years 1927 through 1935. The intercampaign labor-requirement ratios for 27 identical plants for the years 1928-35 are shown in table 21 together with the campaign man-hour and office man-hour ratios.³² It will be noticed that there are marked fluctuations in the intercampaign man-hours per ton of beets sliced. Necessarily, the longer the campaign the smaller the proportion of the labor of the workers who are employed the entire year which is counted as intercampaign labor, and the shorter the campaign the larger the proportion of such labor which is counted as intercampaign labor. Hence, if there were no other factors to take into consideration, the intercampaign labor would tend to be greater per ton of beets sliced during a short campaign than during a long one. Table 21 and figure 23 show this inverse relationship between intercampaign man-hours required per ton of beets and the length of the campaign. This relationship is so marked that it tends to obscure any trend which might exist in the intercampaign man-hour ratio. There is another factor of importance, however, in this intercampaign man-hour ratio, that is, more preparation has to be made for a campaign if the average daily slicing is large, but the increase in the number of beets sliced is probably proportionately greater than the increase in the intercampaign man-hours, unless the campaign is shortened. As has been pointed out, intercampaign man-hours may be utilized for the handling of the sugar for shipping. The more of this that is done during the campaign the less there remains to be done during the intercampaign period and also the smaller is the number of hours needed for the work because, when done during the campaign, the extra handling for storage is eliminated. In 1934 and 1935 the carry-over from the year 1933, when the quotas were exceeded, probably increased the number of man-hours for handling the sugar for shipping and may

³² See table B-18 for the intercampaign, campaign, central-office, and total man-hours per ton of beets sliced for all reporting plants.

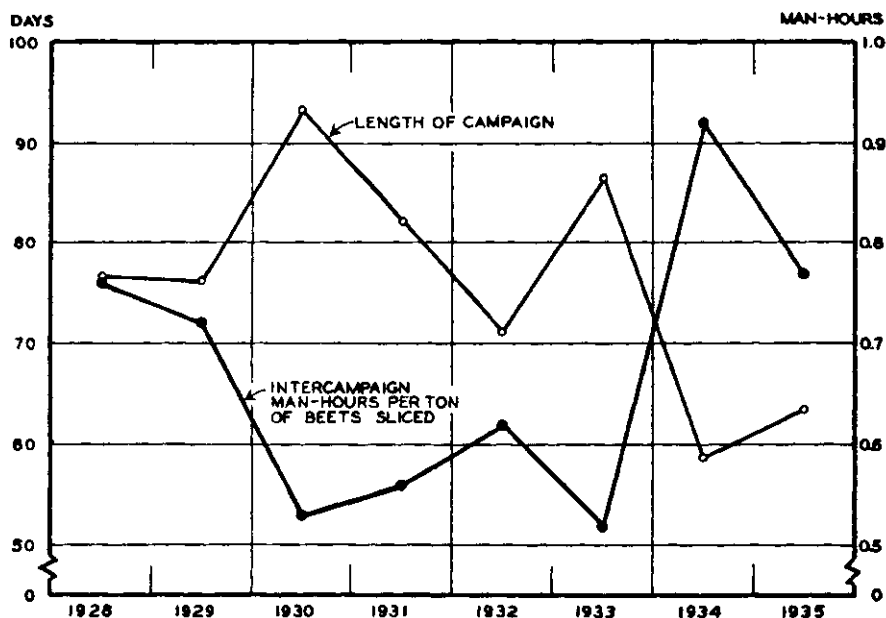
Table 21.- MAN-HOURS PER TON OF BEETS SLICED AND LENGTH OF CAMPAIGN, 27 IDENTICAL FACTORIES, 1928-35^a

| Year | Man-hours | | | | Average length of campaign (days) |
|------|-----------|-----------|-------------------|----------------|-----------------------------------|
| | Total | Campaign | | Inter-campaign | |
| | | Operating | Office | | |
| 1928 | 2.40 | 1.59 | 0.05 ^b | 0.76 | 76.8 |
| 1929 | 2.28 | 1.51 | .05 ^b | .72 | 76.4 |
| 1930 | 1.93 | 1.36 | .04 ^b | .53 | 93.4 |
| 1931 | 1.90 | 1.30 | .04 ^b | .56 | 82.2 |
| 1932 | 1.95 | 1.30 | .03 | .62 | 71.2 |
| 1933 | 1.78 | 1.23 | .03 | .52 | 86.4 |
| 1934 | 2.24 | 1.29 | .03 | .92 | 58.9 |
| 1935 | 2.08 | 1.28 | .03 | .77 | 63.4 |

^aCentral-office labor not included.

^bComputed from data for 25 plants.

Figure 23.- INTERCAMPAIGN MAN-HOURS PER TON OF BEETS SLICED AND LENGTH OF CAMPAIGN, 27 IDENTICAL FACTORIES 1928-35



Based on table 21

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help to explain the large man-hour ratio for intercampaign labor in 1934-35. It seems likely that if the length of the campaign year were held constant, a downward movement would be evident in the intercampaign man-hour ratio except during the years 1934-35. This is borne out by an examination of figure 23 and table 21.

The total labor requirements per ton of beets sliced for the campaign and intercampaign periods is the better measure of the efficiency with which the labor force is utilized than either one taken separately since a variation in one may be related to an inverse or a similar variation in the other. The addition of the intercampaign labor requirements may cause the total of the two series to fluctuate differently from the series for campaign labor requirements. During a year with a long campaign the addition of the intercampaign ratio will tend to decrease the ratio and during a year with a short campaign to increase it, as in 1934. On the average, intercampaign labor is about 50 percent of the campaign labor. The trend of labor requirements is much the same in the two series. If the 2 years 1928 and 1932, in which the length of the campaign was approximately the same, are compared, it will be found that both the campaign man-hour ratio and the intercampaign man-hour ratio decreased 18 percent. The cause of this decline appears to be a steady increase in the capacity of the beet-sugar factories which was accomplished without increasing the labor employed.

**Table 22.- CENTRAL-OFFICE MAN-HOURS PER TON OF BEETS SLICED
1927-35^a**

| Year | Man-hours |
|------|-----------|
| 1927 | 0.10 |
| 1928 | .10 |
| 1929 | .10 |
| 1930 | .08 |
| 1931 | .09 |
| 1932 | .10 |
| 1933 | .08 |
| 1934 | .13 |
| 1935 | .11 |

^a NRP-NBER field-survey data; from data for the central offices of 2 large companies.

Office Man-hour Ratios.- Plant-office man-hours during the campaign are shown in table 21; plant-office man-hours in the balance of the year are included in the intercampaign man-hours. The central-office man-hours which appear in table 22 are based on those of two large companies. During the years from 1927 to 1933 the trend, if there is one, is downward, the direction taken by the other ratios. In 1934 and 1935 the ratio is higher. The reason for a downward tendency is probably to be found in the increase in production which took place without any corresponding increase in office employees. When central-office man-hours are added to campaign plant-office man-hours they average about one-tenth of the campaign operating hours, adding on the average .14 man-hours to the total man-hours per ton of beets sliced.

Agricultural Man-hours per Ton of Beets Sliced

Mr. Macy's estimates of the man-hours required to plant, cultivate, harvest, and transport to the factory an acre of sugar beets were referred to in chapter II of this report in connection with the estimates of the total volume of employment expended in the agricultural part of the beet-sugar industry.³³ In table 23 these average man-hours of labor per acre are presented, together with the average yield per acre, in order to determine what changes have taken place in the labor cost of producing a ton of sugar beets between different periods of time from 1913 to 1936. These ratios showing the man-hours per ton of beets are

Table 23.- AGRICULTURAL MAN-HOURS PER TON OF SUGAR BEETS PRODUCED, 1913-36^a

| Period | Average hours per acre | Average yield per acre (tons) | Average hours per ton (1)÷(2) |
|---------|------------------------|-------------------------------|-------------------------------|
| | (1) | (2) | (3) |
| 1913-17 | 113 | 10.1 | 11.2 |
| 1920-24 | 112 | 9.8 | 11.4 |
| 1928-32 | 99 | 11.3 | 8.8 |
| 1934-36 | 94 | 10.8 | 8.7 |

^aLoring K. Macy and Others, *Changes in Technology and Labor Requirements in Crop Production: Sugar Beets* (Works Progress Administration, National Research Project, Report No. A-1, Aug. 1937), p. 37.

³³Macy and Others, *op. cit.*, pp. 27-39.

slightly smaller than they would have been if the man-hours required per ton of beets sliced in the factories had been used as the denominator because of the wastage and shrinkage which occurs before the beets are weighed for slicing.

The yield per acre has increased over the period and this, in turn, has reduced the number of man-hours per ton of beets. At the same time the average hours expended per acre in the cultivation, harvesting, and transporting of beets has been reduced. The combination of the two factors has brought about a reduction of over 20 percent in the agricultural man-hours required per ton of beets. In periods of low yield per acre, as in 1920-24, the labor requirements may rise temporarily, even with the decrease in the average hours per acre. This may be due either to various natural causes or to a shift in the proportion of production between areas with different yields per acre. It will be noticed that the average agricultural man-hours per ton of beets sliced are somewhat less than four times the total expended in the factories.

Changing Technology in Raising Sugar Beets.— A decrease in the man-hours required to produce a ton of sugar beets may result from a reduction in total man-hours required to produce an acre of beets, or from an increase in the number of tons of beets yielded per acre. Yields are greatly affected by weather and moisture conditions and the presence or absence of disease and insect pests. Annual fluctuations in the yields per acre in the three geographical regions in the United States vary widely because the agricultural conditions prevalent in one region may be entirely different from the conditions prevalent in the other two regions. There has been a slight upward trend for the United States throughout the period 1901-36.³⁴ In California, in recent years, there has been a decided increase in yields per acre. These increased yields for the country as a whole have resulted from (a) improved methods of cultivation, (b) the planting of more fertile lands to sugar beets in California, (c) crop rotation, (d) improvements in fertilizers and an increase in their use, (e) ridge planting, and (f) the development of sugar-beet seed with resistance to disease and insect pests.

Among the reasons for the reduction in the man-hours required to grow and harvest an acre of sugar beets has been the reduction

³⁴See table A-12.

in the number of cultivations and hand hoeings expended upon a beet crop. Since 1915 the mechanization of the growing of sugar beets has to some extent paralleled the mechanization of the raising of other agricultural crops. The tractor has been of paramount importance in this mechanization for it has been applied effectively to the power operations in beet production. The tractor is able not only to draw larger equipment than a two- or four-horse team can but also to move a given distance in less time.

Improved planting, cultivating, and plowing equipment have been designed to be drawn by improved tractor power. Mechanical blocking, introduced in some areas, requires fewer man-hours than blocking by hand.

In the hauling of the beets to the factory, trucks have been almost universally substituted for horses, with a great saving of labor. It should be pointed out in this connection that the use of the truck has made possible more distant hauls of beets; hence the area served by a given beet-sugar factory has been considerably enlarged, and the supply of beets increased. In some sections a machine for piling beets at the factory has been substituted for hand piling.³⁵

Aside from the role played by trucks in making it possible for an increased area of farm land to be served by a given beet-sugar factory, the improvements in the agricultural phases of the industry have not been particularly associated with the decreased labor requirements that have taken place in the processing plants. It should be pointed out, however, that the beets furnished the factory by the farm are not always of the same quality from year to year, as has been recognized in previous chapters of this report. It has been shown that labor requirements per bag of sugar produced, although in general varying with labor requirements per ton of beets sliced, vary inversely with sugar content. Factory managers stress to farmers the necessity of striving for increased sugar content and on a sliding scale pay more for beets of a higher sugar content. Average sugar content for the United States was high between 1909 and 1918, fell off until 1923, fluctuated erratically until 1930, and has been relatively high since that time, but the fluctuations in the three regions have varied widely about the fluctuations of the average sugar

³⁵Macy and Others, *op. cit.*, pp. 23-6.

content for the country as a whole.³⁶ The chief determinants of sugar content are (a) weather and other agricultural conditions; (b) careful blocking, thinning, and cultivation; and (c) selection of seed.

There is still room for further improvements in the growing and harvesting of beets with the consequent increasing efficiency of utilization of agricultural labor. The introduction of tractors, for example, has been much more extensive in some areas than in others. Many small independent farmers in Colorado and elsewhere still use horse-drawn equipment. The introduction of tractors has been most extensive in those areas where beet growing is carried on on a large scale, as, for example, in California, where many more acres are planted per grower than in the other States, and least extensive in the dairy States where the average per grower is low. Mechanical blocking is a relatively new innovation and has been introduced mainly in the States of Iowa and Minnesota, but even here only about 40 percent of the acres planted were cross-blocked in 1932. The use of mechanical blocking is limited in many areas where irrigation is carried on because of the ditches required for some types of irrigation. Mechanical harvesting machines are being perfected which, if adopted, will entail major reductions in the number of man-hours used per acre in harvesting the beets. Hand work at harvest time now consumes a quarter or more of all the man-hours used in producing beets.³⁷

Increased yields may be expected with future developments in irrigation practice, in the use of fertilizers, and in improved methods of cultivation. The development of disease- and insect-resistant varieties of beet seed has come about only within the last 4 or 5 years; their more extensive use and possibly further development are to be expected.

Man-hour Ratios for Fuel Consumed by Beet-Sugar Factories

The calculation of the man-hours embodied in the fuel consumed per ton of beets sliced in beet-sugar factories is based upon the computations used in chapter II³⁸ for estimating the total volume of employment required to produce fuel for the industry.

³⁶ See table A-12 for the average percentage sugar content of sugar beets in the United States, 1901 to 1935.

³⁷ Macy and Others, *op. cit.*, pp. 25, 37.

³⁸ See pp. 30-2 and table A-3.

The net tons of bituminous coal produced per man-hour in the United States since 1913 were obtained from Mr. Yaworski's study of labor productivity in coal mining.³⁹ The total number of tons of bituminous-coal equivalents required in beet-sugar plants were divided by the tons of coal produced per man-hour for each of the years in order to get a rough estimate of the total man-hours required in the production of bituminous-coal equivalents consumed by the industry. Total man-hours was then divided by the total quantities of beets sliced in the United States; the results are shown in table 24. Attention has been called in chapter II to the limitations of these data and the possibilities of error which are present in the methods used.

Table 24. - FUEL MAN-HOURS PER TON OF BEETS SLICED
1913-35^a

| Year | Man-hours | Year | Man-hours |
|------|-----------|------|-----------|
| 1913 | 0.36 | 1925 | 0.27 |
| 1914 | .34 | 1926 | .27 |
| 1915 | .33 | 1927 | .26 |
| 1916 | .33 | 1928 | .27 |
| 1917 | .33 | 1929 | .25 |
| 1918 | .32 | 1930 | .23 |
| 1919 | .31 | 1931 | .22 |
| 1920 | .30 | 1932 | .23 |
| 1921 | .28 | 1933 | .24 |
| 1922 | .28 | 1934 | .25 |
| 1923 | .27 | 1935 | .24 |
| 1924 | .26 | | |

^aTable A-3, col. (10). See fn. 40, p. 117.

The decrease in the man-hours utilized in the fuel industries per ton of beets sliced is the resultant of two factors: increasing fuel efficiency in the boilerhouse of the beet-sugar factory and increasing labor efficiency in the extraction of coal from the mines. With regard to the former, our data for the years 1927 through 1935 reveal that the average efficiency in utilization of fuel in the boilerhouse of the plants surveyed

³⁹The man-hours used as the basis for the series, net tons produced per man-hour, were based on established length of the working day and are therefore subject to error insofar as the established length of the work-day varied from the actual hours worked per day by the employees.

shows little change.⁴⁰ Data for individual plants, however, do reveal that more efficient fuel utilization has taken place in individual plants and that it is not unlikely that efficiency in the utilization of fuel has increased in the industry as a whole over a longer span of years.

Man-hours Embodied in Machinery and Equipment

In estimating the labor embodied in the production of the equipment used in beet-sugar factories, we may measure either the labor utilized in producing the equipment installed in each respective year or the labor required to produce or to replace the machinery "used up" in the factory operations of each year. The first method we shall designate as the "annual-expenditures" method; the second, as the "depreciation" or "time-cost allocation" method.

The annual-expenditures method is appropriate for estimating those current labor opportunities in the capital-goods industry which are attributable to the beet-sugar industry, because for that purpose we are concerned not with how much machinery labor has been required in the past to produce the current sugar output but rather with how much labor is required to produce equipment in the current year, even though this equipment may be utilized in the factory operations for many years to come. The annual expenditures for machinery and equipment in beet-sugar factories vary greatly from year to year because the replacements and additions necessary and financially feasible at any given time may be many or few. The result is a varying draft on the resources of the machinery-producing industry.

But at this point we are concerned with the measurement of changing efficiency rather than with current changes in labor opportunities in the machinery industry, and for this purpose the depreciation or time-cost allocation method is appropriate. We desire to estimate how much labor has been required, either in the past or currently, to produce the sugar output of the specified year.

In this effort we meet the usual difficulties of cost allocation, plus the problem of translating dollar costs into labor-time

⁴⁰ Because of lack of data the average amount of coal required per ton of beets sliced for the years 1927-35 was used for the years previous to 1927 in the calculations in table A-3. This probably underestimates the amount of fuel used during these years (see p. 30).

costs. In estimating such historical time-costs three possible procedures may be followed: (a) Conceivably we might ascertain the labor time embodied in each piece of equipment, its date of installation, and its probable useful life. Then by spreading the embodied labor over the useful life and summing these estimates we would get a total to be charged to the output of each year. We have not found it feasible to apply this method. (b) We may assume that a reasonable estimate of the value of the machinery and equipment needed annually to maintain the plant is furnished by the judgment of executives as reflected in the accounting records of annual charges for depreciation. (c) We may estimate the embodied labor item by calculating annual depreciation from the book record of gross investment in equipment and an estimate of the average useful life of equipment. Gross investment represents original cost less retirements. In table 25 we present two estimates, one based upon accounting records of depreciation charges and another based upon gross investment in equipment.

Table 25.- MACHINERY MAN-HOURS PER TON OF BEETS SLICED, 1917-35

| Year | Man-hours based on - | |
|-------------------|-----------------------------------|-------------------------------|
| | Depreciation charges ^a | Gross investment ^b |
| 1927 | 0.43 | 0.43 |
| 1928 | .47 | .51 |
| 1929 | .42 | .47 |
| 1930 | .36 | .41 |
| 1931 | .49 | .47 |
| 1932 | .62 | .50 |
| 1933 | .54 | .41 |
| 1934 | .65 | .78 |
| 1935 | .53 | .63 |
| Avg. (unweighted) | .50 | .51 |

^aTable B-19, col. (5).

^bTable B-20, col. (6).

Data for annual depreciation charges were available for 27 factories for the years 1927-35. The embodied labor represented by these annual depreciation charges was assumed to be equal to the dollar value multiplied by the current man-hours required in the machinery industry per dollar expended for machines in the

beet-sugar industry. This total of man-hours embodied in machinery was then divided by the total tonnage of beets sliced in the 27 plants for the years 1927-35 to obtain the man-hour ratio of labor embodied in machinery per ton of beets sliced. It should be noted that some beet-sugar companies make their annual depreciation charges proportionate to annual output; this is one of the causes of fluctuations in the annual depreciation charges.

The fluctuations of embodied man-hours resulting from year-to-year fluctuations in the annual depreciation charges are eliminated if the annual value of machinery required to maintain the 27 plants is computed by taking the gross investment in the plant equipment for each year multiplied by a fixed rate of depreciation. The rate selected for this purpose was based on 21.3 years as the average life of sugar machinery, which is considered typical of the industry. The conversion factor used for the purpose of estimating the embodied man-hours was the unweighted average of the annual figures of man-hours per dollar value of machinery for the years 1920 to and including the year in question.

The first of these two methods is the estimated labor that would be necessary to keep the equipment of the industry undepreciated. It is the amount of labor that would be required if the depreciation fund were reinvested each year in machinery and equipment. The second method is an attempt to measure the labor that has been embodied in the machinery in the past, allocating that labor over the years of the life of the machinery.

The two series representing the man-hours chargeable to machinery which is wearing out each year are presented in table 25. Both fluctuate, as would be expected, with the tons of beets sliced. It will be noticed that average man-hours chargeable to machinery over the period calculated by either of the two methods is approximately .50 man-hours, which is about 25 percent of the average total campaign and intercampaign factory man-hours per ton of beets sliced for the same period. This reflects the high degree of mechanization in the industry. Labor in machinery tends to be an increasing proportion as the factory man-hour ratio declines from 1928 to 1935.

Changing Unit Labor Requirements in Transporting and Distributing Sugar

Complete analysis of the changing man-hours per unit of output in the vertical structure of the beet-sugar industry as defined

in chapter I would require the presentation of unit labor requirements in the transportation and distribution of products. Unfortunately, the necessary data are not available. It should be noted in this connection, however, that the technological changes associated with changing labor requirements in the four vertical segments of the industry already presented have in no way been associated, so far as can be ascertained, with changes tending to increase or decrease unit labor requirements in the transportation and distribution of sugar.

Summary of Unit Labor Requirements in Vertical Segments of the Industry

In chapter II an attempt was made to estimate the total man-hours of labor expended in four vertical segments of the industry. These were presented in figures 5 together with the total tons of beets sliced each year. It was evident that while the tons of beets sliced showed an upward movement over the period, the man-hours of the various segments either showed downward movements or remained fairly stable. No attempt was made in that chapter to measure the labor requirements per ton of beets sliced for these segments of the integrated industry. In table 26 the estimated man-hours for the selected periods taken from table 8 in chapter II have been divided by the tons of beets sliced in the United States to obtain an average man-hour ratio for each period.

Table 26.- MAN-HOURS PER TON OF BEETS SLICED FOR THREE VERTICAL SEGMENTS OF THE BEET-SUGAR INDUSTRY, 1917-35^a

| Period | Total | Growing and transportation of beets | Processing | Fuel (for factories) |
|---------|-------|-------------------------------------|------------|----------------------|
| | (1) | (2) | (3) | (4) |
| 1917 | 18.88 | 13.36 | 5.19 | 0.33 |
| 1920-24 | 16.24 | 12.15 | 3.81 | .28 |
| 1928-32 | 11.51 | 9.03 | 2.24 | .24 |
| 1934-35 | 12.08 | 9.51 | 2.33 | .24 |

^aComputed from data in table A-5 and table A-1, col. (2).

The total man-hours per ton of beets sliced for these three segments of the industry must not be looked upon as in any way

an approximation of the total for the integrated industry. Estimates for the important segment of railroad transportation, for building and repair of structures, for equipment, as well as for many minor segments, are lacking. Data for the machinery segment are not included because the appropriate data, as given in table 26, cover only the years 1927-35. Likewise, the man-hour ratios for the factories do not include the central- or campaign-office hours, for the reason that they were available only for the years 1928-35. An estimate might have been made. The amount added would probably have increased the man-hour ratios for the processing plants by .14-.20 man-hours, or by 5 to 6 percent, and the total man-hours for the three segments by little more than 1 percent. The man-hour ratios do include, however, an estimate for the intercampaign man-hours for the years 1917-35 based on data for all reporting plants for the years 1928-35 and supplemented by census employment data for the earlier years. This estimate was attempted because of the fact that the campaign man-hours average about one-third or more of the total labor used in the plants and because of the fluctuating nature of this series of man-hours. It is evident that the parts of the industry for which data are available are characterized by a reduction in hours per unit of output and that over the period from 1917 to 1934-35 this reduction has amounted to about 36 percent. This reduction in labor requirements per unit of output has probably come about as a result of the competition with the cane-sugar industry which made necessary a reduction in costs if the beet-sugar producers were to continue to supply 20 percent of the American market as they had done in 1920. The growth which took place in the domestic beet-sugar industry was no doubt made possible, in part, by this reduction in costs.

It must not be inferred, however, that it was a reduction in labor costs alone which improved the competitive condition of the industry. It is necessary to examine the nature of the costs in the industry to determine the role which they have played in the changes which have taken place.

ANALYSIS OF COSTS

An analysis was made of the costs of production of groups of plants in the years 1922 and 1929 to see what additional light could be thrown on technological changes in the industry and

their effects upon employment.⁴¹ The outstanding characteristics of the cost of production of beet sugar are the relatively small importance of labor costs in the costs of production and the relatively great importance of the cost of beets. Labor was only 6 percent of the total costs including interest, while the cost of beets at the factory averaged 60 percent of total costs for the 2 years surveyed. This serves to corroborate what was pointed out in chapter III, that the cost of beets tends to be the limiting factor in the supply of beet sugar. Moreover, between the campaigns of 1922 and 1929 the cost of the beets, including transportation and receiving costs, increased from 55 percent of the total to 64 percent. The factory burden, in which depreciation is the major cost, was 8 percent of the total costs in 1922 and 7 percent in 1929; while interest charges, which included imputed interest on owners' equity, decreased from 14 percent in 1922 to 9 percent in 1929.⁴² Inasmuch as 1922 was a year in which production was abnormally low, while the year 1929 was a year in which production was more in line with the normal trend, it is difficult to compare the fixed charges for the 2 years. It is obvious that the fixed charges will tend to be relatively higher in a year of low production than in a year of normal production. The variable costs were approximately 90 percent of the total costs of production excluding interest in 1929. It is evident that unless the sales can be made to cover these costs with some margin, a factory will not be operated.

Because of the relatively large capital investment per plant, which amounted to 2 million dollars in 1929,⁴³ it might have seemed expedient to run the plants for a long campaign period in order to spread the capital costs over a larger output. This, however, has proved wasteful of the expensive raw materials. The alternative which the industry has adopted is to increase the output of the plants by speeding up the campaign, that is, by slicing more beets per day.

In order to determine the relationship between elements of cost and capacity the plants were classified into four groupings

⁴¹The analysis of the cost of producing beet sugar in the United States is based on data secured from the U. S. Tariff Commission. These data are for the campaign years 1922 and 1929. For the campaign year 1922, the 69 plants surveyed handled 89 percent of the beet-sugar crop. *Sugar: Report of the United States Tariff Commission to the President of the United States* (U. S. Tariff Com., 1928). 66 plants were surveyed by the Tariff Commission in the year 1929 with a production 50 percent greater than that of the 69 plants in 1922. See tables B-21 to B-24 for summarized cost data from the Tariff Commission.

⁴²See table B-21.

⁴³Estimate based on cost data furnished by the U. S. Tariff Commission.

with a daily slicing capacity of less than 1,100 tons of beets, 1,100 to 1,399 tons, 1,400 to 1,699 tons, and 1,700 tons and over respectively.⁴⁴ When costs were stated per 100-pound bag of sugar, the 12 plants in the largest-capacity group in 1929 had not only the lowest total costs of production but the lowest costs in almost every category of costs including interest and depreciation and labor; and the smallest-capacity group, including 13 plants, had the highest costs in 1929, except for raw materials. As for the other two capacity groups, there was no marked advantage of one over the other in respect to cost. When the size of the plants is compared for the 2 years 1922 and 1929, a decided shifting of plants from the lower-capacity groups into the higher-capacity groups is observed. In 1922, of 49 plants, 26 were in the smallest-capacity class, 13 in the next, 2 in the third, and 8 in the largest. For the same groups of plants these numbers changed to 13, 11, 13, and 12, respectively, in each of the four classes by 1929.

In order to determine the relationship between efficient utilization of labor and the unit cost of production, 30 identical plants were classified by capacity for the years 1922 and 1929 into two groups, those with a capacity of less than 1,250 tons and those with a capacity of 1,250 tons or more, and then were subclassified according to whether their campaign labor-requirement ratios per ton of beets sliced were below 2.00 man-hours per ton of beets sliced or were 2.00 man-hours or more in 1922 and according to whether these ratios were below 1.70 or were 1.70 or more in 1929.⁴⁵ It was found that in 1929 labor costs per 100-pound bag of sugar were least in the large plants with low labor requirements and next in the small plants with low labor requirements. In 1922 these two efficient groups also show the lowest labor costs. Manufacturing costs including labor, repairs, maintenance, supplies, and materials other than raw materials were least in each year in these same two groups of plants. Interest, depreciation, and administration costs tended to be smallest in the large plants, with the exception of the large inefficient plants in 1929 (with labor-requirement ratios 1.70 and above), which had higher costs for interest and depreciation than the small efficient plants. From this it would seem that while size is an important factor in lowering costs, labor productivity is even more im-

⁴⁴See table B-22.

⁴⁵See table B-23.

portant. Efficient use of labor is an accompaniment of efficient use of plant facilities and equipment.

When plants are divided into two geographical groups, the eastern and the western, it is found that the eastern group has higher total costs per 100-pound bag of sugar than the western group and pays more per 100-pound bag of sugar for its labor, for its beets, and also for taxes.⁴⁶ This must not be interpreted to mean that rates of wages are necessarily higher; in fact they might even be lower considering the fact that labor requirements per unit of output are higher in the eastern plants. Likewise it may not reflect accurately the relative prices per ton paid to the farmers for beets or the relative tax rates in the two areas. These higher costs per unit of output are one reason why so many plants in the eastern group found it impossible to keep open during the years 1925-30.

These facts in regard to costs would seem to indicate (a) that relatively large capacity and daily slicing is an important element in reduction of costs, (b) that there is a trend toward larger capacity on the part of all plants, as has been noted earlier, and (c) that the increase in capacity is, in a large part, the result of more-efficient use of machinery and equipment rather than extensive installations of new equipment, since the charges for depreciation and interest per 100-pound bag of sugar tend to decrease as capacity increases. As has been pointed out in a previous section, this has probably come about through a speeding up of the processes by eliminating "bottle necks" in the flow of materials and also by using electrical control mechanisms in place of human control. The lower labor costs associated with the increased capacity are doubtless the accompaniment of these changes which result in more production for the same amount of labor and, therefore, in lower labor-requirement ratios. Thus, increased operating capacity tends to be brought about by more-efficient use of equipment, materials, and labor.

When we turn to a consideration of the relation between the trend in production of beet sugar and the trend in unit costs, the necessary information for the correlation between these two variables is not available, but from the facts at hand certain conclusions may be drawn. As was brought out in chapter III, the cost of production of beet sugar is higher than that of Cuban cane sugar so that even with the tariff against her Cuba

⁴⁶See table B-24.

was able to supply from 40 to 50 percent or more of the market during most of the years from 1900 to 1930. The revolutionary changes in the technology of production which mechanized the processing of sugar beets took place, as was pointed out in an earlier section of this chapter, during the period from 1900 to 1913. Coincident with these changes in technology, production of beet sugar increased ninefold, beets sliced increased sevenfold, and average employment in the factories, fourfold. At the same time beet-sugar processors increased their percentage of the American sugar market from less than 8 percent to more than 16 percent. It seems evident from these facts that the improvement which took place in technology was accompanied by a very significant reduction in the factory-man-hour ratio and a reduction in the cost of beets, as well as other costs, per unit of output in the individual factories. That this took place during a period of relatively stable prices of both sugar and sugar beets does not alter the presumption of reduced costs. The effect of lowering costs in the protected part of an industry, such as the sugar industry, where a large proportion of the product is produced outside of the protected areas, will be seen in an increase in the proportion of the market supplied by the protected areas rather than in a lowering of price. It is probable then that the reduction in costs per unit of output was an important factor in enabling a larger proportion of the American market to be supplied by beet sugar than would have been possible without these changes. The result of this, as has been mentioned in chapter III, was to bring into the industry an increasing number of workers during this period, both for work in the beet fields and in the factories.

The expansion of the industry continued with some interruption until 1921, when beet sugar was supplying 23 percent of the American market, but it seems likely that the great increase in prices of sugar and certain changes in demand coincident with war and post-war disturbances were the important factors at this time in bringing about an increased quantity of production and an increase in the proportion of the market supplied by beet sugar.

From 1923 to 1930 the price of sugar fell, while beet prices and other farm prices remained relatively stable. This is reflected in the change in the percentage cost of beets per 100 pounds of sugar, which increased from 55 percent to 64 percent of the total costs between the years 1923 and 1930, as shown in

table B-21. During this period Cuban cane sugar was supplying from 47 to 58 percent of the market while beet sugar fell to as low as 14.7 percent in 2 years and fluctuated between that and 18.7 percent the rest of the time. The cost figures discussed above and the facts disclosed by the NRP-NBER field survey seem to indicate that the attention given to increasing the efficient organization of the factories and the resulting decrease in costs enabled a larger proportion of the industry to maintain production than would otherwise have been possible under these conditions of severe competition, while the relatively high cost of beets was an important factor in the much slower rate of increase of production in these years.

After 1930 the price of beets fell relatively more than the price of refined sugar and less than the prices of other farm products. As pointed out elsewhere, these changes, favorable to an increased production, were accompanied by an increase in the duty on Cuban sugar. An increase in production of beet sugar followed so that by 1933 the industry was again supplying 22 percent of the market.

The limiting factor determining the amount of the production and employment in the beet-sugar industry seems to have been generally the relative cost of sugar beets, but under conditions of relatively stable prices the factor of technology has probably been important in lowering costs and therefore in increasing production or in preventing declining production. Moreover, this factor in costs is important in determining which beet-sugar producers will be able to stay in the market. For example, the relatively greater increases in production in California since 1932 and in the western area during the period from 1918 to 1932 were probably due to reduction in costs brought about by improved technology, increased capacity, and more-efficient organization in the factories and in the production of beets.

Since production of beet sugar under the quota system has fallen far short of the allotment each year, it is possible that the ability to reduce costs may still determine to a large extent whether the beet-sugar processors in this country will be able to fill their quota of 23 percent of the consumption demand.

PROPORTIONING THE FACTORS OF PRODUCTION

The question naturally arises as to whether the proportions of the different factors of production are changing, that is,

whether more or less labor or more or less machinery is being used. Is there any evidence that more machinery in proportion to the labor or more machinery in proportion to the output is being used? It is well to recognize at this point the difficulties in the way of any satisfactory answer to either of these questions. Although we have physical units in which we can measure both labor and output, there are no satisfactory physical units in which we can measure machinery. Moreover, even if we assume that the prices of machinery have not changed over the period and therefore that the dollar value is a satisfactory measure of the quantity of machinery, how are we to add together machinery in different stages of depreciation? This attempt to find physical units in which to measure these factors assumes an engineering conception of the idea of proportioning the factors of production and is primarily concerned with determining any change in the degree of mechanization. There is, of course, the business idea of proportioning the factors, which would concern itself with the relative dollar costs of labor and machinery. But the 2 years for which cost data are available are years that are not comparable because one is a year of relatively low and the other of relatively high output. This of itself would affect the relation between variable and fixed costs. These difficulties which have rendered the results of our investigation of the proportioning of the factors of production rather inconclusive should be kept in mind in the following discussion.

It is difficult to find 2 or more years which can be used for the purpose of determining whether the proportion of machinery to output is changing, since the machinery per unit of output is a function of output and fluctuates inversely with the changing production. Year-to-year changes in production, as we have seen, have been very marked since 1919. For the purpose of this comparison 2 years of high output have been chosen. It is well known that the beet-sugar companies are accustomed to preparing the machinery and equipment in advance of the year's campaign. This must be done on the expectation of a given tonnage of beets; this expectation is based on their contracts with the sugar-beet growers in regard to acreage and their experience in regard to previous yields per acre. It was assumed that the years in which the proportioning of machinery and labor would correspond most closely to their planning would be those of high production since any additional equipment or machinery installed in those years

would be in view of such expectations.⁴⁷ The years chosen were 1927 and 1933. Two methods were used for computing the value of machinery and equipment - the gross value of machinery and equipment and the net value of machinery and equipment after depreciation. While the two methods give, as might be expected, different absolute values, they both give evidence of the fact that the value of machinery and equipment per ton of beets sliced decreased from 1927 to 1933.

Between 1927 and 1933 the net value of the machinery⁴⁸ per ton of beets sliced in the 27 plants for which data were available decreased from \$6.99 to \$4.42, but this decrease might have been expected for factories whose annual depreciation on machinery and equipment was greater than the annual expenditures for it. The gross value of the machinery per ton of beets sliced, however, also decreased, falling from \$9.91 to \$9.33. Thus, despite an expenditure of 823 thousand dollars for machinery and equipment in 1933, which was a marked increase over any previous year since 1925, the unit output per dollar of gross investment was more in 1933 than in 1927.

When we turn to a consideration of the changes in the proportioning of the factors of capital equipment and labor, we find, as might be expected from the previous discussion, that the gross value of the investment in machinery and equipment per man-hour of labor increased between the years 1927 and 1933. The average increase was from \$6.16 to \$7.47 for the 27 plants for which data were available. Also a comparison of the man-hours of labor per ton of beets sliced embodied in machinery (table 25) with the man-hours of factory labor per ton of beets sliced (table 21) reveals an increasing proportion of man-hours embodied in machinery to those used in the factory during this same period.

These shifts in the proportioning of the factors of production to less machinery per unit of output and less labor in proportion to the machinery have come about in large part through a better organization of the facilities of production resulting in a better flow of materials through the plants and thus a more efficient use of both machinery and labor, coupled, to be sure, with some displacement of labor by labor-saving devices. Hence, if we

⁴⁷In a year of small yield following these years, the total equipment might well be larger than would have been available if installation were dependent on the judgment of the executives with respect only to the needs for such a year.

⁴⁸This is the net value as determined by the accounting practices of the beet-sugar companies, using their deductions for depreciation.

speak of the factors of production as management, labor, and capital, it seems evident that the efforts of management have resulted in more-efficient use of the other two factors of production so that, with no change in investment in machinery and equipment and with no additional utilization of labor, it has been possible to increase the output or to increase the output more than the proportional increase in the labor and machinery.

SUMMARY

During the 20 years covered by our survey the beet-sugar industry in this country has steadily improved its equipment, the daily capacity of its factories, the functioning of the factory organization, the flow of beets to the factories, the quality and sugar content of the beets, the yield of beets per acre, and the mechanical equipment used by the farmer. All of this has resulted in a steady decrease in the man-hours per ton of beets sliced and per 100-pound bag of sugar produced.

Increased average yearly production in the factory and increased acreage and sugar content of the beets has resulted in a decrease in the man-hours per unit of output. Instances of the introduction of machinery which has displaced labor have been reported, but even here probably the primary purpose of the installation was to improve the flow of materials, or to improve the product, or to increase production.

That all parts of the industry have taken part in this improvement has been evident. While regional shifts, such as an increase in the relative importance of the western area, have been a factor in the reduction of man-hour requirements both in the raising of beets and in the processing, the improvement in all agricultural areas and in all plants has been characteristic of the industry. In the factory, low man-hour ratios are associated with low manufacturing costs and with efficient use of capital equipment or low costs for capital.

The years 1933 to 1935 are an exception to the general declining movement in the man-hour ratios. That the drought must have been an important factor in bringing this about seems evident, but the unusual conditions existing make it impossible to evaluate the effects of other factors, such as the quota system and the change to 8-hour shifts for the campaign labor, during this period. Whether a change has taken place in the downward movement

of the man-hour ratios or whether these higher average ratios are due to unusual weather conditions it is impossible to say with the data at hand. The question of the effects of the changes in the unit labor requirements upon the displacement and reabsorption of labor will receive more attention in the next chapter.

CHAPTER V

ABSORPTION AND DISPLACEMENT OF LABOR IN THE BEET-SUGAR INDUSTRY

That employment in the beet-sugar industry was expanding up to 1920 after which there were evidences of declining tendencies, interrupted by rather marked year-to-year fluctuations, has been made clear in earlier chapters, together with the economic causes related to these changes in employment. Also, much attention has been given to measuring changes in the efficiency of the utilization of labor which are related to changes in employment. In this chapter, attention will be centered more directly on the main purpose of this study, which was to analyze and measure where possible the tendencies toward displacement and absorption of labor in the industry with special reference to present conditions.

EFFECT OF MACHINERY INSTALLATIONS

In the discussions in the previous chapters attention has been called to the fact that the man-hour ratio declined as a result of the installation of labor-saving machinery on the one hand and the more efficient use of labor and machinery on the other. As a measure or indication of the effects on employment of specific installations of machinery the effect of the introduction during 1922-35 of 155 units of equipment in 26 factories has been studied. (See table B-25.) This study revealed that of the 155 units installed in 26 plants, 60, or 39 percent, of them displaced labor; 30, or 19 percent, added men; and 65, or 42 percent, brought no change in employment. Of the 198 men affected (net) per shift by these installations, 34, or 17 percent, were added and 164, or 83 percent, were displaced.

Further analysis shows that of the 164 men who were displaced, 49, or 30 percent, were employed on unskilled hand labor, and 115, or 70 percent, were skilled or semiskilled machine operators. Fifty, or 83 percent, of the total of 60 units installed in which the consequence was a displacement of labor affected skilled operators, while 10 units, or 17 percent, affected unskilled or hand labor. It may be inferred that in consequence of capital expenditures for equipment used in the production processes, a

displacement of skilled, and to a lesser extent of unskilled, labor has occurred in the factory.

The total sales value of the 155 machines was \$634,567, representing approximately 591 thousand man-hours of embodied labor, an average of 42,000 man-hours per year or approximately 18 man-years of labor. In the factories 164 men per shift were displaced during this period and 34 men per shift added. Since the number of men is given per shift, it means that from two to three times as many men were displaced or added as stated in table B-25. Before 1933 when most of the factories ran two shifts of 12 hours each, two men were displaced for every job eliminated by a machine, while since then with three 8-hour shifts three men have been displaced for every job eliminated.

It will be noticed that the installation of some of these machines was associated with an addition to the labor force. This addition may or may not have been accompanied by an increase in the total campaign man-hours of employment in these factories. It is probable that the purpose of the installation of the machinery was to increase the daily slicing capacity; in this case the length of the campaign would be shortened as a consequence of the installation unless there was also an increased production. Since increased daily slicing capacity in the industry tends to be associated with a shortening of the campaign, it is likely that these apparent additions to the employment of labor in reality resulted in reductions in the total annual man-hours utilized.

While the immediate and obvious effect of the installation of machinery seems to be to displace labor, such a conclusion may not be warranted when all facts are considered. If the installation of machinery reduces costs of production and as a result of this decrease in costs makes possible a large production, it can be said to be a factor of reabsorption rather than displacement. Any factor tending to increase production even though employees are displaced in the plants brings about at the same time an increase in employment in the beet fields due to the greater demand for beets. In the history of the beet-sugar industry it is probable that the great advance in technology which has taken place since 1890 has been an important factor tending toward absorption of labor during the period from 1890 to 1913 and helping to prevent displacement since 1920.

**CHANGES IN UTILIZATION OF LABOR ASSOCIATED WITH CHANGES
IN PRODUCTION AND PRODUCTIVITY**

It is evident that during the history of the beet-sugar industry in this country the man-hours required to produce a 100-pound bag of sugar or to produce the sugar from a ton of beets has been steadily decreasing. The field study has made possible a measurement of the year-to-year changes in labor requirements from 1917 to 1935. During this period the labor requirements for 31 identical plants decreased from 2.78 man-hours per ton of beets sliced to 1.35 man-hours per ton of beets sliced. As has been seen, the reduction in unit labor requirements comes about, in part, through the installation of machinery which requires additional man-hours for its production. In analyzing the changes in the use of labor related to technological change there should be considered not only changes in the man-hours of labor in the plants due to changes in production and to changes in productivity, that is, in the unit labor requirements, but also changes in labor utilized in the machinery industry due to an increase or a decrease in expenditures for machinery and equipment.

Table B-26 presents the changes in the use of labor associated with these three types of change for the 31 identical plants for the years 1917-35. In 12 of the 18 years from 1917 to 1935 there was an increase in production over the previous year and hence a tendency toward increased total labor requirements, but in all of these 12 years except 1932 there was a decrease in the unit labor requirements. The net result, however, not including changes in employment embodied in machinery, was an increase in total labor requirements in 9 out of the 12 years of increased production and a decrease in 3 of these years. In 3 of the 6 years in which production declined there was an increase in the man-hour ratio, but only in 1918 was the increase in the man-hour ratio sufficient to compensate for the decreased production. Hence, in 10 out of 18 years the absorption of labor more than balanced the displacement in these 31 plants, and in 8 years more labor was displaced than reabsorbed.

The year-to-year changes in the labor requirements per ton of beets sliced are becoming smaller, both absolutely and relatively; the largest reduction was in 1921 when the change was $-.51$ man-hours; in 1926 it was $-.30$; and in 1930 and 1933 it was $-.15$.

This may indicate that in the future an absorption of labor due to increased production is not likely to be offset by displacement due to a decrease in the man-hour ratio. The 3 years in which increased production was accompanied by a net displacement of labor were 1919, 1921, and 1926, when the changes in the unit labor-requirement ratios were $-.35$, $-.51$, and $-.30$ respectively. These were also years immediately following or accompanying large investments in machinery and equipment. When year-to-year changes in the man-hours required to manufacture the machinery are added, there is little change in direction. In 10 of the 18 years there was a net increase in the use of labor, but over the period there has been an average yearly net decrease of 250 thousand man-hours per year in the beet-sugar factories and the machinery industry. This is equivalent to 4.2 percent of the average employment of campaign labor in the plants. Approximately one-third of this, however, is labor displaced in the machinery industry largely because of the very great investments in machinery and equipment in the early years of this period. The net displacement in the plants averages, therefore, about 2.7 percent of the average campaign employment in the plants. Attention should be called to the fact that the labor here considered in the beet-sugar factories is only campaign labor. It is not likely that the inclusion of intercampaign and office labor, however, would materially alter the conclusion.

The years covered by this survey have been years in which the demand for labor was far from stable. The larger fluctuations in the demand for labor are caused primarily by fluctuations in production rather than by changes in the man-hour ratio. The large decreases in the man-hour ratio have come in years of increasing production, with the result that the increased production offset wholly or in part the tendency toward displacement of labor due to increased productivity.

The year-to-year net changes in utilization of labor have been relatively large. In 1934, the year when beet-sugar crops were seriously affected by the drought, there were 35 percent fewer campaign man-hours utilized in the 31 plants than in 1933, and in 1928, 18 percent less than in 1927; in 1923 there was an increase of 21 percent over 1922; but in 1922 there was a decrease of 28 percent over 1921.

During the period of rapid growth of the industry up to 1920 it is evident that the factories and sugar-beet farms were absorbing more and more labor even though there were years in which there was net displacement due to temporarily lessened production. After this period of growth, however, the displacement of labor in terms of man-hours of employment tended to be greater than the absorption. In the 31 plants the increase in the demand for labor, due to a 28-percent increase in production between 1920 and 1933, was insufficient to offset the displacement due to the decrease in the man-hour ratio.

Even in the beet fields the absorption of labor due to an increase in production has been offset by improvements in the method of growing sugar beets and by increased mechanization. It is likely that further improvement will take place in the culture of beets and in the mechanization of farming, since experimentation is going on in the raising of beets and since the use of tractors and trucks in the place of horse-drawn implements and wagons has not been generally adopted in all areas. The mechanization of the processes of blocking, hoeing, and topping the beets will probably depend upon the cost and continued availability of the transient labor. If the labor provisions of the Sugar Act are made effective, which provide that benefit payments to the farmers are conditional on the farmers paying fair and reasonable wages to their laborers and also on their eliminating child labor, then the cost of labor is likely to rise, and there will be a decided stimulus toward mechanization of these operations. Harvesting and blocking machines, already perfected, may then displace some of this hand labor.

SEASONALITY AND INCOME

It is pertinent to note that even if there were no fluctuations in employment such as those we have just ascribed to fluctuations in the net effects of changes in the total volume of production and in efficiency, there would still remain the serious problems arising from the seasonal nature of the industry. Transient labor in the beet fields has come about as a result of the seasonality of the work and the fact that it was a type of work not attractive to the average farm worker. Incomes from this seasonal

work are not sufficient for a year's living, and yet other opportunities for work are often lacking.¹ Likewise in the beet-sugar factories the problem of seasonality is present. From 3 to 4 thousand workers have employment in the plants throughout the year; the remainder, 22 thousand, more or less, have employment for a period averaging about 70 days, or 560 hours of employment, bringing in an average income of about \$225. Obviously the income from this employment can only be considered as supplementary to other income.

FUTURE EMPLOYMENT IN THE INDUSTRY

The question naturally arises of the future prospects for employment in the beet-sugar industry. Under the new Sugar Act which the President signed in September 1937 the then-existing quota system has been extended until 1940. Since beyond that date the guideposts for any estimate of future production in the industry disappear, the campaign year 1939-40 has been chosen as a year for which an estimate might be made. It is assumed that by that year the beet-sugar industry may be able to fill the quota of 1,487 thousand tons of sugar (1,591 thousand tons, raw value) set by the Secretary of Agriculture for the calendar year 1938 (production of the 1937-38 campaign).² This seems possible since this amount was exceeded in the year 1933-34, but in no other year has production been above 1,357 thousand tons.

In the 1935-36 campaign year, the last year which the field study covers, there were 7,745 thousand tons of beets sliced and 1,186 thousand tons of sugar produced with an expenditure of 11.8 million campaign man-hours by 25 thousand men working on the average 59 campaign days. These figures on employment, which are exclusive of intercampaign and office labor, are estimated on the assumption that the average rate of 1.52 man-hours per ton of beets sliced, which is the weighted average for the plants in the field study, is a reasonable estimate for the average for the United States and on the basis of the average length of campaign for the plants in the sample.

¹W. Lewis Abbott, *Report for the Committee on Labor Conditions in the Growing of Sugar Beets* (Washington, D. C.: mimeo., Mar. 1934).

²*Sugar Consumption Requirements and Quotas for the Calendar Year 1938* (U. S. Dept. Agr., Agricultural Adjustment Administration, General Sugar Quota Regulations, Series 5, No. 1, Dec. 20, 1937).

In order to produce 1,487 thousand tons of sugar it will be necessary to slice approximately 9,700 thousand tons of beets. If the same rate of improvement persists in the man-hour ratio that has been evident during the 4 years preceding 1935, as shown by the chained aggregative index, then the man-hour ratio will decrease approximately 6 percent to 1.43 man-hours per ton of beets sliced. In this event it would require 13.9 million man-hours to produce the sugar. If an average campaign of 70 days and an 8-hour campaign shift, or 560 hours per campaign per man, were assumed, the production of the sugar would furnish campaign jobs for 25 thousand men in the plants. The number of men would remain approximately the same as for the 1935-36 campaign since we have assumed that with the larger production the campaign will be lengthened, but a better measure of employment is the number of man-hours of work. This would increase about 18 percent.

If, however, the average rate of decrease in the man-hour ratio since 1926 were assumed, then the campaign man-hour ratio for 1939-40 would be 1.27; this assumes a rate of decrease of 4.4 percent per year. This longer period is chosen to lessen the influence upon the average of the unusual years of 1934 and 1935. If this man-hour ratio were used, the number of man-hours needed for the campaign in 1939-40 would be approximately 12.3 million, or an increase of only 4 percent over 1935.

Even though an increased total consumption of sugar might warrant an increased beet-sugar quota, there seems little reason to expect any great increase in production over the 1937-38 quota since improved agricultural conditions bring into action the factor of the competition of other crops and general economic improvement may lessen the supply of labor available in the beet fields by raising its price, but, on the other hand, the law imposing quota restrictions on refined sugar from the islands may tend to bring up the price of sugar in the United States and hence encourage its production and the production of sugar beets. The advantage given to the beet-sugar industry in this country may encourage many companies to fill their quotas, but it is questionable whether it will have the effect of lowering the man-hour ratio at the former rate of decline. If it encourages production in the East, the effect will be to retard the other tendencies toward lowering the ratio; but if it encourages production in California, it will have the opposite effect, tending to lower

the ratio faster. During the period over which the quota restrictions have been extended, the prospects seem hopeful for a fairly stable demand for labor both in the factories and in the beet fields, at least in the western areas where there is less competition for the use of the land and labor. This would tend to bring about a fairly stable employment in the other segments of the integrated industry. Since the present capital equipment in the plants affords sufficient facilities for the production of the quota allocated to beet sugar and since the industry seems to depend on minor changes in equipment to increase its slicing capacity, there seems little likelihood of any creation of increased employment in the machine industries as a result of increased demand in the beet-sugar industry.

GOVERNMENT POLICY

The government policy in regard to the beet-sugar industry seems to be the crux of the matter when it comes to any consideration of the future of the industry. Experience under the quota system is too brief to warrant any conclusions as to its effect upon employment, especially since 2 of the years were years of severe drought. If the quotas apportioned to domestic beet-sugar processors are increased from year to year in a correct proportion to the increasing demand for sugar, it is possible that the industry may enjoy a fair degree of stability in regard to its demand for labor. The absorption due to increases in production may be offset by displacement due to decreases in unit man-hour requirements. Under these conditions expansion of the industry will probably continue through the increase of size of plants already built and the building of new plants to take care of new areas of production of sugar beets. The first will probably be brought about with little if any increase in the demand for labor, while new plants will create demand for labor in new areas.

What effect the quota system will have upon the continuance of the decrease in the man-hour ratio it is impossible to say. That there is still room for improvement is evident from the variations which exist between plants and between areas, but it is probable that continued improvement will be at a slower pace. In the past the decreasing cost of sugar beets and of their processing were important factors leading to an increased production of beet sugar in competition with cane sugar. Under the quota system there will continue to be a limited adjustment

of production in the beet-sugar areas on the basis of marginal costs, but only within the upper limit of the quota and therefore only provided that the price established by the total of all quotas is below that necessary to bring about the production of the beet-sugar quota. By the provisions of the Sugar Act of 1937 the Secretary of Agriculture is empowered to determine the amount of sugar needed to meet the requirements of the consumers in the United States and on this basis to make allocations to the different producing areas. This determination of the amount of sugar, together with the individual quotas in effect, determines the price on the American market. It is this price of sugar, set indirectly by the Secretary of Agriculture, which is the important factor in determining whether the beet-sugar areas will fill their quota. If the price of sugar as established by the quota is held below that necessary to induce the less-efficient processors or those with higher costs to fill their quotas, as seems to have been the case during the past 3 years, the production of sugar will pass to the processors with the lower costs. Since lower costs tend to be associated with lower man-hour ratios, the employment in the industry will not increase proportionally with increased production, but a relative stability may be attained if the quota permits the gradual increase of production.

Benefit payments to the growers of sugar beets may have the effect of inducing the sugar-beet farmers to plant a larger acreage of beets, but at the same time similar encouragement is being given by the Government to other farm crops. So the farmers must decide between the various inducements offered. Thus it is that the Government, by means of benefit payments to growers of sugar beets and other basic farm crops, by its soil-conservation and crop-control programs designed to affect the prices of farm products and the incomes of farmers, by its regulation of labor conditions in the beet fields, and by its establishment of quotas for sugar and, indirectly, of the price of sugar controls to a very large extent the conditions of supply in the industry.

So the increase which takes place in the production of beet sugar will be, in a large part, the planned increase which represents the judgment of government officials and legislators as to the demand for sugar and the amounts to be allocated to the beet-sugar industry. The stability of employment in the

industry will be dependent upon government policies and the judgment with which government officials carry them out. This means not that a quota allotted will necessarily be produced but that the Government will determine from year to year certain conditions, and within these the beet-sugar processors and farmers will make their decisions in regard to the amounts to be produced.

APPENDIXES

Except as credited to another source, all data presented in the appendixes are based on the first and second surveys mentioned in the "Introduction." Where necessary in order to distinguish these surveys from other sources they have been cited as the NRP-NBER field survey.

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Table A-1.- ACREAGE AND PRODUCTION IN THE BEET-SUGAR INDUSTRY, 1899-1936^a

| Year ^b | Acres harvested (thousands) | Beets sliced (thousands of short tons) | Beets sliced per acre harvested (short tons) (2)÷(1) | Beet sugar produced, chiefly refined (thousands of short tons) |
|-------------------|-----------------------------|--|--|--|
| | (1) | (2) | (3) | (4) |
| 1899 | 135 | 795 | 5.89 | 82 |
| 1900 | n.a. | n.a. | n.a. | 85 |
| 1901 | 175 | 1,686 | 9.63 | 185 |
| 1902 | 216 | 1,896 | 8.78 | 218 |
| 1903 | 243 | 2,076 | 8.54 | 241 |
| 1904 | 198 | 2,072 | 10.46 | 242 |
| 1905 | 307 | 2,666 | 8.68 | 313 |
| 1906 | 376 | 4,236 | 11.27 | 484 |
| 1907 | 371 | 3,768 | 10.16 | 464 |
| 1908 | 365 | 3,415 | 9.36 | 426 |
| 1909 | 420 | 4,081 | 9.72 | 512 |
| 1910 | 398 | 4,047 | 10.17 | 510 |
| 1911 | 474 | 5,062 | 10.68 | 600 |
| 1912 | 555 | 5,224 | 9.41 | 693 |
| 1913 ^c | 580 | 5,659 | 9.76 | 733 |
| 1914 ^c | 483 | 5,288 | 10.95 | 722 |
| 1915 ^c | 611 | 6,150 | 10.07 | 874 |
| 1916 ^c | 665 | 5,920 | 8.90 | 821 |
| 1917 ^c | 665 | 5,626 | 8.46 | 765 |
| 1918 ^c | 594 | 5,578 | 9.39 | 761 |
| 1919 ^c | 692 | 5,888 | 8.51 | 726 |
| 1920 ^c | 872 | 7,991 | 9.16 | 1,089 |
| 1921 ^c | 815 | 7,414 | 9.10 | 1,020 |
| 1922 ^c | 530 | 4,963 | 9.36 | 676 |
| 1923 ^c | 657 | 6,586 | 10.02 | 861 |
| 1924 | 816 | 7,075 | 8.67 | 1,090 |
| 1925 | 648 | 6,993 | 10.79 | 913 |
| 1926 | 677 | 6,782 | 10.02 | 897 |
| 1927 | 721 | 7,443 | 10.32 | 1,093 |
| 1928 | 644 | 6,880 | 10.68 | 1,061 |
| 1929 | 688 | 7,117 | 10.34 | 1,018 |
| 1930 | 776 | 8,789 | 11.33 | 1,208 |
| 1931 | 713 | 7,659 | 10.74 | 1,156 |
| 1932 | 764 | 8,856 | 11.59 | 1,357 |
| 1933 | 983 | 10,778 | 10.96 | 1,642 |
| 1934 | 770 | 7,391 | 9.60 | 1,160 |
| 1935 | 763 | 7,745 ^d | 10.15 | 1,185 |
| 1936 | 776 | n.a. | n.a. | 1,304 |

^aData for: 1899 acreage harvested and beets sliced from Yearbook of the United States Department of Agriculture, 1900 (U. S. Dept. Agr., 1901), p. 751; 1899 and 1900 sugar produced from same for 1903 (1904), pp. 653-4; 1901-11 from same for 1912 (1913), p. 651; 1912-32 from Yearbook of Agriculture, 1934 (U. S. Dept. Agr., 1934), p. 471; 1933-34 from Agricultural Statistics, 1936 (U. S. Dept. Agr., 1936), p. 91; 1935-36 from Crops and Markets, 14, No. 19 (Dec. 1937), 259 and 279.

^bYears given here are campaign years; production usually runs into the next year.

^cMost years from 1913 to 1923 include a small unknown quantity of beets grown in Canada for Michigan factories.

^dCensus of Manufactures: 1935 (U. S. Dept. Com., Bur. Census, 1938), p. 218.

n.a.—Data not available.

Table A-2.- MONTHLY EMPLOYMENT IN THE BEET-SUGAR INDUSTRY, 1903-35^a

| Month | 1903 | 1908 | 1913 | 1918 | 1920 | 1922 | 1924 | 1926 | 1928 | 1931 | 1933 | 1935 |
|-----------|--------|--------|--------|--------|--------|--------|--------|-------|--------|--------|--------|--------|
| January | 2,949 | 6,465 | 6,593 | 11,627 | 13,645 | 3,062 | 5,303 | n.a. | 3,591 | 2,985 | 4,757 | 4,673 |
| February | 902 | 2,206 | 2,527 | 5,926 | 4,525 | 2,058 | 3,225 | n.a. | 2,620 | 1,845 | 2,870 | 3,114 |
| March | 1,050 | 2,750 | 2,537 | 4,661 | 4,610 | 2,044 | 3,309 | n.a. | 2,673 | 1,992 | 2,857 | 3,241 |
| April | 1,167 | 3,057 | 3,164 | 5,573 | 6,311 | 2,322 | 3,701 | n.a. | 2,758 | 2,174 | 3,477 | 3,527 |
| May | 1,359 | 3,432 | 3,989 | 6,386 | 6,239 | 2,655 | 4,022 | n.a. | 2,870 | 2,444 | 4,239 | 3,970 |
| June | 1,459 | 3,943 | 4,045 | 7,248 | 6,537 | 3,012 | 4,272 | n.a. | 3,114 | 2,806 | 4,467 | 4,230 |
| July | 1,889 | 4,505 | 4,470 | 7,994 | 7,584 | 3,417 | 4,676 | n.a. | 3,548 | 3,277 | 5,166 | 4,955 |
| August | 2,686 | 6,045 | 7,180 | 9,064 | 10,877 | 4,711 | 6,034 | n.a. | 5,100 | 4,638 | 7,853 | 7,740 |
| September | 5,233 | 7,215 | 9,066 | 10,607 | 12,012 | 7,598 | 8,785 | n.a. | 6,129 | 5,700 | 10,377 | 9,979 |
| October | 9,361 | 15,815 | 20,353 | 23,281 | 31,493 | 21,728 | 22,522 | n.a. | 21,379 | 18,867 | 29,384 | 26,468 |
| November | 10,251 | 16,807 | 18,686 | 27,064 | 32,206 | 23,551 | 22,422 | n.a. | 22,164 | 16,306 | 29,358 | 25,335 |
| December | 9,250 | 14,233 | 13,354 | 21,941 | 27,182 | 14,690 | 18,193 | n.a. | 14,003 | 11,858 | 23,667 | 13,895 |
| Average | 3,963 | 7,204 | 7,997 | 11,781 | 13,602 | 7,571 | 8,872 | 7,402 | 7,496 | 6,241 | 10,706 | 9,261 |

^aCensus of Manufactures data. Figures represent the number of wage earners on the pay roll for the week including the 15th of the month, or some other normal week. Years are campaign, not census years.

n.a. Data not available.

Table A-3.- ESTIMATED LABOR REQUIREMENTS FOR PRODUCTION OF FUEL FOR BEET-SUGAR FACTORIES, 1913-35

| Year | Tons of beets sliced ^a (thousands) | Bituminous coal equivalents used - | | Net tons mined per man-day ^c | Man-days (thousands) (5)-(4) | Average number of mining days worked per year ^c | Number of fuel man-years (5)-(6) | Net tons mined per man-hour ^c | Number of fuel man-hours (thousands) (3)-(8) | Number of fuel man-hours per ton of beets sliced ^d (9)-(1) |
|------|---|---|---|---|------------------------------|--|----------------------------------|--|--|---|
| | | Per ton of beets sliced ^b (tons) | In beet-sugar factories (thousands of tons) (1)x(2) | | | | | | | |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) |
| 1913 | 5,659 | 0.149 | 843 | 3.61 | 234 | 232 | 1,007 | 0.419 | 2,012 | 0.356 |
| 1914 | 5,288 | .149 | 788 | 3.71 | 212 | 196 | 1,089 | .432 | 1,824 | .345 |
| 1916 | 6,150 | .149 | 916 | 3.91 | 234 | 203 | 1,154 | .455 | 2,014 | .327 |
| 1916 | 5,920 | .149 | 882 | 3.89 | 227 | 230 | 986 | .453 | 1,947 | .329 |
| 1917 | 5,626 | .149 | 838 | 3.76 | 223 | 243 | 917 | .454 | 1,846 | .328 |
| 1918 | 5,578 | .149 | 851 | 3.78 | 220 | 249 | 883 | .466 | 1,784 | .320 |
| 1919 | 5,888 | .149 | 877 | 3.84 | 228 | 196 | 1,172 | .477 | 1,839 | .312 |
| 1920 | 7,991 | .149 | 1,191 | 4.04 | 296 | 220 | 1,340 | .503 | 2,367 | .296 |
| 1921 | 7,414 | .149 | 1,106 | 4.21 | 262 | 149 | 1,761 | .523 | 2,112 | .285 |
| 1922 | 4,963 | .149 | 739 | 4.32 | 171 | 142 | 1,205 | .536 | 1,380 | .278 |
| 1923 | 6,585 | .149 | 981 | 4.48 | 219 | 179 | 1,224 | .555 | 1,788 | .268 |
| 1924 | 7,075 | .149 | 1,064 | 4.57 | 231 | 171 | 1,349 | .565 | 1,866 | .264 |
| 1925 | 6,993 | .149 | 1,042 | 4.55 | 230 | 196 | 1,180 | .561 | 1,867 | .266 |
| 1926 | 6,782 | .149 | 1,011 | 4.49 | 225 | 215 | 1,047 | .557 | 1,814 | .268 |
| 1927 | 7,443 | .148 | 1,087 | 4.56 | 238 | 191 | 1,248 | .565 | 1,923 | .258 |
| 1928 | 6,880 | .156 | 1,073 | 4.72 | 227 | 203 | 1,120 | .586 | 1,835 | .267 |
| 1929 | 7,117 | .149 | 1,060 | 4.86 | 218 | 219 | 998 | .601 | 1,764 | .248 |
| 1930 | 8,789 | .146 | 1,283 | 5.07 | 253 | 187 | 1,353 | .627 | 2,047 | .233 |
| 1931 | 7,659 | .147 | 1,126 | 5.30 | 212 | 160 | 1,328 | .656 | 1,716 | .224 |
| 1932 | 8,856 | .147 | 1,302 | 5.22 | 249 | 146 | 1,708 | .644 | 2,021 | .228 |
| 1933 | 10,778 | .143 | 1,541 | 4.77 | 323 | 167 | 1,985 | .591 | 2,608 | .242 |
| 1934 | 7,591 | .154 | 1,138 | 4.41 | 258 | 178 | 1,450 | .606 | 1,878 | .254 |
| 1935 | 7,746 | .161 | 1,169 | 4.50 | 260 | 179 | 1,452 | .641 | 1,824 | .236 |

^aTable A-1, col. (2).

^bComputed from data covering from 38 to 50 factories. Fuel data not available prior to 1927. Ratio used for the years 1913-26 inclusive is the unweighted mean of the 9 ratios for the years 1927-35. This probably underestimates the amount of fuel for the years prior to 1927 (see p. 30).

^cTaken from data adapted by Nicholas Yaworski from U. S. Bureau of Mines material. Production data include, and employment data exclude, wagon-mine data. The exclusion in the case of employment was not considered serious except in 1920 and 1922

because in no other years did such production rise as high as 2 million tons. In 1920 and 1922, however, production rose to 4,934,300 and 3,459,442 net tons respectively. The labor productivity figures for these years, based only on production by commercial mines, become respectively 4.01 and 4.29 net tons per man-day and 0.498 and 0.532 net tons per man-hour.

^dData on man-hours worked and output per man-hour are based on established lengths of working days and therefore are subject to error insofar as the established length of the work-day varied from the actual hours worked per day by the employees.

Table A-4.- ESTIMATED LABOR REQUIREMENTS FOR PRODUCTION OF MACHINERY FOR BEET-SUGAR FACTORIES, 1917-35

| Year | Improvement expenditures in 31 identical factories | | | Labor requirements for production of beet-sugar machinery in all factories | |
|------|--|--|--|---|--|
| | Thousands of dollars ^a | Man-hours per dollar of value ^b | Thousands of man- hours (1)x(2) | Thousands of man- hours ^c (3)÷0.38 | Number of men ^d (4)÷2,400 |
| | (1) | (2) | (3) | (4) | (5) |
| 1917 | 2,315 | 0.809 | 1,873 | 4,929 | 2,054 |
| 1918 | 1,570 | 0.893 | 1,402 | 3,689 | 1,537 |
| 1919 | 728 | 0.931 | 678 | 1,784 | 743 |
| 1920 | 699 | 0.816 | 570 | 1,500 | 625 |
| 1921 | 920 | 1.057 | 972 | 2,558 | 1,066 |
| 1922 | 137 | 1.023 | 140 | 368 | 153 |
| 1923 | 431 | 0.930 | 401 | 1,055 | 440 |
| 1924 | 820 | 0.916 | 751 | 1,976 | 823 |
| 1925 | 1,150 | 0.884 | 1,017 | 2,676 | 1,115 |
| 1926 | 490 | 0.884 | 433 | 1,139 | 475 |
| 1927 | 134 | 0.913 | 122 | 321 | 134 |
| 1928 | 402 | 0.868 | 349 | 918 | 383 |
| 1929 | 724 | 0.821 | 594 | 1,563 | 651 |
| 1930 | 667 | 0.815 | 544 | 1,432 | 597 |
| 1931 | 252 | 0.928 | 234 | 616 | 257 |
| 1932 | 284 | 1.196 | 340 | 895 | 373 |
| 1933 | 917 | 1.104 | 1,012 | 2,663 | 1,110 |
| 1934 | 527 | 1.013 | 534 | 1,405 | 585 |
| 1935 | 292 | 0.968 | 283 | 745 | 310 |

^aFigures are for aggregate cost of additions, replacements, and improvements for all purposes. No deductions were made for credits for sales although in some cases only net costs were available. In some other cases the data include small amounts for structures and nonmechanical improvements.

^bThese ratios, with the exception of those for 1917-19, were provided by the "Studies in Equipment Changes and Industrial Techniques" section of the WPA National Research Project. The ratios for 1917-19 were extrapolated back of 1920 with the aid of a wholesale-price index of all metals and metal products [Handbook of Labor Statistics, 1936 Edition (U. S. Dept. Lab., Bur. Labor Statistics, 1936), p. 679] which moved inversely to the ratios through the period from 1920-35.

^c0.38 is the proportion of total daily slicing capacity in the industry represented by the 31 identical plants in 1934. See chap. II, fn. 14.

^d2,400 is the assumed number of man-hours per year per man based on data from companies manufacturing sugar machinery.

Table A-5.- ESTIMATED MAN-HOURS IN FOUR VERTICAL SEGMENTS OF THE BEET-SUGAR INDUSTRY, 1917-35

(Thousands)

| Year | Beet fields ^a (growing and transportation) | Processing ^b | Fuel ^c (for factories) | Machinery ^d (for factories) |
|------|--|-------------------------|--------------------------------------|---|
| | (1) | (2) | (3) | (4) |
| 1917 | 75,145 | 29,210 | 1,846 | 4,929 |
| 1918 | | 28,632 | 1,784 | 3,689 |
| 1919 | | 29,210 | 1,839 | 1,784 |
| 1920 | | 36,064 | 2,367 | 1,500 |
| 1921 | | 28,877 | 2,112 | 2,558 |
| 1922 | 82,656 ^e | 19,946 | 1,380 | 368 |
| 1923 | | 20,973 | 1,768 | 1,055 |
| 1924 | | 23,793 | 1,866 | 1,976 |
| 1925 | | 23,000 | 1,857 | 2,676 |
| 1926 | | 20,298 | 1,814 | 1,139 |
| 1927 | | 19,114 | 1,923 | 321 |
| 1928 | | 17,530 | 1,835 | 918 |
| 1929 | | 17,359 | 1,764 | 1,564 |
| 1930 | 70,983 ^f | 18,334 | 2,047 | 1,432 |
| 1931 | | 15,838 | 1,716 | 618 |
| 1932 | | 18,917 | 2,021 | 895 |
| 1933 | | 21,341 | 2,608 | 2,663 |
| 1934 | 72,004 ^g | 17,628 | 1,878 | 1,405 |
| 1935 | | 17,573 | 1,824 | 745 |

^aComputed from table A-1, col. (1) and table 5, col. (1).

^bThe campaign ratio of beets sliced per man-hour was estimated for each year by taking the weighted mean of the man-hour ratios for all reporting plants for 1928 (table B-9), a year in which the sample was fairly representative, and multiplying it by the chained index of man-hour ratios for the given year (table B-12) adjusted to 1928 as a base. For the intercampaign man-hour ratios 1928-35 the weighted average ratios for all plants reporting intercampaign data (table B-18) for these years were used. For the period 1917-27 an estimate was made based on census data on employment during the intercampaign months, the length of the campaign, and man-hour ratios computed from the NRF-NBER field survey for 1927-35. This estimate was furnished by Mr. Harry Magdoff of the National Research Project. The total plant man-hours for each year were computed by multiplying the tons of beets sliced (table A-1) for the given year by the sum of the campaign and intercampaign ratios.

^cTable A-3, col. (9).

^dTable A-4, col. (4).

^eAverage for the years 1920-24.

^fAverage for the years 1928-32.

^gAverage for the years 1934-35.

Table A-6.- INDEXES OF PRODUCTION OF BEET SUGAR
AND ALL MANUFACTURES, 1919-36

(1923-25=100)

| Year | Beet sugar ^a | All manufactures ^b |
|------|-------------------------|-------------------------------|
| 1919 | 75.5 | 84 |
| 1920 | 113.3 | 87 |
| 1921 | 106.1 | 67 |
| 1922 | 70.2 | 86 |
| 1923 | 91.6 | 101 |
| 1924 | 113.4 | 94 |
| 1925 | 95.0 | 105 |
| 1926 | 93.3 | 108 |
| 1927 | 113.7 | 106 |
| 1928 | 110.4 | 112 |
| 1929 | 105.9 | 119 |
| 1930 | 125.7 | 95 |
| 1931 | 120.2 | 80 |
| 1932 | 141.2 | 63 |
| 1933 | 170.8 | 75 |
| 1934 | 120.7 | 78 |
| 1935 | 123.3 | 90 |
| 1936 | 135.6 | 105 |

^aComputed from table A-1, col. (4).

^bFederal Reserve Bulletin, 23, No. 7 (July 1937), 674.

Table A-7.- PER-CAPITA AND TOTAL CONSUMPTION AND WHOLESALE PRICE OF SUGAR, 1899-1936^a

| Year | Per-capita consumption (pounds) | Total consumption (thousands of short tons) | Wholesale price per pound in New York (cents) |
|------|---------------------------------|---|---|
| 1899 | 61.0 | 2,346 | 4.92 |
| 1900 | n.a. | n.a. | 5.32 |
| 1901 | n.a. | n.a. | 5.05 |
| 1902 | n.a. | 2,874 | 4.46 |
| 1903 | n.a. | 2,856 | 4.64 |
| 1904 | 75.3 | 3,099 | 4.77 |
| 1905 | n.a. | 2,948 | 5.26 |
| 1906 | n.a. | 3,208 | 4.52 |
| 1907 | n.a. | 3,353 | 4.65 |
| 1908 | n.a. | 3,568 | 4.96 |
| 1909 | 81.8 | 3,649 | 4.77 |
| 1910 | 81.6 | 3,752 | 4.97 |
| 1911 | 79.2 | 3,754 | 5.34 |
| 1912 | 81.3 | 3,925 | 5.04 |
| 1913 | 85.4 | 4,192 | 4.28 |
| 1914 | 84.3 | 4,212 | 4.68 |
| 1915 | 83.8 | 4,258 | 5.56 |
| 1916 | 79.3 | 4,098 | 6.86 |
| 1917 | 78.6 | 4,126 | 7.66 |
| 1918 | 73.4 | 3,915 | 7.83 |
| 1919 | 85.4 | 4,556 | 9.00 |
| 1920 | 86.6 | 4,575 | 11.39 ^b |
| 1921 | 84.6 | 4,600 | 6.21 |
| 1922 | 103.2 | 5,704 | 5.90 |
| 1923 | 95.6 | 5,354 | 8.44 |
| 1924 | 95.9 | 5,437 | 7.47 |
| 1925 | 107.5 | 6,171 | 5.48 |
| 1926 | 109.3 | 6,352 | 5.47 |
| 1927 | 101.0 | 5,933 | 5.83 |
| 1928 | 104.3 | 6,208 | 5.54 |
| 1929 | 108.1 | 6,508 | 5.02 |
| 1930 | 99.4 | 6,271 | 4.63 |
| 1931 | 98.5 | 6,132 | 4.42 |
| 1932 | 93.3 | 5,840 | 3.99 |
| 1933 | 93.6 | 5,903 | 4.31 |
| 1934 | 90.7 | 5,751 | 4.12 |
| 1935 | 93.8 | 5,981 | 4.30 |
| 1936 | 96.3 | 6,184 | 4.66 |

^aWillett and Grey, Inc., *Weekly Statistical Sugar Trade Journal*, 1899-1936. Long ton figures were converted to short tons.

^bAverage for August 12 to December 31. There were no open-market quotations of granulated sugar for the earlier part of the year, when refiners disposed of their product by allocation to their regular trade.

n.a.—Data not available.

Table A-8.- SOURCES OF REFINED SUGAR CONSUMED IN CONTINENTAL UNITED STATES, 1897-1932^a

(Thousands of short tons)

| Period or year | Total, all sources ^b | Continental United States | | Insular areas of United States | | | Foreign countries | | |
|----------------|---------------------------------|---------------------------|-------|--------------------------------|--------|-------------|-------------------|-------|-------|
| | | Cane | Beet | Total ^c | Hawaii | Puerto Rico | Philippines | Cuba | Other |
| 1897-1901 | 2,407 | 267 | 77 | 357 | 289 | 50 | 18 | 401 | 1,287 |
| 1902-06 | 2,997 | 339 | 244 | 546 | 365 | 136 | 25 | 1,139 | 702 |
| 1907-11 | 3,615 | 378 | 508 | 863 | 514 | 267 | 82 | 1,508 | 339 |
| 1912-15 | 4,058 | 260 | 640 | 1,022 | 578 | 345 | 99 | 2,047 | 69 |
| 1914-16 | 4,190 | 222 | 782 | 1,073 | 580 | 361 | 132 | 2,063 | 31 |
| 1917-21 | 4,354 | 222 | 803 | 1,039 | 540 | 394 | 98 | 2,117 | 149 |
| 1921 | 4,600 | 306 | 1,061 | 1,112 | 540 | 419 | 147 | 2,090 | 30 |
| 1922 | 5,704 | 306 | 1,006 | 1,111 | 517 | 349 | 240 | 3,237 | 42 |
| 1923 | 5,354 | 241 | 986 | 1,020 | 515 | 281 | 222 | 2,966 | 139 |
| 1924 | 5,437 | 91 | 834 | 1,249 | 567 | 383 | 297 | 3,163 | 97 |
| 1925 | 6,171 | 140 | 994 | 1,740 | 713 | 564 | 453 | 3,258 | 38 |
| 1926 | 6,352 | 79 | 978 | 1,563 | 692 | 515 | 350 | 3,686 | 45 |
| 1927 | 5,933 | 43 | 874 | 1,745 | 712 | 540 | 487 | 3,262 | 6 |
| 1928 | 6,208 | 130 | 1,162 | 1,962 | 766 | 653 | 533 | 2,920 | 33 |
| 1929 | 6,508 | 176 | 959 | 1,979 | 868 | 430 | 677 | 3,376 | 16 |
| 1930 | 6,271 | 184 | 1,066 | 2,240 | 753 | 729 | 752 | 2,753 | 29 |
| 1931 | 6,132 | 192 | 1,255 | 2,366 | 904 | 699 | 762 | 2,281 | 37 |
| 1932 | 5,840 | 150 | 1,232 | 2,786 | 957 | 851 | 974 | 1,647 | 25 |

^aReport to the President on Sugar (U. S. Tariff Commission, Report No. 73, Second Series, 1934), p. 38. Figures are for refined sugar, whether refined in the United States or in insular areas and foreign countries. "Of the refined sugar consumed in continental United States in 1932, 88 percent was refined there, 3.3 percent in insular areas, and 8.7 percent in foreign countries, principally in Cuba." (Ibid., p. 37.)

^bIncludes a small "miscellaneous" item during years preceding 1930; maximum of this item, in 1919, was 38,000 tons.

^cIncludes after 1916 a small amount from Virgin Islands (4,000 tons in 1932).

Table A-9.- PRICE DIFFERENTIALS OF RAW CUBAN SUGAR AT NEW YORK AND LONDON, QUARTERLY, 1922-31^a

(Cents per pound, 96° centrifugal)

| Year and quarter | Average price at - | | Differential |
|------------------|---------------------|--------------------------------------|--------------|
| | New York, duty paid | London, cost, insurance, and freight | |
| 1922 | 4.64 | 3.09 | 1.55 |
| Jan.-Mar. | 3.75 | 2.31 | 1.44 |
| Apr.-June | 4.20 | 2.79 | 1.41 |
| July-Sept. | 5.06 | 3.61 | 1.45 |
| Oct.-Dec. | 5.56 | 3.65 | 1.91 |
| 1923 | 7.05 | 5.33 | 1.72 |
| Jan.-Mar. | 6.41 | 4.60 | 1.81 |
| Apr.-June | 7.83 | 6.36 | 1.47 |
| July-Sept. | 6.55 | 4.89 | 1.66 |
| Oct.-Dec. | 7.43 | 5.48 | 1.95 |
| 1924 | 5.95 | 4.27 | 1.68 |
| Jan.-Mar. | 6.97 | 5.39 | 1.58 |
| Apr.-June | 5.89 | 4.20 | 1.49 |
| July-Sept. | 5.44 | 3.92 | 1.52 |
| Oct.-Dec. | 5.70 | 3.68 | 2.12 |
| 1925 | 4.33 | 2.65 | 1.68 |
| Jan.-Mar. | 4.65 | 3.03 | 1.62 |
| Apr.-June | 4.40 | 2.86 | 1.72 |
| July-Sept. | 4.28 | 2.53 | 1.75 |
| Oct.-Dec. | 3.98 | 2.36 | 1.62 |
| 1926 | 4.35 | 2.70 | 1.65 |
| Jan.-Mar. | 4.13 | 2.46 | 1.67 |
| Apr.-June | 4.16 | 2.51 | 1.66 |
| July-Sept. | 4.30 | 2.64 | 1.66 |
| Oct.-Dec. | 4.79 | 3.18 | 1.61 |
| 1927 | 4.75 | 2.93 | 1.77 |
| Jan.-Mar. | 4.95 | 3.31 | 1.64 |
| Apr.-June | 4.75 | 3.07 | 1.67 |
| July-Sept. | 4.63 | 2.84 | 1.78 |
| Oct.-Dec. | 4.66 | 2.69 | 1.96 |
| 1928 | 4.22 | 2.51 | 1.71 |
| Jan.-Mar. | 4.41 | 2.67 | 1.74 |
| Apr.-June | 4.44 | 2.80 | 1.63 |
| July-Sept. | 4.13 | 2.48 | 1.65 |
| Oct.-Dec. | 3.92 | 2.17 | 1.75 |
| 1929 | 3.77 | 1.97 | 1.80 |
| Jan.-Mar. | 3.76 | 2.06 | 1.69 |
| Apr.-June | 3.60 | 1.89 | 1.70 |
| July-Sept. | 3.89 | 1.99 | 1.90 |
| Oct.-Dec. | 3.85 | 1.92 | 1.93 |
| 1930 | 3.37 | 1.43 | 1.94 |
| Jan.-Mar. | 3.63 | 1.67 | 1.96 |
| Apr.-June | 3.32 | 1.53 | 1.79 |
| July-Sept. | 3.19 | 1.24 | 1.94 |
| Oct.-Dec. | 3.34 | 1.28 | 2.06 |
| 1931 | 3.33 | 1.25 | 2.08 |
| Jan.-Mar. | 3.32 | 1.31 | 2.01 |
| Apr.-June | 3.26 | 1.37 | 1.90 |
| July-Sept. | 3.46 | 1.31 | 2.14 |
| Oct.-Dec. | 3.30 | 1.09 | 2.21 |

^aAdapted from Lippert S. Ellis, The Tariff on Sugar (Freeport, Ill.: The Rawleigh Foundation, 1933), p. 122. Quarterly averages were computed from monthly figures.

Table A-10.- AVERAGE WHOLESALE PRICE OF SUGAR
AT NEW YORK, 1899-1936^a

(Cents per pound)

| Year | Granulated | Raw Cuban, 96° | | Differential (3)-(2) |
|------|---------------------|----------------|----------------|-------------------------|
| | | Excluding duty | Including duty | |
| | (1) | (2) | (3) | (4) |
| 1899 | 4.919 | 2.734 | 4.419 | 1.685 |
| 1900 | 5.320 | 2.881 | 4.566 | 1.685 |
| 1901 | 5.050 | 2.362 | 4.047 | 1.685 |
| 1902 | 4.455 | 1.857 | 3.542 | 1.685 |
| 1903 | 4.638 | 2.035 | 3.720 | 1.685 |
| 1904 | 4.772 | 2.628 | 3.974 | 1.348 |
| 1905 | 5.256 | 2.918 | 4.278 | 1.360 |
| 1906 | 4.515 | 2.316 | 3.686 | 1.370 |
| 1907 | 4.649 | 2.396 | 3.756 | 1.360 |
| 1908 | 4.957 | 2.713 | 4.073 | 1.360 |
| 1909 | 4.765 | 2.646 | 4.007 | 1.361 |
| 1910 | 4.972 | 2.828 | 4.188 | 1.360 |
| 1911 | 5.345 | 3.090 | 4.453 | 1.363 |
| 1912 | 5.041 | 2.804 | 4.162 | 1.358 |
| 1913 | 4.278 | 2.150 | 3.506 | 1.356 |
| 1914 | 4.683 | 2.745 | 3.814 | 1.069 |
| 1915 | 5.559 | 3.626 | 4.642 | 1.016 |
| 1916 | 6.862 | 4.767 | 5.786 | 1.019 |
| 1917 | 7.663 | 5.208 | 6.228 | 1.020 |
| 1918 | 7.834 | 5.014 | 6.447 | 1.433 |
| 1919 | 9.003 | 6.354 | 7.724 | 1.370 |
| 1920 | 11.390 ^b | 11.337 | 12.362 | 1.025 |
| 1921 | 6.207 | 3.459 | 4.763 | 1.304 |
| 1922 | 5.904 | 2.977 | 4.632 | 1.655 |
| 1923 | 8.441 | 5.240 | 7.020 | 1.780 |
| 1924 | 7.471 | 4.186 | 5.964 | 1.778 |
| 1925 | 5.483 | 2.562 | 4.334 | 1.772 |
| 1926 | 5.473 | 2.568 | 4.337 | 1.769 |
| 1927 | 5.828 | 2.959 | 4.730 | 1.771 |
| 1928 | 5.540 | 2.459 | 4.229 | 1.770 |
| 1929 | 5.025 | 2.001 | 3.769 | 1.768 |
| 1930 | 4.634 | 1.499 | 3.387 | 1.888 |
| 1931 | 4.425 | 1.329 | 3.329 | 2.000 |
| 1932 | 3.992 | 0.925 | 2.925 | 2.000 |
| 1933 | 4.308 | 1.208 | 3.208 | 2.000 |
| 1934 | 4.123 | 1.469 | 2.987 | 1.518 |
| 1935 | 4.302 | 2.317 | 3.217 | 0.900 |
| 1936 | 4.660 | 2.673 | 3.595 | 0.922 |

^aCompiled from Willett and Grey, Inc., Weekly Statistical Sugar Trade Journal, 1899-1936.

^bAverage for August 12 to December 31.

Table A-11.- INDEXES OF WHOLESALE PRICE OF ALL FARM PRODUCTS, SUGAR BEETS, AND SUGAR AND OF ACRES OF SUGAR BEETS HARVESTED, 1899-1936

(1926=100)

| Year | Wholesale price | | | Acres of sugar beets harvested ^d |
|------|--------------------------------|--------------------------|----------------------------|---|
| | All farm products ^a | Sugar beets ^b | Refined sugar ^c | |
| 1899 | 45.8 | n.a. | 89.9 | 19.9 |
| 1900 | 50.5 | n.a. | 97.2 | n.a. |
| 1901 | 52.8 | n.a. | 92.3 | 25.8 |
| 1902 | 58.4 | 66.1 | 81.4 | 31.9 |
| 1903 | 55.6 | 65.3 | 84.7 | 35.9 |
| 1904 | 58.5 | 85.0 | 87.2 | 29.2 |
| 1905 | 56.4 | 65.7 | 96.0 | 45.3 |
| 1906 | 57.3 | 67.0 | 82.5 | 55.5 |
| 1907 | 62.2 | 68.3 | 84.9 | 54.8 |
| 1908 | 62.2 | 70.3 | 90.6 | 53.9 |
| 1909 | 69.6 | n.a. | 87.1 | 62.0 |
| 1910 | 74.3 | n.a. | 90.8 | 58.8 |
| 1911 | 66.8 | 72.3 | 97.7 | 70.0 |
| 1912 | 72.6 | 76.5 | 92.1 | 82.0 |
| 1913 | 71.5 | 74.8 | 78.2 | 85.7 |
| 1914 | 71.2 | 71.6 | 86.6 | 71.3 |
| 1915 | 71.5 | 74.5 | 101.6 | 90.3 |
| 1916 | 84.4 | 80.4 | 125.4 | 98.2 |
| 1917 | 129.0 | 97.1 | 140.0 | 98.2 |
| 1918 | 148.0 | 131.4 | 143.1 | 87.7 |
| 1919 | 157.6 | 154.3 | 164.5 | 102.2 |
| 1920 | 150.7 | 152.6 | 208.1 ^e | 128.8 |
| 1921 | 88.4 | 83.4 | 113.4 | 120.4 |
| 1922 | 93.8 | 103.9 | 107.9 | 78.3 |
| 1923 | 98.6 | 118.1 | 154.2 | 97.0 |
| 1924 | 100.0 | 104.5 | 136.5 | 120.5 |
| 1925 | 109.8 | 84.0 | 100.2 | 95.7 |
| 1926 | 100.0 | 100.0 | 100.0 | 100.0 |
| 1927 | 99.4 | 100.8 | 106.5 | 106.5 |
| 1928 | 105.9 | 93.4 | 101.2 | 95.1 |
| 1929 | 104.9 | 93.0 | 91.8 | 101.6 |
| 1930 | 88.3 | 93.8 | 84.7 | 114.6 |
| 1931 | 64.8 | 78.1 | 80.9 | 105.3 |
| 1932 | 48.2 | 69.1 | 72.9 | 112.9 |
| 1933 | 51.4 | 67.4 | 78.7 | 145.2 |
| 1934 | 65.3 | 67.8 | 75.3 | 113.7 |
| 1935 | 78.8 | 76.1 | 78.6 | 112.7 |
| 1936 | n.a. | n.a. | 85.1 | 114.6 |

^aHandbook of Labor Statistics, 1936 Edition (U. S. Dept. Lab., Bur. Labor Statistics, Bull. No. 616, 1936), p. 674.

^bComputed from data for: 1902-3, 1911-16 from Statistical Abstract of the United States, 1917 (U. S. Dept. Com., Bur. For. and Dom. Com., 1918), p. 217; 1917-23 from same for 1926 (1927), p. 664; 1924-35 from same for 1936 (1936), p. 656; 1904-8 from U. S. Congress, Senate, Beet Sugar Industry in the United States, S. Doc. 22, 61st Cong., 1st sess., Apr. 8, 1909.

^cComputed from table A-10, col. (1).

^dComputed from table A-1, col. (1).

^eComputed from average price for August 12 to December 31.

n.a.—Data not available.

Table A-12.-- YIELD OF SUGAR BEETS PER ACRE AND SUCROSE CONTENT OF SUGAR BEETS, 1901-36^a

| Year ^b | Yield per acre ^c (short tons) | Sucrose content ^d (percent) | Year ^b | Yield per acre ^c (short tons) | Sucrose content ^d (percent) |
|-------------------|---|---|-------------------|---|---|
| | (1) | (2) | | (1) | (2) |
| 1901 | 9.6 | 14.8 | 1919 | 9.3 | 14.5 |
| 1902 | 8.8 | 14.6 | 1920 | 9.8 | 16.0 |
| 1903 | 8.6 | 15.1 | 1921 | 9.6 | 15.8 |
| 1904 | 10.5 | 15.3 | 1922 | 9.8 | 15.4 |
| 1905 | 8.7 | 15.3 | 1923 | 10.7 | 15.3 |
| 1906 | 11.3 | 14.9 | 1924 | 9.2 | 17.2 |
| 1907 | 10.2 | 15.8 | 1925 | 11.4 | 14.9 |
| 1908 | 9.4 | 15.7 | 1926 | 10.7 | 14.9 |
| 1909 | 9.7 | 16.1 | 1927 | 10.8 | 16.1 |
| 1910 | 10.2 | 16.4 | 1928 | 11.0 | 16.7 |
| 1911 | 10.7 | 15.9 | 1929 | 10.6 | 15.6 |
| 1912 | 9.4 | 16.3 | 1930 | 11.9 | 15.2 |
| 1913 | 9.8 | 15.8 | 1931 | 11.1 | 16.2 |
| 1914 | 11.6 | 16.4 | 1932 | 11.9 | 16.4 |
| 1915 | 10.7 | 16.5 | 1933 | 11.2 | 16.6 |
| 1916 | 9.4 | 16.3 | 1934 | 9.8 | 17.0 |
| 1917 | 9.0 | 16.3 | 1935 | 10.4 | 16.5 |
| 1918 | 10.0 | 16.2 | 1936 | 11.6 | n.a. |

^aData for: 1901-13 from Yearbook of Agriculture, 1914 (U. S. Dept. Agr., 1915), p. 600; 1914-25 from same for 1926 (1927), pp. 1003-4; 1926-36 from Agricultural Statistics, 1937 (U. S. Dept. Agr., 1937), pp. 89, 91; 1936 from Crops and Markets, 13, No. 12 (Dec. 1936), 427.

^bYear is that in which beets are grown. The campaign extends into the succeeding year.

^cThis series differs from the yield shown in table A-1 in that this series is for beets produced or beets delivered to the factory per acre, while the other is for beets sliced per acre.

^dBased upon weight of beets sliced.

n.a.—Data not available.

Table B-1.- ANALYSIS OF SAMPLE OF BEET-SUGAR FACTORIES: NUMBER OF FACTORIES AND PRODUCTION OF GRANULATED SUGAR, BY REGION, 1918-35^a

(Production in short tons)

| Region | 1918 | | 1920 | | 1922 | | 1924 | | 1926 | | 1928 | | 1931 | | 1933 | | 1935 | |
|---|----------------------------------|------------|----------------------------------|------------|----------------------------------|------------|----------------------------------|------------|----------------------------------|------------|----------------------------------|------------|----------------------------------|------------|----------------------------------|------------|----------------------------------|------------|
| | Number of factories ^b | Production | Number of factories ^b | Production | Number of factories ^b | Production | Number of factories ^b | Production | Number of factories ^b | Production | Number of factories ^b | Production | Number of factories ^b | Production | Number of factories ^b | Production | Number of factories ^b | Production |
| United States | | | | | | | | | | | | | | | | | | |
| Sample | 40 ^c | 419,034 | 44 | 615,912 | 42 | 437,017 | 52 | 680,045 | 56 | 706,350 | 63 | 834,161 | 46 | 624,801 | 68 | 1,252,838 | 59 | 867,125 |
| Universe | 85 | 719,420 | 92 | 1,023,174 | 84 | 749,447 | 89 | 1,075,570 | 79 | 893,215 | 82 | 1,068,285 | 67 | 1,155,712 | 84 | 1,625,954 | 77 | 1,178,368 |
| Sample as percent of universe | 47.1 | 58.2 | 47.8 | 60.2 | 50.0 | 58.3 | 58.4 | 63.2 | 70.9 | 79.1 | 76.9 | 78.1 | 68.7 | 71.4 | 69.0 | 77.1 | 76.6 | 75.3 |
| Region I - California | | | | | | | | | | | | | | | | | | |
| Sample | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 12,349 | 1 | 29,573 | 1 | 38,447 | 3 | 188,914 | 4 | 149,305 |
| Universe | 10 | 124,903 | 9 | 168,957 | 6 | 86,612 | 7 | 118,603 | 5 | 67,502 | 5 | 103,990 | 6 | 164,769 | n.a. | n.a. | 8 | n.a. |
| Sample as percent of universe | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20.0 | 18.3 | 20.0 | 28.4 | 16.7 | 23.3 | 50.0 | - | 50.0 | - |
| Region II - Colorado, Idaho, Kansas, Montana, Nebraska, Nevada, South Dakota, Utah, Washington, Wyoming | | | | | | | | | | | | | | | | | | |
| Sample | 33 ^d | 398,707 | 37 | 532,661 | 32 | 380,172 | 36 | 519,368 | 32 | 541,028 | 41 | 674,887 | 39 | 661,243 | 42 | 876,849 | 37 | 584,000 |
| Universe ^d | 49 | 421,824 | 56 | 662,434 | 52 | 513,979 | 55 | 722,175 | 46 | 642,561 | 52 | 809,096 | 49 | 621,634 | 53 | n.a. | 46 | n.a. |
| Sample as percent of universe | 67.3 | 85.0 | 66.1 | 80.4 | 61.5 | 74.0 | 65.5 | 71.9 | 69.6 | 84.2 | 78.8 | 83.4 | 79.6 | 82.9 | 79.2 | - | 80.4 | - |
| Region III - Illinois, Indiana, Iowa, Michigan, Minnesota, Ohio, Wisconsin | | | | | | | | | | | | | | | | | | |
| Sample | 7 | 60,327 | 7 | 83,231 | 10 | 56,844 | 16 | 160,677 | 23 | 153,173 | 21 | 129,699 | 6 | 105,111 | 13 | 187,075 | 18 | 153,680 |
| Universe ^d | 26 | 172,693 | 27 | 191,783 | 26 | 148,856 | 27 | 234,792 | 29 | 183,052 | 25 | 155,199 | 12 | 169,309 | 25 | n.a. | 23 | n.a. |
| Sample as percent of universe | 26.9 | 34.9 | 25.9 | 43.4 | 38.5 | 38.2 | 59.3 | 68.4 | 82.1 | 83.7 | 84.0 | 83.6 | 50.0 | 62.1 | 52.0 | - | 78.3 | - |

^aData for universe from Census of Manufactures. Sample data in tables B-1 to B-6 exclude 1 Canadian factory. Years are campaign years, not census years.

^bUniverse data refer to number of establishments rather than number of factories. 2 or more factories located in the same county, town, or city and under common ownership could have been reported as 1 establishment.

^cExcludes 1 factory in the sample for which the quantity of granulated sugar produced is not available.

^dCensus data were adjusted on the basis of NRP and U. S. Department of Agriculture data in order to make the regional break-down correspond with the regional data in the sample. Because of the census method of grouping data in a miscellaneous class to conceal the identity of individual establishments, data for establishments in the following States were included in Region II instead of Region III: (1) 1 establishment each in Illinois, Iowa, and Minnesota in 1918 and 1920; (2) 1 establishment in Illinois, 2 in Iowa, and 1 in Minnesota in 1922; and (3) 2 establishments in Iowa and 1 in Minnesota in 1924.

n.a. Data not available.

Table B-2.- ANALYSIS OF SAMPLE OF BEET-SUGAR FACTORIES: PERCENTAGE DISTRIBUTION OF FACTORIES AND GRANULATED-SUGAR PRODUCTION, BY REGION, 1918-35^a

(United States=100 percent)

| Region | 1918 | | 1920 | | 1922 | | 1924 | | 1926 | | 1928 | | 1931 | | 1933 | | 1935 | |
|----------------------|-------------|--------------|-------------|--------------|-------------|--------------|-------------|--------------|-------------|--------------|-------------|--------------|-------------|--------------|-------------|--------------|-------------|--------------|
| | Fac-to-ries | Pro-duc-tion | Fac-to-ries | Pro-duc-tion | Fac-to-ries | Pro-duc-tion | Fac-to-ries | Pro-duc-tion | Fac-to-ries | Pro-duc-tion | Fac-to-ries | Pro-duc-tion | Fac-to-ries | Pro-duc-tion | Fac-to-ries | Pro-duc-tion | Fac-to-ries | Pro-duc-tion |
| Region I Sample | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1.8 | 1.7 | 1.6 | 3.5 | 2.2 | 4.7 | 5.2 | 15.1 | 6.8 | 16.8 |
| Universe | 11.6 | 17.4 | 9.8 | 16.5 | 7.1 | 11.8 | 7.9 | 11.0 | 6.3 | 7.6 | 6.1 | 9.7 | 9.0 | 14.3 | 7.1 | n.a. | 10.4 | n.a. |
| Region II Sample | 82.5 | 85.6 | 84.1 | 86.5 | 76.2 | 87.0 | 69.2 | 76.4 | 57.1 | 76.6 | 65.1 | 60.9 | 84.8 | 82.6 | 72.4 | 70.0 | 62.7 | 65.9 |
| Universe | 57.6 | 58.6 | 60.9 | 64.7 | 61.9 | 68.6 | 61.8 | 67.2 | 58.2 | 71.9 | 56.5 | 75.8 | 75.1 | 71.1 | 85.1 | n.a. | 59.7 | n.a. |
| Region III Sample | 17.5 | 14.4 | 15.9 | 15.5 | 25.8 | 15.0 | 30.8 | 23.6 | 41.1 | 21.7 | 35.3 | 15.6 | 15.0 | 12.7 | 22.4 | 14.9 | 30.5 | 17.3 |
| Universe | 30.6 | 24.0 | 29.3 | 18.8 | 31.0 | 19.9 | 30.3 | 21.8 | 35.5 | 20.5 | 35.4 | 14.5 | 17.9 | 14.6 | 29.8 | n.a. | 29.9 | n.a. |

^aComputed from table B-1. See table B-1 for States included in each region.

^bn.a.-Data not available.

Table B-3.- ANALYSIS OF SAMPLE OF BEET-SUGAR FACTORIES: AVERAGE PRODUCTION OF GRANULATED SUGAR PER FACTORY, BY REGION, 1918-35^a

(Production in short tons)

| Region | 1918 | 1920 | 1922 | 1924 | 1926 | 1928 | 1931 | 1933 | 1935 |
|-------------------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| United States Sample | 10,476 | 13,996 | 10,405 | 13,078 | 12,617 | 13,241 | 17,930 | 21,601 | 15,036 |
| Universe | 8,464 | 11,121 | 8,922 | 12,085 | 11,507 | 13,028 | 17,249 | 19,357 | 15,303 |
| Sample as percent of universe | 123.8 | 125.9 | 116.6 | 108.2 | 111.6 | 101.6 | 103.9 | 111.6 | 98.3 |
| Region I Sample | 0 | 0 | 0 | 0 | 12,349 | 29,575 | 58,447 | 62,971 | 37,326 |
| Universe | 12,490 | 18,773 | 14,438 | 16,945 | 13,920 | 20,798 | 27,462 | n.a. | n.a. |
| Sample as percent of universe | 0 | 0 | 0 | 0 | 91.3 | 142.2 | 140.0 | - | - |
| Region II Sample | 10,870 | 14,397 | 11,880 | 14,427 | 16,907 | 16,461 | 17,468 | 20,877 | 15,784 |
| Universe | 8,609 | 11,829 | 9,884 | 13,130 | 13,969 | 16,856 | 16,768 | n.a. | n.a. |
| Sample as percent of universe | 126.3 | 121.7 | 120.2 | 109.9 | 121.0 | 97.7 | 104.2 | - | - |
| Region III Sample | 8,618 | 11,890 | 5,684 | 10,042 | 6,660 | 6,176 | 17,519 | 14,390 | 8,046 |
| Universe | 6,642 | 7,103 | 5,725 | 8,696 | 6,539 | 5,352 | 14,109 | n.a. | n.a. |
| Sample as percent of universe | 129.8 | 167.4 | 99.3 | 115.5 | 101.9 | 115.4 | 124.2 | - | - |

^aComputed from table B-1. See table B-1 for States included in each region.

^bn.a.-Data not available.

Table B-4.- ANALYSIS OF SAMPLE OF BEET-SUGAR FACTORIES: QUANTITY OF SUGAR BEETS SLICED AND AVERAGE QUANTITY PER FACTORY, 1918-35^a

| Year | Sugar beets sliced (thousands of short tons) | | | | Sample as percent of universe | | |
|-------------------|--|----------------------------------|---------------|----------------------------------|-------------------------------|-----------------------------|---|
| | Sample | | Universe | | Sugar beets sliced | | Granulated sugar produced, average per factory ^c |
| | All factories | Average per factory ^b | All factories | Average per factory ^b | All factories (1)-(3) | Average per factory (2)-(4) | |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| 1918 ^d | 3,070 | 75 | 5,649 | 66 | 54.3 | 113.6 | 123.6 |
| 1920 | 4,439 | 101 | 7,873 | 86 | 56.4 | 117.4 | 125.9 |
| 1922 | 3,242 | 77 | 5,786 | 69 | 56.0 | 111.6 | 116.6 |
| 1924 | 4,444 | 85 | 7,423 | 83 | 59.9 | 102.4 | 108.2 |
| 1926 | 5,389 | 96 | 6,711 | 85 | 80.3 | 112.9 | 111.6 |
| 1928 | 5,467 | 87 | 6,951 | 85 | 76.7 | 102.4 | 101.6 |
| 1931 | 5,628 | 122 | 7,620 | 114 | 75.9 | 107.0 | 105.9 |
| 1933 | 8,317 | 143 | n.a. | - | - | - | 111.6 |
| 1935 | 5,911 | 100 | 7,745 | 101 | 76.3 | 99.8 | 98.3 |

^aData for universe from Census of Manufactures.

^bQuantity for all factories divided by number of factories (table B-1).

^cTable B-3.

^dFor 1 factory in the sample data are available for the quantity of beets sliced but not for granulated sugar produced.

^en.a.-Data not available.

.Table B-5.- ANALYSIS OF SAMPLE OF BEET-SUGAR FACTORIES: AGE DISTRIBUTION OF FACTORIES IN EXISTENCE IN 1934-35^a

| Period erected ^b | Sample | | Universe | | Sample as percent of universe (1)÷(3) |
|-----------------------------|-----------------|---------|------------------|---------|--|
| | Number | Percent | Number | Percent | |
| | (1) | (2) | (3) | (4) | (5) |
| Total | 78 ^c | 100 | 100 ^d | 100 | 78 |
| Prior to 1900 | 11 | 14 | 13 | 13 | 85 |
| 1900-04 | 23 | 30 | 25 | 25 | 92 |
| 1905-09 | 8 | 10 | 12 | 12 | 67 |
| 1910-14 | 6 | 8 | 11 ^e | 11 | 55 |
| 1915-19 | 15 | 19 | 20 | 20 | 75 |
| 1920-24 | 6 | 8 | 8 | 8 | 75 |
| 1925-29 | 8 | 10 | 10 | 10 | 80 |
| 1930-35 | 1 | 1 | 1 | 1 | 100 |

^aData for universe from American Beet Sugar Companies, 1934-35 (Washington, D. C.: The United States Beet Sugar Association). Both series exclude dismantled factories.

^cExcludes 1 factory located in Canada and 1 factory (erected prior to 1900) that was dismantled prior to 1934-35.

^bDate of erection is counted from date factory was first on present site. Some factories, first erected in an earlier period, were later moved. 7 such factories are included in the NRP-NBER sample and are listed under separate code numbers (tables B-7 and B-8); they are included in this table only in the period during which they were moved to their site as of 1934-35.

^dExcludes 3 factories located in Canada and 1 factory (erected prior to 1900) listed as dismantled.

^eIncludes 1 factory listed as "partly dismantled."

Table B-6.- BEETS SLICED IN THE UNITED STATES AND CHAIN INDEX OF BEETS SLICED
BY SAMPLE FACTORIES, 1912-35

| Year | Beets sliced by universe ^a (thousands of short tons) | Chain index of beets sliced by sample (1923=100) | Year | Beets sliced by universe ^a (thousands of short tons) | Chain index of beets sliced by sample (1923=100) |
|------|--|---|------|--|---|
| 1912 | 5,224 | 142.5 | 1924 | 7,075 | 105.3 |
| 1913 | 5,659 | 203.4 | 1925 | 6,993 | 104.0 |
| 1914 | 5,288 | 175.8 | 1926 | 6,782 | 112.1 |
| 1915 | 6,150 | 184.6 | 1927 | 7,443 | 118.5 |
| 1916 | 5,920 | 93.0 | 1928 | 6,880 | 104.4 |
| 1917 | 5,626 | 79.3 | 1929 | 7,117 | 111.1 |
| 1918 | 5,578 | 83.3 | 1930 | 8,789 | 131.6 |
| 1919 | 5,888 | 90.0 | 1931 | 7,659 | 121.2 |
| 1920 | 7,991 | 113.4 | 1932 | 8,856 | 117.7 |
| 1921 | 7,414 | 112.8 | 1933 | 10,778 | 141.5 |
| 1922 | 4,963 | 83.8 | 1934 | 7,391 | 100.0 |
| 1923 | 6,585 | 100.0 | 1935 | 7,745 | 99.4 |

^aTable A-1, col. (2).

Table B-7.- CAMPAIGN OPERATING AND INDIRECT MAN-HOURS PER TON OF BEETS SLICED, BY FACTORY, 1912-35^a

| Year | Area and factory | | | | | | | | | | | | | | | | | | | | | |
|------|--------------------|--------------------|--------------------|--------------------|--------------------|-------------------|-------------------|------|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--|
| | I-1 ^{b c} | I-2 ^{b c} | I-3 ^{b c} | I-4 ^{b c} | I-5 ^{b c} | I-6 ^b | I-7 | II-8 | II-9 | II-10 | II-11 | II-12 | II-13 | II-14 | II-15 | II-16 | II-17 | II-18 | II-19 | II-20 | II-21 | |
| 1912 | 2.42 | 4.17 | 3.84 | 2.89 | 5.83 | 5.74 | | | | | | | | | | | | | | | | |
| 1913 | 2.73 | 3.79 | 3.90 | 2.49 | 4.02 | 4.20 | 2.95 | | | | | | | | | | | | | | | |
| 1914 | 2.43 | 3.91 | 3.52 | 2.41 | 4.21 | 3.75 | 2.77 | | | | | | | | | | | | | | | |
| 1915 | 2.32 | 4.11 | 2.68 | 2.48 | 4.34 | 3.59 | 2.64 | | | | | | | | | | | | | | | |
| 1916 | 3.23 ^d | 5.30 | 3.65 | 3.72 | 4.71 | 4.86 | 3.21 | 2.09 | 2.64 | 2.40 | 2.28 | 2.55 | 2.28 | 2.66 | 2.33 | 2.15 | 2.35 | 2.22 | 2.71 | 4.06 | | |
| 1917 | 3.20 ^d | 5.92 ^d | 5.24 ^d | 3.48 ^d | 5.80 ^d | 5.05 ^d | 4.63 | 2.08 | 2.65 | 2.99 | 2.48 | 2.28 | 2.15 | 2.94 | 2.49 | 2.21 | 2.61 | 2.98 | 3.05 | 3.09 | 3.52 | |
| 1918 | 2.88 ^d | 3.99 ^d | 3.53 ^d | 3.05 ^d | 4.52 ^d | 4.36 ^d | 3.36 | 2.38 | 2.81 | 2.70 | 3.13 | 3.25 | 2.84 | 3.50 | 2.66 | 2.21 | 3.15 | 3.24 | 3.37 | 4.48 | 2.90 | |
| 1919 | 3.01 ^d | 4.02 ^d | 3.30 ^d | 3.83 ^d | 5.18 ^d | 4.74 ^d | 3.36 | 2.33 | 2.62 | 2.23 | 2.41 | 2.40 | 2.14 | 3.30 | 2.32 | 3.06 | 2.53 | 2.99 | 2.66 | 3.64 | 2.29 | |
| 1920 | 2.45 | 4.04 | 3.62 | 3.51 | 5.77 | 4.33 | 3.10 | 2.71 | 2.50 | 2.22 | 2.05 | 1.95 | 1.99 | 3.14 | 2.19 | 2.85 | 2.49 | 2.75 | 2.62 | 3.17 | 2.36 | |
| 1921 | 2.07 | 3.44 | 2.82 | 2.96 ^d | 4.66 | 3.82 | 2.49 | 2.02 | 2.08 | 1.88 | 1.68 | 1.63 | 1.63 | 2.19 | 1.84 | 2.19 | 2.05 | 2.16 | 1.83 | 2.45 | 1.70 | |
| 1922 | 2.06 | 4.22 | 4.14 | 3.49 | 6.36 | 4.52 | 2.89 | 2.03 | 2.12 | 1.90 | 1.71 | 1.55 | 1.67 | 2.27 | 1.82 | 2.12 | 1.96 | 2.19 | 1.88 | 2.10 | 1.66 | |
| 1923 | 2.86 | 3.96 | 3.04 | 3.72 | 6.03 | 4.57 | 2.79 | 1.94 | 1.97 | 1.64 | 1.76 | 1.66 | 1.66 | 2.23 | 1.80 | 2.02 | 2.03 | 2.01 | 2.02 | 2.17 | 1.61 | |
| 1924 | 2.26 | 3.72 | 3.13 | 3.67 | 5.21 | 3.95 | 2.77 | 1.93 | 1.91 | 1.78 | 1.61 | 1.56 | 1.65 | 2.27 | 1.83 | 2.10 | 1.91 | 1.96 | 1.76 | 2.10 | 1.44 | |
| 1925 | 2.02 | 3.30 | 3.26 | 3.12 | 3.31 | 3.60 | 2.54 | 2.16 | 2.15 | 2.01 | 1.78 | 1.80 | 1.82 | 2.43 | 1.96 | 2.28 | 1.91 | 2.04 | 1.67 | 2.22 | 1.76 | |
| 1926 | 2.16 | 4.02 | 2.93 | 3.56 | 3.01 | 4.32 | 3.18 | 1.56 | 1.75 | 1.52 | 1.41 | 1.37 | 1.44 | 2.02 | 1.53 | 1.86 | 1.71 | 1.77 | 1.47 | 1.87 | 1.36 | |
| 1927 | 1.86 | 2.62 | 2.40 | 2.95 | 2.62 | 3.24 | 2.49 | 1.46 | 1.50 | 1.47 | 1.42 | 1.39 | 1.40 | 1.92 | 1.42 | 1.83 | 1.62 | 1.78 | 1.58 | 1.80 | 1.26 | |
| 1928 | 1.85 | 2.82 | 2.50 | 3.02 | 2.81 | n.a. | 3.16 | 1.44 | 1.50 | 1.48 | 1.33 | 1.29 | 1.35 | 1.94 | 1.47 | 1.75 | 1.47 | 1.81 | 1.60 | 1.73 | 1.38 | |
| 1929 | 1.90 | 2.81 | 2.79 | 2.84 | n.a. | n.a. | 2.65 | 1.34 | 1.45 | 1.34 | 1.27 | 1.23 | 1.22 | 1.81 | 1.38 | 1.64 | 1.47 | 1.63 | 1.39 | 1.50 | 1.36 | |
| 1930 | 1.71 | 2.50 | 2.43 | 2.37 | n.a. | n.a. | 2.58 | 1.22 | 1.24 | 1.21 | 1.15 | 1.09 | 1.08 | 1.62 | 1.43 | 1.44 | 1.29 | 1.49 | 1.31 | 1.47 | 1.21 | |
| 1931 | 1.70 | n.a. | n.a. | n.a. | n.a. | n.a. | 2.64 | 1.21 | 1.28 | 1.19 | 1.06 | 1.02 | 1.12 | 1.46 | 1.29 | 1.37 | 1.22 | 1.28 | 1.19 | 1.52 | 1.12 | |
| 1932 | 1.66 | 2.36 | n.a. | n.a. | n.a. | n.a. | 2.44 ^e | 1.18 | 1.21 | 1.15 | 1.09 | 1.05 | 1.11 | 1.47 | 1.23 | 1.39 | 1.15 | 1.38 | 1.23 | 1.46 | 1.12 | |
| 1933 | 1.67 | 2.51 | 1.72 | n.a. | n.a. | n.a. | 2.24 ^e | 1.17 | 1.23 | 1.14 | 1.04 | 0.97 | 1.09 | 1.46 | 1.25 | 1.39 | 1.19 | 1.31 | 1.16 | 1.39 | 1.10 | |
| 1934 | 1.52 | 2.41 | 1.75 | n.a. | 2.61 | n.a. | 2.14 ^e | 1.17 | 1.27 | 1.20 | 1.10 | 0.99 | 1.16 | 1.49 | 1.32 | 1.50 | 1.23 | 1.37 | 1.05 | 1.51 | 1.17 | |
| 1935 | 1.56 | 2.43 | 1.79 | n.a. | 2.68 | n.a. | 2.21 | 1.28 | 1.29 | 1.16 | 1.06 | 0.97 | 1.08 | 1.50 | 1.31 | 1.49 | 1.17 | 1.35 | 1.04 | 1.43 | 1.10 | |

See footnotes at end of table.

Table B-7.- CAMPAIGN OPERATING AND INDIRECT MAN-HOURS PER TON OF BEETS SLICED, BY FACTORY, 1912-35^a - Continued

| Year | Area and factory | | | | | | | | | | | | | | | | | | | |
|------|------------------|--------------------|--------------------|--------------------|-------------------|-------------------|--------------------|--------------------|--------------------|-------------------|-------------------|--------------------|-------------------|--------------------|-------------------|-------|--------------------|-------------------|-------|--------------------|
| | II-22 | II-23 ^b | II-24 ^b | II-25 ^b | II-26 | II-27 | II-28 ^b | II-29 ^b | II-30 ^b | II-31 | II-32 | II-33 ^b | II-34 | II-35 ^b | II-36 | II-37 | II-38 ^b | II-39 | II-40 | II-41 ^b |
| 1912 | | | | | | | | | | | | | | | | | | | | |
| 1913 | | | | | | | | | | | | | | | | | | | | |
| 1914 | | | | | | | | | | | | | | | | | | | | |
| 1915 | | | | | | | | | | | | | | | | | | | | |
| 1916 | | | | | | | | | | | | | | | | | | | | |
| 1917 | 3.08 | 2.60 | 2.33 | 3.07 | 3.67 | 3.33 | 2.70 | 3.00 | 2.35 | 4.16 | 3.36 | 4.45 | 3.60 | 2.44 | 2.41 | 3.37 | 2.57 | 6.34 | 2.37 | |
| 1918 | 2.74 | 2.53 | 2.56 | 3.10 | 3.31 | 3.34 | 2.57 | 3.20 | 2.80 | 3.45 | 3.99 | 4.37 | 3.44 | 2.13 | 2.03 | 3.10 | 2.18 | 3.39 | 2.47 | |
| 1919 | 2.22 | 3.02 | 2.59 | 3.14 | 3.28 | 3.02 | 2.11 | 3.09 | 2.62 | 3.44 | 4.20 | n.a. | 2.58 | 2.00 | 2.78 | 3.06 | 3.32 | 3.17 | n.a. | 3.93 |
| 1920 | 2.03 | 3.03 | 2.60 | 3.12 | 3.39 | 2.96 | 2.21 | 2.96 | 2.91 | 3.37 | 3.75 | 2.61 | 1.87 | 2.52 | 2.22 | 2.77 | 2.16 | 2.68 | n.a. | 3.26 |
| 1921 | 1.60 | 2.48 | 2.30 | 2.32 | 3.02 | 2.19 | 2.06 | 2.46 | 2.35 | 2.66 | 3.18 | n.a. | 2.11 | 1.90 | 2.24 | 2.82 | 1.84 | 2.18 | n.a. | 3.16 |
| 1922 | 1.52 | 2.42 | 1.92 | 2.13 | 2.43 ^b | 2.26 ^b | 1.75 | 2.51 | n.a. | 2.41 ^b | 2.55 ^b | n.a. | 1.59 ^b | 1.75 | n.a. | 2.57 | n.a. | n.a. | n.a. | 1.97 ^f |
| 1923 | 1.72 | 2.00 | 1.88 | 2.12 | 2.24 ^b | 2.39 ^b | 2.07 | 2.16 | 2.51 | 2.15 ^b | 2.57 ^b | 2.10 | 1.41 ^b | 2.02 | 2.18 ^b | 2.59 | 1.96 | 1.64 ^b | n.a. | 3.86 ^f |
| 1924 | 1.50 | 2.16 | 1.84 | 2.01 | 2.30 ^b | 2.11 ^b | 1.75 | 1.92 | 2.28 | 2.02 ^b | n.a. | 1.96 | 1.43 ^b | 1.70 | 2.08 ^b | 2.83 | 1.96 | 1.64 ^b | n.a. | 2.99 |
| 1925 | 1.61 | 2.13 | 1.63 | 1.98 | 2.16 ^b | 1.95 ^b | 1.70 | 1.82 | 2.01 | n.a. | 2.43 ^b | 1.75 | 1.41 ^b | 1.55 | 1.93 ^b | n.a. | 1.59 | 1.60 ^b | n.a. | n.a. |
| 1926 | 1.33 | 2.05 | 1.80 | 2.21 | 2.07 ^b | 2.04 ^b | 1.82 | 2.25 | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | 1.93 ^b | n.a. | n.a. | n.a. | n.a. | n.a. |
| 1927 | 1.33 | 1.96 | 1.95 | 1.91 | 2.09 ^b | 2.03 ^b | 1.69 | 1.90 | n.a. | 2.12 ^b | 2.12 ^b | n.a. | 1.40 ^b | 1.69 | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. |
| 1928 | 1.32 | 2.08 | 1.98 | 1.94 | 1.90 ^b | 2.02 ^b | 1.61 | 1.95 | 2.04 | 2.01 ^b | n.a. | 2.21 | 1.42 ^b | 1.84 | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. |
| 1929 | 1.30 | 2.10 | 1.91 | 2.01 | 1.93 ^b | 1.78 ^b | 1.74 | 1.95 | 2.11 | 1.93 ^b | 2.07 ^b | 1.86 | 1.34 ^b | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. |
| 1930 | 1.16 | 1.89 | 1.69 | 1.89 | 1.77 ^b | 1.73 ^b | 1.56 | 1.66 | 1.77 | 1.85 ^b | 1.96 ^b | 1.67 | 1.34 ^b | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. |
| 1931 | 1.12 | 1.65 | 1.65 | 1.64 | 1.73 ^b | 1.59 ^b | 1.59 | 1.47 | 1.58 | 1.56 ^b | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. |
| 1932 | 1.08 | 1.53 | 1.57 | 1.59 | 1.61 ^b | 1.56 ^b | 1.77 | n.a. | 1.40 | 1.59 ^b | 1.56 ^b | 1.34 | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. |
| 1933 | 1.07 | 1.42 | 1.50 | 1.64 | 1.71 ^b | 1.46 ^b | 1.39 | 1.51 | 1.45 | 1.47 ^b | 1.38 ^b | 1.37 | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. |
| 1934 | 1.09 | 1.51 | 1.62 | 1.48 | 1.61 ^b | n.a. | n.a. | 1.78 | 1.41 | n.a. | n.a. | 1.48 | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. |
| 1935 | 1.09 | 1.46 | 1.31 | 1.37 | 1.45 ^b | 1.55 ^b | 1.56 | 1.48 | 1.36 | 1.36 ^b | n.a. | 1.38 | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. |

See footnotes at end of table.

Table B-7.- CAMPAIGN OPERATING AND INDIRECT MAN-HOURS PER TON OF BEETS SLICED, BY FACTORY, 1912-35^a - Continued

| Year | Area and factory | | | | | | | | | | | | | | | | | | | |
|------|------------------|--------------------|-------------------|--------------------|-------------------|-------------------|-------------------|-------------------|-------------------|---------------------|------|---------------------|-------------------|--------------------|-------------------|-------------------|-------------------|-------------------|-------------------|--------------------|
| | II-42 | II-43 ^b | II-44 | II-45 ^b | I-46 | I-47 ^d | I-48 ^e | I-49 ^f | I-50 | I-51 ^{b c} | I-52 | I-53 ^{b c} | I-54 ^f | II-55 ^b | II-56 | II-57 | II-58 | I-59 | I-60 | II-61 ^b |
| 1912 | | | | | | | | | | | | | | | | | | | | |
| 1913 | | | | | | | | | | | | | | | | | | | | |
| 1914 | | | | | | | | | | | | | | | | | | | | |
| 1915 | | | | | | | | | | | | | | | | | | | | |
| 1916 | | | | | | | | | | | | | | | | | | | | |
| 1917 | | | | | | | | | | | | | | | | | | | | |
| 1918 | | | | | | | | | | | | | | | | | | | | |
| 1919 | | | | | | | | | | | | | | | | | | | | |
| 1920 | 2.38 | 1.77 | 3.11 | 2.76 | | | | | | | | | | | | | | | | |
| 1921 | 1.54 | 1.75 | 2.43 | 2.27 | 2.92 ^b | 4.56 | 3.49 | 2.34 | | | | | | | | | | | | |
| 1922 | 1.47 | 1.59 | 2.28 ^b | 2.31 | n.a. | 3.67 | 3.19 | 2.19 | | | | | | | | | | | | |
| 1923 | 1.50 | 1.39 | 2.40 ^b | n.a. | 3.22 ^b | 3.36 | 3.08 | 2.62 | | | | | | | | | | | | |
| 1924 | 1.47 | 1.51 | n.a. | 2.47 | 2.91 ^b | 3.68 | 3.07 | 2.18 | 2.93 | 3.55 | 3.19 | 3.52 | 4.77 | | | | | | | |
| 1925 | 1.58 | 1.44 | n.a. | n.a. | 2.87 ^b | 2.72 | 2.82 | 2.40 | 2.55 | 3.97 | 2.58 | 2.76 | 3.85 | 2.77 | 2.17 ^h | 4.33 ^h | 4.15 ^h | 2.39 ^h | 2.37 ^h | 2.39 |
| 1926 | 1.39 | n.a. | 2.28 ^b | n.a. | 3.36 ^b | 3.54 | 2.64 | 2.20 | 3.02 | 3.45 | 2.58 | 3.13 | 3.00 | 1.65 | 2.01 ^h | 3.72 ^h | 3.95 ^h | 2.33 ^h | 2.29 ^h | 2.12 |
| 1927 | 1.36 | 1.56 | n.a. | n.a. | 3.39 ^b | 2.41 | n.a. | 2.17 | 2.33 | 2.82 | n.a. | 2.46 | 2.84 | 1.85 | 2.02 ^h | 2.68 ^h | 4.03 ^h | 2.38 ^h | 2.13 ^h | 1.45 |
| 1928 | 1.22 | 1.31 | n.a. | n.a. | 2.88 ^b | 2.28 | 2.68 | 2.21 | 2.36 | n.a. | n.a. | 2.28 | 3.15 | 1.80 | 1.72 | 2.06 | 3.33 | 2.04 | 1.86 | 1.94 |
| 1929 | 1.22 | 1.31 | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | 1.60 | 1.50 | 2.74 | 3.36 | 1.82 | 1.78 | 1.74 |
| 1930 | 1.18 | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | 1.49 | 1.25 | 2.03 | 2.97 | 1.61 | 1.55 | 1.50 |
| 1931 | 1.10 | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | 1.52 | 1.08 | 1.56 | 2.74 | 1.54 | 1.45 | 1.42 |
| 1932 | 1.07 | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | 1.52 | 1.00 | 1.45 | 2.79 | 1.57 | 1.43 | 1.38 |
| 1933 | 1.03 | 1.13 | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | 2.18 ^g | 2.71 | 2.42 | 2.57 | n.a. | 1.28 | 0.94 | 1.39 | 2.36 | 1.42 | 1.56 | 1.34 |
| 1934 | 1.12 | n.a. | n.a. | n.a. | 2.79 | 2.54 | 2.14 | n.a. | 2.05 ^g | 2.19 | 2.28 | n.a. | n.a. | 1.38 | 1.16 | 1.47 | 2.45 | 1.48 | 1.48 | 1.47 |
| 1935 | n.a. | n.a. | n.a. | n.a. | 2.81 | 2.31 | 1.85 | n.a. | 2.13 ^g | 2.17 | 2.28 | n.a. | n.a. | 1.41 | 1.12 | 1.86 | 2.33 | 1.47 | 1.46 | 1.34 |

See footnotes at end of table.

Table B-7.- CAMPAIGN OPERATING AND INDIRECT MAN-HOURS PER TON OF BEETS SLICED, BY FACTORY, 1912-35^a - Continued

| Year | Area and factory | | | | | | | | | | | | | | | | | | | | | | |
|------|------------------|--------------------|-------|-------|------|-------------------|-------------------|-------------------|------|-------|--------------------|-------|--------------------|--------------------|------|------|-------|-------|------|-------|-------|-------|--|
| | II-62 | II-63 ^b | II-64 | II-65 | I-66 | I-67 ^c | I-68 ^c | I-69 ¹ | I-70 | II-71 | II-72 ^b | II-73 | II-74 ^f | II-75 ^b | I-76 | I-77 | II-78 | II-79 | I-80 | II-81 | II-82 | II-83 | |
| 1912 | | | | | | | | | | | | | | | | | | | | | | | |
| 1913 | | | | | | | | | | | | | | | | | | | | | | | |
| 1914 | | | | | | | | | | | | | | | | | | | | | | | |
| 1915 | | | | | | | | | | | | | | | | | | | | | | | |
| 1916 | | | | | | | | | | | | | | | | | | | | | | | |
| 1917 | | | | | | | | | | | | | | | | | | | | | | | |
| 1918 | | | | | | | | | | | | | | | | | | | | | | | |
| 1919 | | | | | | | | | | | | | | | | | | | | | | | |
| 1920 | | | | | | | | | | | | | | | | | | | | | | | |
| 1921 | | | | | | | | | | | | | | | | | | | | | | | |
| 1922 | | | | | | | | | | | | | | | | | | | | | | | |
| 1923 | | | | | | | | | | | | | | | | | | | | | | | |
| 1924 | | | | | | | | | | | | | | | | | | | | | | | |
| 1925 | 2.37 | 3.54 | | | | | | | | | | | | | | | | | | | | | |
| 1926 | 1.89 | 1.96 | 1.74 | 1.60 | 2.39 | 3.35 | 3.28 | 4.35 | 2.54 | | | | | | | | | | | | | | |
| 1927 | 1.69 | 2.46 | 1.31 | 1.33 | 1.82 | 3.34 | n.a. | 3.80 | 2.88 | 1.48 | 1.43 | 3.47 | 1.53 | | | | | | | | | | |
| 1928 | 1.65 | 2.02 | 1.68 | 1.62 | 1.33 | 3.41 | n.a. | 4.68 | 2.65 | 1.32 | 1.53 | 3.14 | 1.53 | 2.87 | 3.68 | 2.36 | | | | | | | |
| 1929 | 1.53 | 1.89 | 1.47 | 1.45 | 1.15 | n.a. | n.a. | n.a. | n.a. | 1.20 | 1.41 | 3.09 | 1.42 | 1.97 | 4.08 | 1.83 | | | | | | | |
| 1930 | 1.43 | 1.66 | 1.46 | 1.32 | 1.36 | n.a. | n.a. | n.a. | n.a. | 1.03 | 1.10 | 2.60 | 1.40 | 1.51 | 3.18 | 1.67 | 1.70 | 1.16 | | | | | |
| 1931 | 1.39 | n.a. | 1.26 | 1.17 | 1.10 | n.a. | n.a. | n.a. | n.a. | 0.94 | 1.04 | 2.29 | 1.46 | 1.45 | 3.08 | n.a. | 1.66 | 1.01 | | | | | |
| 1932 | 1.26 | n.a. | 1.20 | 1.13 | 1.20 | n.a. | n.a. | n.a. | n.a. | 0.93 | 1.54 | 2.07 | 1.49 | 1.45 | 2.93 | n.a. | 1.68 | 0.98 | | | | | |
| 1933 | 1.26 | n.a. | 1.15 | 1.18 | 1.16 | n.a. | n.a. | n.a. | n.a. | 0.90 | 1.22 | 1.92 | 1.54 | 1.35 | 2.79 | n.a. | 1.57 | 1.00 | 2.29 | 2.23 | 1.85 | | |
| 1934 | 1.38 | n.a. | 1.12 | 1.17 | 1.10 | 2.97 | 2.62 | n.a. | n.a. | 0.90 | 1.13 | 1.78 | n.a. | 1.38 | 2.75 | n.a. | 1.34 | 1.15 | 2.07 | 2.14 | 1.58 | 2.34 | |
| 1935 | n.a. | n.a. | 1.11 | 1.16 | 1.15 | 2.73 | 2.63 | n.a. | n.a. | 0.88 | 1.08 | 2.00 | 1.56 | 1.32 | 2.24 | n.a. | 1.43 | n.a. | 2.19 | 2.12 | 1.51 | 1.90 | |

See footnotes at end of table.

Table B-7.- CAMPAIGN OPERATING AND INDIRECT MAN-HOURS PER TON OF BEETS SLICED, BY FACTORY, 1912-35^a - Continued

^aData above the line in each column are based upon the first survey, conducted by the National Bureau of Economic Research in 1927-29. (In columns where no line appears all data are from the NRP - NBER survey.) Usually data for 1927 or 1928 were obtained in both the 1927-29 and the 1936 surveys. Inasmuch as the occupations included in the 2 surveys differed slightly, the man-hour data in the overlapping years also differ slightly. In such instances the data of the earlier survey have been adjusted upward or downward in proportion to the discrepancy in the overlapping years. Ratios available for 1 year only are not included in this table. The factories, years, and ratios are:

| Area and factory | Year | Man-hours per ton |
|------------------|------|-------------------|
| II-84 | 1917 | 2.73 |
| II-85 | 1917 | 4.73 |
| II-86 | 1918 | 4.14 |
| II-87 | 1924 | 2.23 |

The year refers to that in which the factory campaign period began. The campaign period covers the time from the first slicing of the beets to the time that all beets are processed. Data cover operating and indirect labor during the campaign period beginning in the specified year, exclusive of plant-office and central-office labor and labor devoted to pulp pressing and drying. (See appendixes D and E.)

The area is shown by the Roman numeral preceding the factory code number. I indicates that the factory is located east of the Mississippi River or in Iowa or Minnesota; II, that it is located in some other State.

^bPart of beet-shed man-hours not included.

^cMan-hours for storekeepers, timekeepers, and clerks included for years covered by first (NBER) survey.

^dMan-hours for campaign clean-up not included.

^eMan-hours for sugar melting and receiving not included.

^fMan-hours calculated by multiplying gross slicing days, total employees, and number of hours per shift. (Net slicing days are normally used in obtaining man-hours by this method.)

^gMan-hours for yardmen not included.

^hMan-hours for storeroom and superintendence-clerks are included.

ⁱMan-hours for pulp handling and drying may be included.

^{n.a.}Data not available because plant is idle, dismantled, or leased to a company not surveyed, or for some other reason.

Table B-8.- INTERCAMPAIGN MAN-HOURS PER TON OF BREETS SLICED
BY FACTORY, 1927-35^a

| Year | Area and factory | | | | | |
|------|----------------------|----------------------|------------------|----------------------|----------------------|----------------------|
| | I-1 ^{b o} | I-2 ^{b c d} | I-3 ^d | I-4 ^{b c d} | I-5 ^{b c d} | I-7 |
| 1927 | | | | | | |
| 1928 | 0.87 | 1.55 | | 1.53 | 1.81 | |
| 1929 | .84 | 1.26 | 1.52 | 1.08 | n.a. | 1.08 |
| 1930 | .51 | 0.84 | 0.53 | 0.57 | n.a. | 0.78 |
| 1931 | .24 | n.a. | n.a. | n.a. | n.a. | 0.49 |
| 1932 | .27 | 0.59 | n.a. | n.a. | n.a. | 0.51 |
| 1933 | .47 | 0.86 | 0.43 | n.a. | n.a. | 0.91 |
| 1934 | .49 | 0.80 | 0.59 | n.a. | 1.34 | 0.79 |
| 1935 | .88 | 1.14 | 1.19 | n.a. | 1.18 | 1.16 |
| | II-8 | II-9 | II-10 | II-11 | II-12 | II-13 |
| 1927 | 0.48 | 0.43 | 0.45 | 0.49 | 0.40 | 0.40 |
| 1928 | .62 | .68 | .57 | .88 | .49 | .59 |
| 1929 | .55 | .44 | .52 | .47 | .53 | .45 |
| 1930 | .42 | .40 | .33 | .38 | .34 | .43 |
| 1931 | .56 | .56 | .44 | .46 | .36 | .52 |
| 1932 | .74 | .71 | .65 | .67 | .66 | .75 |
| 1933 | .46 | .40 | .44 | .43 | .39 | .49 |
| 1934 | .88 | .94 | .95 | .87 | .72 | .98 |
| 1935 | .67 | .63 | .52 | .68 | .51 | .68 |
| | II-14 | II-15 | II-16 | II-17 | II-18 | II-19 |
| 1927 | 0.54 | 0.46 | 0.44 | 0.53 | 0.56 | 0.56 |
| 1928 | 0.72 | .61 | .61 | 0.69 | 0.80 | 0.99 |
| 1929 | 0.66 | .63 | .69 | 0.68 | 0.61 | 0.81 |
| 1930 | 0.62 | .36 | .36 | 0.62 | 0.69 | 0.54 |
| 1931 | 0.71 | .68 | .46 | 0.80 | 0.69 | 0.45 |
| 1932 | 0.83 | .70 | .71 | 0.75 | 0.69 | 0.36 |
| 1933 | 0.47 | .50 | .44 | 0.74 | 0.60 | 0.51 |
| 1934 | 1.01 | .99 | .98 | 1.31 | 1.23 | 1.13 |
| 1935 | 0.81 | .97 | .78 | 0.91 | 1.07 | 1.25 |
| | II-20 | II-21 | II-22 | II-26 ^{e f} | II-27 ^f | II-31 ^{e f} |
| 1927 | 0.63 | 0.49 | 0.63 | | | |
| 1928 | 1.22 | .68 | 0.84 | 0.88 | 1.12 | 2.86 |
| 1929 | 0.78 | .53 | 0.70 | .86 | 1.82 | 0.82 |
| 1930 | 0.69 | .44 | 0.66 | .82 | 1.66 | 1.45 |
| 1931 | 0.53 | .58 | 0.80 | .57 | 0.74 | 1.10 |
| 1932 | 0.45 | .72 | 0.68 | .60 | 0.75 | 0.34 |
| 1933 | 0.41 | .45 | 0.59 | .51 | 0.71 | 0.72 |
| 1934 | 0.35 | .88 | 1.25 | .54 | n.a. | n.a. |
| 1935 | 0.84 | .75 | 1.06 | .78 | 0.89 | 0.38 |
| | II-32 ^{e f} | II-34 ^f | II-42 | I-46 ^d | I-47 ^d | I-48 ^d |
| 1927 | | | 0.67 | | | |
| 1928 | | 0.94 | 0.72 | | | |
| 1929 | 0.79 | 1.17 | 0.57 | | | |
| 1930 | 1.56 | 0.92 | 0.62 | | | |
| 1931 | n.a. | n.a. | 0.82 | | | |
| 1932 | 0.68 | n.a. | 0.70 | | | |
| 1933 | 0.47 | n.a. | 0.68 | | | |
| 1934 | n.a. | n.a. | 1.13 | 1.13 | 0.86 | 1.35 |
| 1935 | n.a. | n.a. | n.a. | 1.37 | 1.04 | 0.92 |

See footnotes at end of table.

Table B-8.- INTERCAMPAIGN MAN-HOURS PER TON OF BEETS SLICED BY FACTORY, 1927-55^a - Continued

| Year | Area and factory | | | | | |
|------|--------------------|-----------------------|-------------------|-----------------------|--------------------|----------------------|
| | I-50 | I-51 ^{b o d} | I-52 | I-53 ^{b o d} | II-56 ^f | II-57 ^f |
| 1927 | | | | | | |
| 1928 | | | | 0.69 | 0.70 | 0.72 |
| 1929 | | | | n.a. | 0.87 | 1.29 |
| 1930 | | | | n.a. | 0.42 | 0.87 |
| 1931 | | | | n.a. | 0.81 | 0.38 |
| 1932 | | | | n.a. | 0.78 | 0.40 |
| 1933 | 0.92 | 0.68 | 1.50 | 0.66 | 0.52 | 0.48 |
| 1934 | .76 | 0.82 | 0.82 | n.a. | 1.67 | 0.72 |
| 1935 | n.a. | 1.19 | n.a. | n.a. | 1.30 | 0.86 |
| | II-58 ^f | I-59 ^f | I-60 ^f | II-62 | II-64 | II-65 |
| 1927 | | | | 0.43 | 0.44 | 0.59 |
| 1928 | 1.52 | | 0.98 | 0.56 | .58 | 0.77 |
| 1929 | 1.19 | | 0.94 | 0.52 | .66 | 0.86 |
| 1930 | 0.70 | 0.66 | 0.43 | 0.37 | .42 | 0.63 |
| 1931 | 0.78 | 0.61 | 0.58 | 0.52 | .54 | 0.78 |
| 1932 | 0.80 | 0.56 | 0.47 | 0.67 | .69 | 0.75 |
| 1933 | 0.72 | 0.62 | 0.54 | 0.42 | .40 | 0.62 |
| 1934 | 5.14 | 1.37 | 1.36 | 1.06 | .74 | 1.19 |
| 1935 | 0.68 | 1.03 | 0.99 | n.a. | .55 | 1.12 |
| | I-66 ^f | I-67 ^d | I-68 ^d | II-71 | II-74 | II-75 ^{e f} |
| 1927 | | | | 0.38 | 0.81 | |
| 1928 | 0.98 | | | .62 | 0.77 | 3.50 |
| 1929 | .75 | | | .46 | 1.04 | 1.29 |
| 1930 | .58 | | | .45 | 0.77 | 1.11 |
| 1931 | .37 | | | .55 | 0.91 | 0.46 |
| 1932 | .34 | | | .51 | 0.50 | 0.56 |
| 1933 | .37 | | | .41 | 0.81 | 0.63 |
| 1934 | .82 | | | .70 | n.a. | 0.35 |
| 1935 | .51 | 1.73 | 2.46 | .51 | 1.00 | 0.69 |
| | I-76 ^c | I-77 ^f | II-78 | II-79 | I-80 | II-83 |
| 1927 | | | | | | |
| 1928 | 2.20 | | | | | |
| 1929 | 3.06 | 1.64 | | | | |
| 1930 | 1.78 | 0.74 | 0.59 | | | |
| 1931 | 0.85 | n.a. | 1.22 | 0.75 | | |
| 1932 | 1.08 | n.a. | 0.42 | 1.03 | | |
| 1933 | 1.01 | n.a. | 0.52 | 0.76 | | |
| 1934 | 1.26 | n.a. | 1.58 | 1.85 | 0.99 | 1.33 |
| 1935 | 1.60 | n.a. | 0.52 | n.a. | 1.20 | 2.13 |

^aNRP-NBER field-survey data. The intercampaign period includes that time in the fiscal year March 1st to February 28th which falls outside the campaign period. (The campaign period covers the time from the first slicing of the beets to the time that all beets are processed.) Data cover all man-hours during the intercampaign period except central-office. The areas are indicated as in table B-7.

^bRatio is underestimated, as some intercampaign man-hours are included with campaign man-hours.

^cRatio refers to fiscal year other than March 1st to February 28th.

^dAdministrative man-hours not included.

^eNumber of administrative man-hours in the years prior to 1932 assumed to be the same as in 1932.

^fClerical and administrative man-hours approximated by assuming that the same number of clerical and administrative men who worked in the campaign period also worked during the intercampaign period.

n.a.-Data not available because plant is idle, dismantled, or leased to a company not surveyed, or for some other reason.

Table B-9.- ANALYSIS OF CAMPAIGN MAN-HOURS PER TON OF BEETS SLICED, ALL REPORTING FACTORIES, 1916-35^a

| Year | Number of factories | Average and position measures | | | | | | Dispersion measures | | Contingent labor-reduction ratios ^b | | | | Shift intervals (years) ^b | |
|------|---------------------|-------------------------------|----------------|----------------|----------------|----------------|------|-------------------------------|---------------------------|--|-----------------------------|---|---|--------------------------------------|----------------------------------|
| | | Q ₀ | Q ₁ | Q ₂ | Q ₃ | Q ₄ | WM | Average deviation from median | Coefficient of dispersion | Range ratio method | Most efficient to WM method | Q ₁ to Q ₂ method | Q ₁ to Q ₅ method | Q ₂ to Q ₁ | Q ₅ to Q ₁ |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) | (15) |
| 1916 | 20 | 2.09 | 2.30 | 2.650 | 3.68 | 6.30 | 2.61 | 0.74 | 0.28 | 0.61 | 0.20 | 0.13 | 0.37 | 4+ | 12+ |
| 1917 | 42 | 2.08 | 2.49 | 3.025 | 5.60 | 6.34 | 2.86 | .78 | .28 | .67 | .27 | .18 | .31 | 3+ | 9+ |
| 1918 | 41 | 2.03 | 2.67 | 3.130 | 3.44 | 4.62 | 3.07 | .58 | .19 | .55 | .34 | .15 | .22 | 2+ | 3+ |
| 1919 | 39 | 2.00 | 2.44 | 3.020 | 3.32 | 5.18 | 2.86 | .64 | .18 | .61 | .30 | .19 | .27 | 1+ | 8+ |
| 1920 | 44 | 1.77 | 2.29 | 2.765 | 3.13 | 5.77 | 2.66 | .52 | .19 | .69 | .33 | .17 | .27 | 1+ | 8+ |
| 1921 | 47 | 1.54 | 1.93 | 2.240 | 2.78 | 4.65 | 2.22 | .49 | .22 | .67 | .31 | .14 | .31 | 5+ | 8+ |
| 1922 | 42 | 1.47 | 1.82 | 2.125 | 2.51 | 6.36 | 2.18 | .59 | .28 | .77 | .33 | .14 | .27 | 6+ | 7+ |
| 1923 | 47 | 1.39 | 1.90 | 2.120 | 2.61 | 6.03 | 2.16 | .57 | .27 | .77 | .36 | .10 | .27 | 5+ | 6+ |
| 1924 | 52 | 1.43 | 1.80 | 2.105 | 2.92 | 5.21 | 2.14 | .55 | .26 | .73 | .33 | .14 | .38 | 4+ | 5+ |
| 1925 | 57 | 1.41 | 1.82 | 2.165 | 2.73 | 4.33 | 2.20 | .58 | .27 | .67 | .36 | .16 | .33 | 3+ | 4+ |
| 1926 | 57 | 1.33 | 1.75 | 2.095 | 3.01 | 4.35 | 1.97 | .69 | .33 | .69 | .32 | .16 | .42 | 2+ | 4+ |
| 1927 | 61 | 1.26 | 1.50 | 1.905 | 2.46 | 4.03 | 1.82 | .53 | .29 | .69 | .31 | .21 | .39 | 3+ | (c) |
| 1928 | 64 | 1.22 | 1.53 | 1.940 | 2.36 | 4.63 | 1.76 | .51 | .26 | .74 | .31 | .21 | .35 | 1+ | (e) |
| 1929 | 53 | 1.15 | 1.39 | 1.740 | 1.95 | 4.08 | 1.62 | .43 | .25 | .72 | .29 | .20 | .29 | 4 | (e) |
| 1930 | 54 | 1.03 | 1.29 | 1.505 | 1.77 | 3.18 | 1.46 | .34 | .23 | .68 | .29 | .14 | .27 | (a) | (c) |
| 1931 | 46 | 0.94 | 1.17 | 1.435 | 1.59 | 3.08 | 1.37 | .29 | .20 | .69 | .31 | .16 | .26 | (a) | (e) |
| 1932 | 60 | 0.93 | 1.18 | 1.440 | 1.59 | 3.52 | 1.46 | .33 | .23 | .74 | .36 | .16 | .26 | (e) | (e) |
| 1933 | 58 | 0.90 | 1.17 | 1.390 | 1.67 | 2.79 | 1.46 | .34 | .24 | .68 | .38 | .16 | .30 | (e) | (e) |
| 1934 | 58 | 0.90 | 1.17 | 1.480 | 2.07 | 2.97 | 1.59 | .41 | .28 | .70 | .43 | .21 | .43 | (e) | (e) |
| 1935 | 59 | 0.68 | 1.20 | 1.460 | 1.98 | 2.91 | 1.52 | .38 | .26 | .69 | .42 | .18 | .39 | (e) | (e) |

^aSymbols used are: Q₀, lowest man-hour ratio; Q₄, highest man-hour ratio; WM, weighted arithmetic mean of all ratios.

^bFor explanation see text, pp. 97-9.

^cDoes not reach Q₁ in 1935.

Table B-10.- ANALYSIS OF CAMPAIGN MAN-HOURS PER TON OF BEETS SLICED, 31 IDENTICAL FACTORIES, 1917-35^a

| Year | Average and position measures | | | | | | Dispersion measures | | Contingent labor-reduction ratios ^b | | | | Array-stability measures ^c | | | | | | Shift intervals (years) ^b | |
|------|-------------------------------|----------------|----------------|----------------|----------------|------|-------------------------------|---------------------------|--|-----------------------------|---|---|---------------------------------------|-----------|---------------------------------|-----------|----------------------------------|-----------|--------------------------------------|----------------------------------|
| | Q ₀ | Q ₁ | Q ₂ | Q ₃ | Q ₄ | WM | Average deviation from median | Coefficient of dispersion | Range ratio method | Most efficient to WM method | Q ₁ to Q ₃ method | Q ₁ to Q ₂ method | Percent remaining in upper half | | Percent remaining in lower half | | Percent remaining in middle half | | Q ₂ to Q ₁ | Q ₃ to Q ₁ |
| | | | | | | | | | | | | | Each year | Last year | Each year | Last year | Each year | Last year | | |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) | (15) | (16) | (17) | (18) | (19) | (20) | |
| 1917 | 2.08 | 2.49 | 3.00 | 3.56 | 5.82 | 2.78 | 0.65 | 0.22 | 0.64 | 0.26 | 0.26 | 0.17 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 3+ | 3+ |
| 1918 | 2.21 | 2.70 | 3.14 | 3.57 | 4.52 | 3.11 | .46 | .15 | .51 | .29 | .20 | .14 | 73.3 | 73.3 | 73.3 | 73.3 | 60.0 | 60.0 | 2+ | 2+ |
| 1919 | 2.11 | 2.58 | 2.99 | 3.28 | 5.18 | 2.76 | .58 | .18 | .59 | .24 | .27 | .20 | 66.7 | 80.0 | 60.0 | 80.0 | 53.0 | 60.0 | 1+ | 3+ |
| 1920 | 1.77 | 2.23 | 2.75 | 3.12 | 5.77 | 2.61 | .52 | .19 | .69 | .32 | .29 | .19 | 66.7 | 66.7 | 53.3 | 73.3 | 53.3 | 60.0 | 0+ | 3+ |
| 1921 | 1.60 | 1.85 | 2.18 | 2.46 | 4.66 | 2.10 | .41 | .19 | .66 | .24 | .25 | .15 | 66.7 | 73.3 | 46.7 | 66.7 | 46.7 | 73.3 | 4+ | 9+ |
| 1922 | 1.52 | 1.80 | 2.10 | 2.41 | 6.36 | 2.08 | .48 | .23 | .76 | .27 | .25 | .14 | 60.0 | 66.7 | 40.0 | 60.0 | 40.0 | 66.7 | 5 | 8+ |
| 1923 | 1.39 | 1.82 | 2.03 | 2.24 | 6.03 | 2.05 | .42 | .21 | .77 | .32 | .19 | .10 | 60.0 | 80.0 | 33.3 | 80.0 | 26.7 | 66.7 | 2+ | 7+ |
| 1924 | 1.44 | 1.76 | 1.94 | 2.16 | 5.21 | 1.95 | .38 | .20 | .72 | .26 | .19 | .09 | 53.3 | 73.3 | 33.3 | 66.7 | 26.7 | 60.0 | 4+ | 6+ |
| 1925 | 1.44 | 1.78 | 1.97 | 2.16 | 3.31 | 2.00 | .29 | .16 | .56 | .28 | .18 | .10 | 40.0 | 60.0 | 20.0 | 53.3 | 26.7 | 60.0 | 3 | 5+ |
| 1926 | 1.33 | 1.53 | 1.81 | 2.07 | 4.02 | 1.70 | .41 | .23 | .67 | .22 | .26 | .15 | 40.0 | 73.3 | 20.0 | 73.3 | 20.0 | 53.3 | 4+ | 6+ |
| 1927 | 1.26 | 1.47 | 1.80 | 1.98 | 2.62 | 1.65 | .29 | .16 | .52 | .24 | .26 | .18 | 40.0 | 66.7 | 20.0 | 73.3 | 20.0 | 73.3 | 3+ | 6 |
| 1928 | 1.29 | 1.47 | 1.78 | 1.98 | 3.16 | 1.62 | .35 | .20 | .59 | .20 | .26 | .17 | 40.0 | 73.3 | 20.0 | 66.7 | 13.3 | 66.7 | 2+ | 5 |
| 1929 | 1.22 | 1.36 | 1.69 | 1.95 | 2.81 | 1.55 | .32 | .19 | .57 | .21 | .30 | .20 | 40.0 | 73.3 | 20.0 | 66.7 | 13.3 | 60.0 | 6 | (d) |
| 1930 | 1.08 | 1.24 | 1.56 | 1.93 | 2.58 | 1.40 | .29 | .19 | .58 | .23 | .36 | .21 | 40.0 | 73.3 | 20.0 | 73.3 | 6.7 | 66.7 | (d) | (d) |
| 1931 | 1.02 | 1.19 | 1.42 | 1.59 | 2.64 | 1.35 | .24 | .17 | .61 | .24 | .25 | .18 | 40.0 | 80.0 | 20.0 | 66.7 | 6.7 | 53.3 | (d) | (d) |
| 1932 | 1.05 | 1.17 | 1.40 | 1.59 | 3.52 | 1.46 | .31 | .22 | .70 | .28 | .26 | .16 | 40.0 | 73.3 | 20.0 | 73.3 | 6.7 | 60.0 | (d) | (d) |
| 1933 | 0.97 | 1.16 | 1.38 | 1.47 | 2.24 | 1.31 | .21 | .15 | .57 | .26 | .21 | .16 | 33.3 | 66.7 | 20.0 | 60.0 | 6.7 | 80.0 | (d) | (d) |
| 1934 | 0.99 | 1.17 | 1.44 | 1.52 | 2.61 | 1.42 | .27 | .19 | .62 | .29 | .23 | .19 | 33.3 | 73.3 | 20.0 | 60.0 | 6.7 | 80.0 | (d) | (d) |
| 1935 | 0.97 | 1.17 | 1.36 | 1.49 | 2.68 | 1.35 | .24 | .18 | .64 | .28 | .21 | .14 | 26.7 | 66.7 | 20.0 | 73.3 | 6.7 | 46.7 | (d) | (d) |

^aSymbols used are: Q₀, lowest man-hour ratio; Q₄, highest man-hour ratio; WM, weighted arithmetic mean of all ratios.

^bFor explanation see text, pp. 97-9.

^c1917 used as base. In this year there were 30 operating factories and 1 idle factory. Columns (13), (15), and (17) show the percentage of the factories in

the given half of the 1917 array that have remained continuously in that half. Columns (14), (16), and (18) show the percentage of the factories in a given half of the 1917 array that are in the same half of the given-year array.

^dDoes not reach Q₁ in 1935.

Table B-11.- ANALYSIS OF LINK RELATIVES^a OF CAMPAIGN MAN-HOUR RATIOS, 1913-35

| Year | Link relatives | | | | Average deviation | Coefficient of dispersion ^c | Chain index of median link relatives ^d (1912=100) | |
|------|----------------|----------------------------------|----------|----------|-------------------|--|--|--------|
| | Number | Percentage distribution by class | | | | | | Median |
| | | Neutral ^b | Decrease | Increase | | | | |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | |
| 1913 | 6 | 17 | 67 | 17 | 0.886 | 0.13 | 0.15 | 88.6 |
| 1914 | 7 | 0 | 71 | 29 | 0.939 | .05 | .06 | 83.0 |
| 1915 | 7 | 0 | 57 | 43 | 0.957 | .06 | .07 | 79.6 |
| 1916 | 7 | 0 | 0 | 100 | 1.354 | .09 | .07 | 107.7 |
| 1917 | 20 | 15 | 20 | 65 | 1.078 | .13 | .12 | 116.2 |
| 1918 | 40 | 10 | 50 | 40 | 0.978 | .15 | .15 | 113.6 |
| 1919 | 38 | 18 | 58 | 24 | 0.941 | .13 | .14 | 106.9 |
| 1920 | 39 | 18 | 62 | 21 | 0.952 | .08 | .09 | 101.8 |
| 1921 | 43 | 7 | 91 | 2 | 0.820 | .06 | .08 | 83.4 |
| 1922 | 42 | 21 | 55 | 24 | 0.972 | .10 | .10 | 81.1 |
| 1923 | 41 | 17 | 46 | 37 | 0.989 | .10 | .10 | 80.3 |
| 1924 | 45 | 22 | 60 | 18 | 0.968 | .07 | .07 | 77.6 |
| 1925 | 47 | 11 | 53 | 36 | 0.971 | .10 | .10 | 75.3 |
| 1926 | 49 | 4 | 67 | 29 | 0.909 | .14 | .15 | 68.5 |
| 1927 | 52 | 21 | 65 | 13 | 0.942 | .10 | .11 | 64.6 |
| 1928 | 58 | 26 | 45 | 29 | 0.995 | .08 | .08 | 64.1 |
| 1929 | 52 | 21 | 65 | 13 | 0.940 | .06 | .07 | 60.3 |
| 1930 | 52 | 6 | 90 | 4 | 0.896 | .05 | .05 | 54.1 |
| 1931 | 46 | 9 | 78 | 13 | 0.936 | .05 | .06 | 50.6 |
| 1932 | 46 | 28 | 52 | 20 | 0.976 | .08 | .08 | 49.3 |
| 1933 | 49 | 22 | 57 | 20 | 0.963 | .06 | .06 | 47.4 |
| 1934 | 51 | 12 | 39 | 49 | 1.019 | .07 | .07 | 48.4 |
| 1935 | 55 | 31 | 45 | 24 | 0.990 | .06 | .06 | 47.9 |

^aFigure for given year divided by figure for preceding year.^cAverage deviation divided by median.^bChange was less than 2 percent.^dComputed by serial multiplication of link relatives.

Table B-12.- INDEX OF CAMPAIGN MAN-HOUR RATIOS, 1912-35

| Year | Number of factories | Man-hours per ton of beets sliced ^a | | Link relative (2)÷(3) | Chain index of link relatives (1912=100) |
|------|---------------------|--|----------------|--------------------------|---|
| | | Given year | Preceding year | | |
| | (1) | (2) | (3) | (4) | (5) |
| 1913 | 6 | 3.45 | 3.96 | 0.870 | 87.0 |
| 1914 | 7 | 3.21 | 3.36 | 0.956 | 83.2 |
| 1915 | 7 | 3.10 | 3.21 | 0.967 | 80.4 |
| 1916 | 7 | 4.13 | 3.10 | 1.330 | 107.0 |
| 1917 | 20 | 2.75 | 2.61 | 1.055 | 112.9 |
| 1918 | 40 | 3.06 | 2.85 | 1.074 | 121.2 |
| 1919 | 38 | 2.85 | 3.06 | 0.932 | 113.0 |
| 1920 | 39 | 2.67 | 2.86 | 0.936 | 105.7 |
| 1921 | 43 | 2.17 | 2.66 | 0.815 | 86.2 |
| 1922 | 42 | 2.18 | 2.22 | 0.985 | 84.9 |
| 1923 | 41 | 2.15 | 2.18 | 0.986 | 83.7 |
| 1924 | 45 | 2.07 | 2.15 | 0.964 | 80.7 |
| 1925 | 47 | 2.11 | 2.14 | 0.985 | 79.5 |
| 1926 | 49 | 1.94 | 2.25 | 0.861 | 68.4 |
| 1927 | 52 | 1.83 | 1.95 | 0.937 | 64.1 |
| 1928 | 58 | 1.73 | 1.80 | 0.961 | 61.6 |
| 1929 | 52 | 1.61 | 1.69 | 0.955 | 58.8 |
| 1930 | 52 | 1.47 | 1.62 | 0.906 | 53.3 |
| 1931 | 46 | 1.37 | 1.42 | 0.966 | 51.5 |
| 1932 | 46 | 1.42 | 1.37 | 1.036 | 53.3 |
| 1933 | 49 | 1.33 | 1.44 | 0.926 | 49.4 |
| 1934 | 51 | 1.50 | 1.46 | 1.032 | 51.0 |
| 1935 | 55 | 1.52 | 1.60 | 0.949 | 48.4 |

^aComputed from aggregates of man-hours and tons of beets sliced for all identical factories available in consecutive pairs of years.

Table B-13.- INDEX OF BEETS SLICED PER FACTORY PER DAY, 1917-35^a

| Year | Short tons of beets sliced per day | | Link relatives | Chain index of link relatives (1917=100) |
|------|------------------------------------|----------------|----------------|--|
| | Given year | Preceding year | | |
| | (1) | (2) | (3) | (4) |
| 1918 | 991 | 1,023 | 0.969 | 96.9 |
| 1919 | 1,073 | 1,012 | 1.060 | 102.7 |
| 1920 | 1,156 | 1,066 | 1.084 | 111.3 |
| 1921 | 1,286 | 1,129 | 1.139 | 126.8 |
| 1922 | 1,363 | 1,297 | 1.051 | 133.3 |
| 1923 | 1,391 | 1,367 | 1.018 | 135.7 |
| 1924 | 1,501 | 1,356 | 1.107 | 150.2 |
| 1925 | 1,358 | 1,462 | 0.929 | 139.5 |
| 1926 | 1,480 | 1,337 | 1.107 | 154.5 |
| 1927 | 1,490 | 1,462 | 1.019 | 157.4 |
| 1928 | 1,517 | 1,476 | 1.028 | 161.8 |
| 1929 | 1,627 | 1,542 | 1.055 | 170.7 |
| 1930 | 1,628 | 1,622 | 1.004 | 171.4 |
| 1931 | 1,743 | 1,672 | 1.042 | 176.8 |
| 1932 | 1,641 | 1,743 | 0.941 | 168.1 |
| 1933 | 1,712 | 1,622 | 1.055 | 177.3 |
| 1934 | 1,800 | 1,819 | 0.990 | 175.5 |
| 1935 | 1,698 | 1,684 | 1.008 | 176.9 |

^aComputed by dividing the aggregate tonnage of beets sliced by the factories used in table B-12 (all identical factories available in consecutive pairs of years) by the total number of net campaign days during which the factories were in operation.

Table B-14.- INDEX OF BEETS SLICED, 1912-35^a

| Year | Beets sliced (thousands of tons) | | Link relatives | Chain index of link relatives (1912=100) |
|------|----------------------------------|----------------|----------------|--|
| | Given year | Preceding year | | |
| | (1) | (2) | (3) | (4) |
| 1913 | 429 | 300 | 1.428 | 142.8 |
| 1914 | 451 | 523 | 0.864 | 123.4 |
| 1915 | 474 | 451 | 1.060 | 129.6 |
| 1916 | 239 | 474 | 0.504 | 65.3 |
| 1917 | 1,940 | 2,274 | 0.853 | 65.7 |
| 1918 | 3,055 | 2,907 | 1.051 | 68.5 |
| 1919 | 3,234 | 2,994 | 1.080 | 63.2 |
| 1920 | 4,102 | 3,259 | 1.259 | 79.6 |
| 1921 | 4,379 | 4,403 | 0.995 | 79.2 |
| 1922 | 3,242 | 4,366 | 0.742 | 68.8 |
| 1923 | 3,847 | 3,222 | 1.194 | 70.2 |
| 1924 | 4,181 | 3,969 | 1.053 | 74.9 |
| 1925 | 4,299 | 4,352 | 0.988 | 73.0 |
| 1926 | 4,924 | 4,567 | 1.078 | 78.7 |
| 1927 | 5,652 | 5,254 | 1.067 | 83.2 |
| 1928 | 5,302 | 6,016 | 0.881 | 73.3 |
| 1929 | 5,404 | 5,074 | 1.065 | 78.0 |
| 1930 | 6,478 | 5,466 | 1.186 | 92.5 |
| 1931 | 6,628 | 6,118 | 0.920 | 85.1 |
| 1932 | 6,467 | 5,628 | 0.971 | 82.6 |
| 1933 | 6,938 | 5,773 | 1.202 | 99.3 |
| 1934 | 5,309 | 7,509 | 0.707 | 70.2 |
| 1935 | 5,617 | 5,644 | 0.995 | 69.8 |

^aComputed from aggregates of tons of beets sliced by the factories used in table B-12 (all identical factories available in consecutive pairs of years).

Table B-16.- INDICES OF CAMPAIGN MAN-HOUR RATIOS, 1917-35

(1917=100)

| Year | 31 identical factories | | All factories | |
|------|------------------------|----------------------------|---------------------|----------------------------|
| | Median ^a | Weighted mean ^b | Median ^c | Weighted mean ^d |
| 1917 | 100.0 | 100.0 | 100.0 | 100.0 |
| 1918 | 104.7 | 111.9 | 97.8 | 107.4 |
| 1919 | 99.7 | 99.3 | 92.0 | 100.1 |
| 1920 | 91.7 | 93.9 | 87.6 | 93.6 |
| 1921 | 72.7 | 75.5 | 71.8 | 76.4 |
| 1922 | 70.0 | 74.8 | 69.8 | 75.2 |
| 1923 | 67.7 | 73.7 | 69.1 | 74.1 |
| 1924 | 64.7 | 70.1 | 66.8 | 71.5 |
| 1925 | 65.7 | 71.2 | 64.8 | 70.4 |
| 1926 | 60.3 | 61.2 | 59.0 | 60.6 |
| 1927 | 60.0 | 59.4 | 55.8 | 56.8 |
| 1928 | 59.3 | 58.3 | 55.2 | 54.6 |
| 1929 | 56.3 | 55.8 | 51.9 | 52.1 |
| 1930 | 52.0 | 50.4 | 46.6 | 47.2 |
| 1931 | 47.3 | 46.6 | 43.5 | 46.6 |
| 1932 | 46.7 | 52.5 | 42.4 | 47.2 |
| 1933 | 46.0 | 47.1 | 40.8 | 43.8 |
| 1934 | 48.0 | 51.1 | 41.7 | 45.2 |
| 1935 | 45.3 | 48.6 | 41.2 | 42.9 |

^aComputed from table B-10, col. (5).^bComputed from table B-10, col. (6).^cComputed from table B-11, col. (8).^dComputed from table B-12, col. (5).Table B-16.- AVERAGE NUMBER OF NET CAMPAIGN DAYS, 1917-35^a

| Year | Factories | | | |
|------|---------------|----------------------|----------------------|---------------------------|
| | All reporting | Western ^b | Eastern ^c | 31 identical ^d |
| | (1) | (2) | (3) | (4) |
| 1917 | 74.4 | 75.0 | # | 75.5 |
| 1918 | 80.6 | 81.7 | # | 78.8 |
| 1919 | 76.3 | 77.4 | # | 80.5 |
| 1920 | 89.6 | 90.7 | # | 91.7 |
| 1921 | 79.1 | 80.2 | # | 84.8 |
| 1922 | 59.5 | 60.3 | # | 61.0 |
| 1923 | 58.9 | 59.3 | 65.4 | 69.7 |
| 1924 | 58.2 | 59.4 | 53.0 | 67.9 |
| 1925 | 67.4 | 68.0 | 64.7 | 70.1 |
| 1926 | 69.0 | 76.2 | 52.0 | 80.7 |
| 1927 | 74.2 | 77.8 | 60.2 | 81.0 |
| 1928 | 58.9 | 65.8 | 41.7 | 63.4 |
| 1929 | 64.7 | 70.6 | 46.0 | 67.2 |
| 1930 | 76.0 | 80.0 | 65.2 | 77.2 |
| 1931 | 72.0 | 68.0 | 68.1 | 71.9 |
| 1932 | 75.1 | 67.3 | 95.5 | 73.6 |
| 1933 | 79.7 | 80.7 | 76.3 | 81.4 |
| 1934 | 57.7 | 51.4 | 67.6 | 57.3 |
| 1935 | 58.6 | 60.2 | 54.3 | 56.1 |

^aUnweighted mean of net campaign days per factory, for factories reporting such data.^bFactories west of the Mississippi River, except California, Iowa, and Minnesota.^cFactories east of the Mississippi River and in Iowa and Minnesota.^dIn 1917-27 gross campaign days were used for 4 plants for which net campaign days were not available.

#Average not calculated for fewer than 4 plants.

Table B-17.- BEETS SLICED AND MAN-HOUR RATIOS,
EASTERN AND WESTERN FACTORIES, 1917-35^a

| Year | Number of factories | | Beets sliced | | | | Weighted mean of man-hour ratios | | | |
|------|---------------------|------|-------------------|-------|------------------|------|----------------------------------|------|-------------------------------|-------|
| | | | Thousands of tons | | Percent of total | | Man-hours | | Index ^b (1917=100) | |
| | East | West | East | West | East | West | East | West | East | West |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) |
| 1917 | 7 | 35 | 197 | 2,734 | 6.7 | 93.3 | 4.81 | 2.72 | 100.0 | 100.0 |
| 1918 | 7 | 34 | 407 | 2,664 | 15.3 | 86.7 | 3.64 | 2.98 | 75.7 | 109.6 |
| 1919 | 7 | 32 | 555 | 2,724 | 16.4 | 83.5 | 3.84 | 2.56 | 79.8 | 97.8 |
| 1920 | 7 | 37 | 589 | 3,850 | 13.3 | 86.7 | 3.74 | 2.49 | 77.8 | 91.5 |
| 1921 | 11 | 36 | 768 | 3,803 | 16.8 | 83.2 | 3.18 | 2.03 | 66.1 | 74.6 |
| 1922 | 10 | 32 | 447 | 2,795 | 13.8 | 86.2 | 3.70 | 1.94 | 76.9 | 71.3 |
| 1923 | 11 | 36 | 607 | 3,485 | 14.8 | 85.2 | 3.48 | 1.93 | 72.3 | 71.0 |
| 1924 | 16 | 36 | 977 | 3,468 | 22.0 | 78.0 | 3.34 | 1.81 | 69.4 | 66.5 |
| 1925 | 18 | 39 | 1,264 | 3,769 | 25.1 | 74.9 | 2.80 | 2.00 | 58.2 | 73.5 |
| 1926 | 23 | 34 | 1,212 | 4,213 | 22.3 | 77.7 | 2.98 | 1.68 | 62.0 | 61.8 |
| 1927 | 20 | 41 | 1,159 | 5,019 | 18.8 | 81.2 | 2.59 | 1.64 | 53.8 | 60.3 |
| 1928 | 21 | 43 | 945 | 4,557 | 17.2 | 82.8 | 2.42 | 1.62 | 50.3 | 59.6 |
| 1929 | 10 | 43 | 620 | 4,879 | 11.3 | 88.7 | 2.03 | 1.56 | 42.2 | 57.4 |
| 1930 | 10 | 44 | 884 | 5,778 | 13.3 | 86.7 | 1.91 | 1.39 | 39.7 | 51.1 |
| 1931 | 6 | 40 | 774 | 4,854 | 13.8 | 86.2 | 1.77 | 1.31 | 36.8 | 48.2 |
| 1932 | 8 | 42 | 1,070 | 4,854 | 18.1 | 81.9 | 1.87 | 1.37 | 38.9 | 50.4 |
| 1933 | 13 | 45 | 1,354 | 6,963 | 16.3 | 83.7 | 1.89 | 1.38 | 39.3 | 50.7 |
| 1934 | 18 | 40 | 1,502 | 4,297 | 25.9 | 74.1 | 2.05 | 1.43 | 42.6 | 52.6 |
| 1935 | 18 | 41 | 1,252 | 4,659 | 21.2 | 78.8 | 1.97 | 1.40 | 41.0 | 51.5 |

^aThe Mississippi River divides eastern and western plants, except that Minnesota and Iowa plants are included in the eastern group.

^bComputed from cols. (7) and (8).

Table B-18.- CAMPAIGN, INTERCAMPAIGN, CENTRAL-OFFICE, AND FACTORY-OFFICE
MAN-HOURS PER TON OF BEETS SLICED, 1927-35^a

| Year | Total man-hours ^b | Central-office man-hours ^c (entire year) | Campaign factory office | | Campaign operating and indirect | | Intercampaign (except central-office) | |
|------|------------------------------|---|-------------------------|-----------|---------------------------------|-----------|---------------------------------------|-----------|
| | | | Number of factories | Man-hours | Number of factories | Man-hours | Number of factories | Man-hours |
| 1927 | 2.51 | 0.11 | 33 | 0.04 | 61 | 1.82 | 21 | 0.54 |
| 1928 | 2.71 | .11 | 55 | .05 | 64 | 1.76 | 37 | .79 |
| 1929 | 2.63 | .10 | 53 | .05 | 53 | 1.62 | 39 | .76 |
| 1930 | 2.14 | .08 | 54 | .04 | 54 | 1.46 | 42 | .56 |
| 1931 | 2.10 | .09 | 46 | .04 | 46 | 1.37 | 36 | .60 |
| 1932 | 2.20 | .10 | 49 | .03 | 50 | 1.46 | 38 | .61 |
| 1933 | 2.14 | .08 | 56 | .03 | 58 | 1.46 | 43 | .57 |
| 1934 | 2.70 | .14 | 52 | .04 | 58 | 1.59 | 44 | .93 |
| 1935 | 2.56 | .12 | 53 | .03 | 59 | 1.52 | 44 | .89 |

^aMan-hour ratios are weighted means of ratios for individual factories.

^bSum of figures in following columns.

^cBased on data for 3 best-sugar companies, except in 1929-31 when only 2 reported and 1934-35 when 5 reported.

Table B-19.- MAN-HOURS PER TON OF BEETS SLICED EMBODIED IN MACHINERY REQUIREMENTS, 27 BEET-SUGAR FACTORIES, 1927-35

Based on Annual Charges to Depreciation

| Year | Charges to depreciation (thousands) | Man-hours per dollar of value ^a | Total man-hours (thousands) (1)x(2) | Beets sliced (thousands of short tons) | Man-hours per ton of beets sliced (3) \div (4) |
|------|-------------------------------------|--|-------------------------------------|--|--|
| | (1) | (2) | (3) | (4) | (5) |
| 1927 | \$1,705 | 0.913 | 1,557 | 3,660 | 0.43 |
| 1928 | 1,665 | 0.868 | 1,445 | 3,100 | .47 |
| 1929 | 1,742 | 0.821 | 1,430 | 3,379 | .42 |
| 1930 | 1,731 | 0.815 | 1,411 | 3,872 | .36 |
| 1931 | 1,737 | 0.928 | 1,612 | 3,289 | .49 |
| 1932 | 1,689 | 1.196 | 2,020 | 3,267 | .62 |
| 1933 | 2,020 | 1.104 | 2,230 | 4,153 | .54 |
| 1934 | 1,433 | 1.013 | 1,452 | 2,223 | .65 |
| 1935 | 1,510 | 0.968 | 1,462 | 2,754 | .53 |

^aPrepared by the "Studies in Equipment Changes and Industrial Techniques" section of the National Research Project.

Table B-20.- MAN-HOURS PER TON OF BEETS SLICED EMBODIED IN MACHINERY REQUIREMENTS, 27 BEET-SUGAR FACTORIES, 1927-35

Based on Gross Investment

| Year | Gross investment ^a (thousands) | Cumulated annual average of man-hours per dollar of value ^b | Total man-hours (thousands) (1)x(2) | Annual man-hours ^c (thousands) | Man-hours per ton of beets sliced ^d |
|------|---|--|-------------------------------------|---|--|
| | (1) | (2) | (3) | (4) | (5) |
| 1927 | \$36,284 | 0.928 | 33,672 | 1,581 | 0.43 |
| 1928 | 36,776 | .921 | 33,871 | 1,590 | .51 |
| 1929 | 37,230 | .911 | 33,917 | 1,592 | .47 |
| 1930 | 37,567 | .903 | 33,923 | 1,593 | .41 |
| 1931 | 36,529 | .905 | 33,059 | 1,552 | .47 |
| 1932 | 37,879 | .927 | 35,114 | 1,649 | .50 |
| 1933 | 38,745 | .940 | 36,420 | 1,710 | .41 |
| 1934 | 39,064 | .945 | 36,915 | 1,733 | .78 |
| 1935 | 39,299 | .946 | 37,177 | 1,745 | .63 |

^aTotal investment in machinery and equipment, less retirements.

^bBased on man-hours per dollar of value for 1920-35 shown in table A-4, col. (2). The ratio for any one year is the average of the ratios for the preceding years including the given year. Data were not available before 1920.

^cCol. (3) divided by 21.3, which is the estimated average length of life, in years, of machinery and equipment in beet-sugar factories.

^dCol. (4) divided by table B-19, col. (4).

Table B-21.- COST PER 100-POUND BAG OF BEET SUGAR, 1922 AND 1929^a

| Item | Campaign year beginning - | | | |
|--|------------------------------|----------|------------------------------|----------|
| | 1922 | | 1929 | |
| Number of factories | 69 | | 66 | |
| Beets used (short tons) | 4,712,350 | | 6,809,274 | |
| Sugar produced (100-lb. bags) | 12,316,001 | | 18,527,510 | |
| | Cost per 100 pounds of sugar | | Cost per 100 pounds of sugar | |
| | Dol-lars | Per-cent | Dol-lars | Per-cent |
| Net cost of production (including interest) | 6.13 | 100.0 | 4.78 | 100.0 |
| Net cost of production (excluding interest) | 5.26 | 86.7 | 4.54 | 90.8 |
| Credit for byproducts | -0.30 | -5.0 | -0.35 | -7.4 |
| Total cost of production | 5.56 | 90.7 | 4.69 | 98.2 |
| Cost of raw materials | 3.37 | 55.0 | 3.18 | 66.6 |
| Cost of beets | 3.37 | 55.0 | 3.06 | 64.0 |
| Beets | 2.91 | 47.5 | 2.61 | 54.6 |
| Transportation | 0.21 | 3.4 | 0.21 | 4.3 |
| Receiving | 0.25 | 4.1 | 0.24 | 5.1 |
| Cost of raw sugar and molasses | 0 | 0 | 0.12 | 2.6 |
| Cost of manufacturing | 2.19 | 35.7 | 1.51 | 31.6 |
| Cost of conversion | 1.90 | 30.9 | 1.34 | 28.1 |
| Manufacturing | 1.41 | 22.9 | 1.02 | 21.3 |
| Labor | 0.36 | 5.9 | 0.28 | 6.0 |
| Maintenance and repair | 0.30 | 4.9 | 0.23 | 4.8 |
| Materials and supplies | 0.75 | 12.1 | 0.50 | 10.4 |
| Other | 0 | 0 | 0.01 | 0.1 |
| Factory burden | 0.49 | 8.0 | 0.32 | 6.8 |
| Insurance | 0.03 | 0.5 | 0.02 | 0.5 |
| Taxes | 0.12 | 2.0 | 0.06 | 1.4 |
| Depreciation | 0.34 | 5.5 | 0.24 | 4.9 |
| Other | 0 | 0 | * | * |
| General and administrative expense | 0.29 | 4.8 | 0.17 | 3.5 |
| Allowance for interest | 0.87 | 14.3 | 0.44 | 9.2 |
| Imputed interest on owners' net equity | 0.67 | 11.0 | 0.36 | 7.5 |
| Interest paid on borrowed capital ^b | 0.20 | 3.3 | 0.08 | 1.7 |

^aBased on tabulations prepared by the United States Tariff Commission.

^bNet of interest paid and received.

*Less than \$0.005 or 0.05 percent.

Table B-22.- COST PER 100-POUND BAG OF BEET SUGAR, 49 IDENTICAL FACTORIES, BY CAPACITY, 1922 AND 1929^a

| Item | Capacity in campaign year beginning - | | | | | | |
|---|--|-------------------|------------------|--------------------|-------------------|-------------------|------------------|
| | 1922 ^b | | | 1929 | | | |
| | Less than 1,100 | 1,100 to 1,399 | 1,700 or over | Less than 1,100 | 1,100 to 1,399 | 1,400 to 1,699 | 1,700 or over |
| Number of factories | 26 | 13 | 8 | 13 | 11 | 13 | 12 |
| Beets used (short tons) | 1,313,931 | 1,202,332 | 1,220,793 | 758,716 | 801,983 | 1,369,925 | 2,461,411 |
| Sugar produced (100-lb. bags) | 3,524,870 | 2,914,195 | 3,449,497 | 2,076,079 | 2,362,356 | 3,498,331 | 6,863,809 |
| | Cost (dollars) per 100 pounds of sugar | | | | | | |
| Net cost of production (including interest) | 6.07 | 5.86 | 5.73 | 4.93 | 4.76 | 4.93 | 4.47 |
| Net cost of production (excluding interest) | 5.20 | 5.14 | 4.83 | 4.53 | 4.31 | 4.49 | 4.10 |
| Credit for byproducts | -0.24 | -0.33 | -0.25 | -0.40 | -0.31 | -0.39 | -0.31 |
| Total cost of production | 5.44 | 5.47 | 5.08 | 4.93 | 4.62 | 4.88 | 4.41 |
| Cost of raw materials | 3.25 | 3.48 | 3.14 | 3.23 | 3.09 | 3.30 | 3.10 |
| Cost of beets | 3.25 | 3.48 | 3.14 | 3.15 | 2.99 | 3.17 | 2.93 |
| Beets | 2.78 | 3.09 | 2.72 | 2.61 | 2.49 | 2.76 | 2.54 |
| Transportation | 0.18 | 0.21 | 0.23 | 0.24 | 0.17 | 0.19 | 0.21 |
| Receiving | 0.29 | 0.18 | 0.19 | 0.30 | 0.33 | 0.22 | 0.18 |
| Cost of raw sugar and molasses | 0 | 0 | 0 | 0.08 | 0.10 | 0.13 | 0.17 |
| Cost of manufacturing | 2.19 | 1.99 | 1.94 | 1.70 | 1.53 | 1.58 | 1.31 |

| Cost of manufacturing - Continued | | | | | | | |
|--|------|------|------|------|------|------|------|
| Cost of conversion | 1.90 | 1.74 | 1.63 | 1.50 | 1.34 | 1.41 | 1.17 |
| Manufacturing | 1.39 | 1.28 | 1.23 | 1.13 | 0.96 | 1.07 | 0.94 |
| Labor | 0.35 | 0.32 | 0.31 | 0.36 | 0.26 | 0.31 | 0.26 |
| Maintenance and repair | 0.31 | 0.29 | 0.24 | 0.26 | 0.23 | 0.26 | 0.20 |
| Materials and supplies | 0.73 | 0.67 | 0.68 | 0.51 | 0.47 | 0.49 | 0.48 |
| Other | 0 | 0 | 0 | * | * | 0.01 | * |
| Factory burden | 0.51 | 0.46 | 0.40 | 0.37 | 0.38 | 0.34 | 0.23 |
| Insurance | 0.03 | 0.02 | 0.02 | 0.03 | 0.02 | 0.02 | 0.02 |
| Taxes | 0.10 | 0.12 | 0.12 | 0.06 | 0.08 | 0.09 | 0.05 |
| Depreciation | 0.38 | 0.32 | 0.26 | 0.28 | 0.28 | 0.23 | 0.16 |
| Other | 0 | 0 | 0 | 0 | 0 | 0 | * |
| General and administrative expense | 0.29 | 0.25 | 0.31 | 0.20 | 0.19 | 0.17 | 0.14 |
| Allowance for interest | 0.87 | 0.72 | 0.90 | 0.40 | 0.45 | 0.44 | 0.37 |
| Imputed interest on owners' net equity | 0.51 | 0.68 | 0.75 | 0.22 | 0.35 | 0.40 | 0.36 |
| Interest paid on borrowed capital ^c | 0.36 | 0.04 | 0.15 | 0.18 | 0.10 | 0.04 | 0.01 |

^aBased on tabulations prepared by the United States Tariff Commission. Capacities are in terms of short tons of beets sliced per day.

^bData for 1,400-1,699 class withheld to avoid disclosing

information for individual factories.

^cNet of interest paid and received.

*Less than \$0.005.

Table B-25.- COST PER 100-POUND BAG OF BEET SUGAR, 30 IDENTICAL FACTORIES, BY CAPACITY AND UNIT LABOR REQUIREMENTS, 1922 AND 1929^a

| Item | Capacity in campaign year beginning - | | | | | | | |
|---|--|---------------------|-----------------------|---------------------|-------------------------|-----------------------|-------------------------|-----------------------|
| | 1922 | | | | 1929 | | | |
| | Below 1,250 | | 1,250 or over | | Below 1,250 | | 1,250 or over | |
| | Less than 2 man-hours | 2 or more man-hours | Less than 2 man-hours | 2 or more man-hours | Less than 1.7 man-hours | 1.7 or more man-hours | Less than 1.7 man-hours | 1.7 or more man-hours |
| Number of factories | 5 | 10 | 11 | 4 | 4 | 3 | 17 | 6 |
| Beets used (short tons) | 371,422 | 548,206 | 1,487,707 | 432,529 | 222,803 | 211,549 | 2,931,195 | 359,784 |
| Sugar produced (100-lb. bags) | 936,690 | 1,514,267 | 3,803,730 | 1,055,605 | 628,572 | 697,680 | 7,700,780 | 1,124,922 |
| | Cost (dollars) per 100 pounds of sugar | | | | | | | |
| Net cost of production (including interest) | 5.61 | 6.04 | 5.41 | 5.81 | 4.58 | 4.48 | 4.48 | 5.04 |
| Net cost of production (excluding interest) | 4.75 | 5.10 | 4.75 | 5.20 | 4.13 | 4.08 | 4.12 | 4.54 |
| Credit for byproducts | -0.33 | -0.22 | -0.24 | -0.25 | -0.40 | -0.28 | -0.34 | -0.25 |
| Total cost of production | 5.08 | 5.32 | 4.99 | 5.45 | 4.53 | 4.36 | 4.46 | 4.79 |
| Cost of raw materials | 3.30 | 3.11 | 3.29 | 3.45 | 3.07 | 2.85 | 3.12 | 3.08 |
| Cost of beets | 3.30 | 3.11 | 3.29 | 3.45 | 3.05 | 2.74 | 3.00 | 2.91 |
| Beets | 2.97 | 2.66 | 2.91 | 3.07 | 2.62 | 2.32 | 2.68 | 2.39 |
| Transportation | 0.17 | 0.17 | 0.22 | 0.20 | 0.13 | 0.14 | 0.17 | 0.17 |
| Receiving | 0.16 | 0.28 | 0.16 | 0.18 | 0.30 | 0.28 | 0.15 | 0.35 |

| | | | | | | | | |
|--|------|------|------|-------|------|------|-------|------|
| Cost of raw materials - Continued | | | | | | | | |
| Cost of raw sugar and molasses | 0 | 0 | 0 | 0 | 0.02 | 0.11 | 0.12 | 0.17 |
| Cost of manufacturing | 1.78 | 2.21 | 1.70 | 2.00 | 1.46 | 1.51 | 1.34 | 1.71 |
| Cost of conversion | 1.55 | 1.88 | 1.49 | 1.77 | 1.26 | 1.34 | 1.19 | 1.51 |
| Manufacturing | 1.13 | 1.47 | 1.14 | 1.45 | 0.91 | 1.00 | 0.95 | 1.06 |
| Labor | 0.28 | 0.32 | 0.26 | 0.36 | 0.25 | 0.28 | 0.26 | 0.27 |
| Maintenance and repair | 0.26 | 0.33 | 0.25 | 0.28 | 0.25 | 0.20 | 0.21 | 0.26 |
| Materials and supplies | 0.59 | 0.82 | 0.63 | 0.81 | 0.40 | 0.51 | 0.47 | 0.52 |
| Other | 0 | 0 | 0 | 0 | 0.01 | 0.01 | 0.01 | 0.01 |
| Factory burden | 0.40 | 0.41 | 0.35 | 0.32 | 0.35 | 0.34 | 0.24 | 0.45 |
| Insurance | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.01 | 0.02 | 0.02 |
| Taxes | 0.12 | 0.12 | 0.11 | 0.11 | 0.09 | 0.08 | 0.06 | 0.12 |
| Depreciation | 0.26 | 0.27 | 0.22 | 0.19 | 0.24 | 0.25 | 0.16 | 0.31 |
| Other | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| General and administrative expense | 0.25 | 0.33 | 0.21 | 0.23 | 0.20 | 0.17 | 0.15 | 0.20 |
| Allowance for interest | 0.86 | 0.94 | 0.66 | 0.61 | 0.45 | 0.40 | 0.36 | 0.50 |
| Imputed interest on owners' net equity | 0.61 | 0.66 | 0.62 | 0.62 | 0.37 | 0.30 | 0.37 | 0.35 |
| Interest paid on borrowed capital ^b | 0.25 | 0.28 | 0.04 | -0.01 | 0.08 | 0.10 | -0.01 | 0.15 |

^aBased on tabulations prepared by the United States Tariff Commission. Capacities are in terms of short tons of beets sliced per day; man-hours, in terms of campaign man-hours per ton of beets sliced.

^bNet of interest paid and received.

Table B-24.- COST PER 100-POUND BAG OF BEET SUGAR, 49 IDENTICAL FACTORIES,
BY AREA, 1922 AND 1929^a

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| Item | Campaign year beginning - | | | |
|---|--|--------------|--------------|--------------|
| | 1922 | | 1929 | |
| | Eastern area | Western area | Eastern area | Western area |
| Number of factories | 6 | 43 | 6 | 43 |
| Beets used (short tons) | 242,542 | 3,594,831 | 188,455 | 5,203,580 |
| Sugar produced (100-lb. bags) | 530,568 | 9,569,274 | 559,583 | 14,240,992 |
| | Cost (dollars) per 100 pounds of sugar | | | |
| Net cost of production (including interest) | 7.26 | 5.86 | 5.63 | 4.65 |
| Net cost of production (excluding interest) | 6.18 | 5.03 | 5.07 | 4.25 |
| Credit for byproducts | -0.61 | -0.26 | -0.65 | -0.34 |
| Total cost of production | 6.79 | 5.29 | 5.72 | 4.69 |
| Cost of raw materials | 4.09 | 3.26 | 3.59 | 3.15 |
| Cost of beets | 4.09 | 3.26 | 3.58 | 3.00 |
| Beets | 3.27 | 2.84 | 2.72 | 2.59 |
| Transportation | 0.31 | 0.21 | 0.26 | 0.20 |
| Receiving | 0.51 | 0.21 | 0.60 | 0.21 |
| Cost of raw sugar and molasses | 0 | 0 | 0.01 | 0.15 |

BEET SUGAR

| | | | | |
|--|-------|------|------|------|
| Total cost of production - Continued | | | | |
| Cost of manufacturing | 2.70 | 2.02 | 2.13 | 1.44 |
| Cost of conversion | 2.33 | 1.74 | 1.83 | 1.28 |
| Manufacturing | 1.91 | 1.29 | 1.30 | 0.99 |
| Labor | 0.45 | 0.33 | 0.37 | 0.28 |
| Maintenance and repair | 0.45 | 0.27 | 0.33 | 0.22 |
| Materials and supplies | 1.01 | 0.69 | 0.58 | 0.49 |
| Other | 0 | 0 | 0.02 | * |
| Factory burden | 0.42 | 0.45 | 0.53 | 0.29 |
| Insurance | 0.03 | 0.02 | 0.03 | 0.02 |
| Taxes | 0.23 | 0.11 | 0.25 | 0.06 |
| Depreciation | 0.16 | 0.32 | 0.25 | 0.21 |
| Other | 0 | 0 | 0 | * |
| General and administrative expense | 0.37 | 0.28 | 0.30 | 0.16 |
| Allowance for interest | 1.08 | 0.83 | 0.56 | 0.40 |
| Imputed interest on owners' net equity | 1.11 | 0.63 | 0.39 | 0.35 |
| Interest paid on borrowed capital ^b | -0.03 | 0.20 | 0.17 | 0.05 |

^aBased on tabulations prepared by the United States Tariff Commission. The Mississippi River separates the two areas.

^bNet of interest paid and received.

*Less than \$0.005.

Table B-25.- CHANGES IN EMPLOYMENT OF LABOR ACCOMPANYING THE INSTALLATION OF MACHINERY
IN 26 BEET-SUGAR FACTORIES, 1922-35^a

| Year | Machines installed | | | Factory labor (number of men) per shift ^c - | |
|-------|--------------------|--------------------|--|--|-------|
| | Number of units | Value (dollars) | Embodied labor ^b (man-hours) | Displaced | Added |
| Total | 155 | 634,567 | 591,423 | 164 | 34 |
| 1922 | 4 | 3,600 | 3,672 | 0 | 0 |
| 1923 | 6 | 2,700 | 2,511 | 4 | 0 |
| 1924 | 0 | - | - | - | - |
| 1925 | 2 | 15,300 | 13,464 | 0 | 0 |
| 1926 | 0 | - | - | - | - |
| 1927 | 0 | - | - | - | - |
| 1928 | 14 | 65,481 | 56,968 | 0 | 15 |
| 1929 | 14 | 90,985 | 74,608 | 22 | 0 |
| 1930 | 15 | 97,602 | 80,034 | 75 | 0 |
| 1931 | 1 | 8,140 | 7,570 | 13 | 0 |
| 1932 | 15 | 19,167 | 23,000 | 1 | 0 |
| 1933 | 0 | - | - | - | - |
| 1934 | 31 | 198,805 | 200,793 | 41 | 19 |
| 1935 | 53 | 132,787 | 128,803 | 8 | 0 |

^aData not comparable from year to year, since only the installations for which the employment effects were reported are included.

^bValue multiplied by man-hours per dollar of value shown in table A-4, col. (2).

^cBased on net effect of each installation.

Table B-26.- YEAR-TO-YEAR NET CHANGES IN UTILIZATION OF LABOR, 31 IDENTICAL FACTORIES, 1917-35^a

| Year | Beets sliced (thousands of short tons) | | Man-hours per ton of beets sliced | | Man-hours (thousands) embodied in machinery ^c | Changes in man-hours (thousands) since previous year due to changes in - | | | |
|------|--|-----------------------------|-----------------------------------|-----------------------------|--|--|-----------------------------------|---------------------------------|------------------------|
| | Given year | Change since preceding year | Given year ^b | Change since preceding year | | Production | Man-hours per ton of beets sliced | Man-hours embodied in machinery | Total of three factors |
| 1917 | 2,528 | - | 2.78 | - | 1,873 | - | - | - | - |
| 1918 | 2,469 | -59 | 3.11 | +0.33 | 1,402 | -165 | +815 | -471 | +179 |
| 1919 | 2,708 | +239 | 2.76 | -0.35 | 678 | +743 | -948 | -724 | -929 |
| 1920 | 3,498 | +791 | 2.61 | -0.15 | 570 | +2,182 | -525 | -108 | +1,549 |
| 1921 | 3,542 | +44 | 2.10 | -0.51 | 972 | +111 | -1,806 | +402 | -1,290 |
| 1922 | 2,592 | -950 | 2.08 | -0.02 | 140 | -1,995 | -52 | -832 | -2,879 |
| 1923 | 3,194 | +602 | 2.05 | -0.03 | 401 | +1,252 | -96 | +261 | +1,417 |
| 1924 | 3,382 | +188 | 1.95 | -0.10 | 751 | +386 | -338 | +350 | +398 |
| 1925 | 3,175 | -206 | 2.00 | +0.05 | 1,017 | -402 | +159 | +266 | +23 |
| 1926 | 3,600 | +425 | 1.70 | -0.30 | 433 | +849 | -1,080 | -584 | -815 |
| 1927 | 3,877 | +277 | 1.65 | -0.05 | 122 | +470 | -194 | -311 | -35 |
| 1928 | 3,237 | -640 | 1.62 | -0.03 | 349 | -1,056 | -97 | +227 | -926 |
| 1929 | 3,516 | +279 | 1.55 | -0.07 | 594 | +452 | -246 | +245 | +451 |
| 1930 | 4,081 | +565 | 1.40 | -0.15 | 544 | +875 | -612 | -50 | +213 |
| 1931 | 3,563 | -517 | 1.35 | -0.05 | 234 | -724 | -178 | -310 | -1,212 |
| 1932 | 3,675 | +112 | 1.46 | +0.11 | 340 | +151 | +404 | +106 | +661 |
| 1933 | 4,477 | +802 | 1.31 | -0.15 | 1,012 | +1,171 | -672 | +672 | +1,171 |
| 1934 | 2,691 | -1,786 | 1.42 | +0.11 | 534 | -2,339 | +296 | -478 | -2,521 |
| 1935 | 3,042 | +351 | 1.35 | -0.07 | 283 | +498 | -213 | -251 | +34 |

^aIn the measurement of the net yearly change in the number of man-hours expended (N), changes in 3 factors were taken into consideration: the quantity of beets sliced (P), the number of man-hours required per ton of beets sliced (R), and the number of man-hours embodied in machinery purchased (M). To determine man-hour changes attributable to changes in production, the differences between production in the given and preceding years ($P_1 - P_0$) was multiplied by the man-hour ratio for the preceding year (R_0). Since this does not take into account changes in the man-hour ratio, the man-hour changes attributable to changes in the ratio were determined by multiplying the difference between the ratios in the given and preceding years ($R_1 - R_0$) by the quantity of

beets sliced in the given year (P_1). Changes in man-hours embodied in machinery were measured by year-to-year differences ($M_1 - M_0$). Thus $N_1 = [(P_1 - P_0)R_0] + [(R_1 - R_0)P_1] + [M_1 - M_0]$.

The assumption implicit in this procedure is that year-to-year changes in output are largely independent of changes in unit labor requirements.

^bTable B-10, col. (6).

^cTable A-4, col. (3).

APPENDIX C

ADJUSTMENTS OF CENSUS DATA FOR REGIONAL BREAK-DOWN

The establishments producing beet sugar were classified according to geographical location into three groups: group I, including all factories in California; group II, all factories in beet-sugar-producing States west of the Mississippi River except California, Iowa, and Minnesota; and group III, the factories in beet-sugar-producing States east of the Mississippi and in Iowa and Minnesota.

The break-down of production for the United States was derived by including the available *Census of Manufactures* groupings of States under one of these three groups. In many cases, however, where the classification "other States" cut across these groupings, data for factories in some States were necessarily included in data for States in another group, usually group II. Where production data for such factories were available from other sources, they were removed from the group in which the census had placed them and included in the correct regional group. Production data so handled were found in the data of the NRP-NBER field survey and (for Wisconsin factories for the years 1920 and 1922) in the *Yearbook of Agriculture, 1922* (U. S. Dept. Agr., Bur. Agr. Econ., 1923), p. 780.

It should be noted that in the years 1899, 1918, 1920, 1922, and 1924, group II is too large and group III too small by not more than four establishments or 5 percent of the total production of sugar; in 1908 group I is too large and group II is too small by three establishments; in 1903, 1913, 1926, 1928, and 1931 the break-down is correct.

The terms "factory" and "establishment" are not synonymous. Two or more factories in the same locality and under common ownership may have been reported to the census as one establishment. As a result, the actual number of operating factories exceeds establishments as given in the census by 7 in 1908 and by 5 in 1913, the most recent years for which data are available. The production adjustments were made for individual factories.

APPENDIX D

MEASUREMENT OF MAN-HOURS EXPENDED IN REFINING MOLASSES BY THE STEFFENS PROCESS

A beet-sugar factory produces two byproducts, molasses and beet pulp. The labor-requirement ratios analyzed in this study, however, are based only upon beets sliced and sugar produced. The plants were put on a comparable basis with regard to the treatment of pulp by eliminating pulp-drying man-hours in those plants where pulp-drying man-hours were expended.¹ Similar adjustments were not made for Steffens operations.

A number of difficulties were introduced because some plants operate a Steffens house while others do not.² The number of hours and the production of sugar are not comparable in Steffens and non-Steffens plants, because some of the sugar is Steffens sugar extracted from molasses. In addition to the molasses produced by the plant operating the Steffens, molasses transferred from sister plants of the same company or purchased from the plants of other companies is frequently treated in the Steffens process. In other words, not only do some plants produce more sugar per ton of beets sliced because of the presence of Steffens operations, but Steffens plants themselves produce varying amounts of sugar relative to the tonnage of beets sliced because of the fact that varying quantities of foreign molasses in addition to home-produced molasses are treated in the Steffens operations. In some plants no record is kept of the amounts of sugar produced in the Steffens alone. Raw sugar is produced in Steffens operations and is melted and thrown back into the other operations of the factory. Nor can man-hours attributable to Steffens operations be completely segregated. A record is kept of the man-hours expended directly in the Steffens operations, but the proportion of the additional factory overhead labor required as a result of Steffens is not easily estimated.³ In view of the difficulties of solving the problems of noncomparability of man-hours and production arising out of the influence of Steffens, an analysis

¹Man-hours expended for drying pulp are discussed in appendix E.

²See p. 7 for a statement of the function performed by the Steffens operation.

³Considerable quantities of steam from the factory boilerhouse as well as considerable quantities of ground limestone from the lime kiln are required for Steffens operations. The Steffens house also requires the services of the factory laboratory.

was made to ascertain the extent of the error, if any, introduced by the noncomparability. Table D-1 presents the campaign operating and indirect man-hours (including Steffens man-hours) per ton of beets sliced in various types of Steffens and non-Steffens plants. Standard man-hour ratios for 1934 (the average of the ratios for the years 1933-35) for individual plants were classified under the various groups, and an unweighted mean was calculated for the plants falling within each grouping. Ratios are shown separately for eastern and western plants. The Steffens groupings include (a) plants with no Steffens, (b) all plants with a Steffens, (c) plants with a Steffens, processing only home molasses, (d) plants with Steffens, processing foreign as well as home molasses, and (e) Steffens plants for which it is not known whether foreign molasses is processed in addition to home molasses.

It should be observed that a slightly greater number of campaign man-hours per ton of beets sliced are required in Steffens plants than in non-Steffens plants. Plants treating molasses from foreign plants in their Steffens operations expend fewer man-hours

Table D-1.- STANDARD MAN-HOURS PER TON OF BEETS SLICED FOR BEET-SUGAR FACTORIES, BY TYPE OF STEFFENS OPERATION AND BY GEOGRAPHICAL AREA, 1934^a

| Type of Steffens operation | All reporting factories | | Area | | | |
|---|-------------------------|-----------|---------------------|-----------|---------------------|-----------|
| | | | Eastern | | Western | |
| | Number of factories | Man-hours | Number of factories | Man-hours | Number of factories | Man-hours |
| Non-Steffens | 36 | 1.57 | 13 | 2.08 | 23 | 1.29 |
| Steffens, total | 30 | 1.66 | 7 | 2.39 | 23 | 1.46 |
| Treating only home molasses | 5 | 2.27 | 3 | 2.62 | 2 | 1.75 |
| Treating home and foreign molasses | 22 | 1.51 | 4 | 2.22 | 18 | 1.35 |
| Treating home and possibly foreign molasses | 3 | 1.95 | 0 | - | 3 | 1.95 |

^aStandard ratios for 1934 are unweighted means of the ratios for 1933-35. Man-hours shown represent unweighted means of the standard ratios for individual factories.

per ton than Steffens plants which treat only home molasses. This seems to indicate that increased Steffens operations are accomplished with a smaller proportional additional labor force. Extreme care should be used in analyzing the table because of the great influence exerted by the geographical location of the plants within each of the various groups. The influence of location is so great as to overshadow the influence of the Steffens operations.

Although non-Steffens plants appear to be somewhat more efficient than Steffens plants in the utilization of labor, the difference is so small that it has relatively little effect upon other classifications and analyses. Hence, no attempt has been made to estimate and separate out the additional sugar produced and man-hours expended in a plant as a result of Steffens operations.

It should not be inferred from the discussion above that dollar cost per unit of output in Steffens plants is greater than dollar cost per unit of output in non-Steffens plants. The raw material of the beet-sugar factory is sugar beets, the cost of which represents about 50 percent of total costs. The raw material of the Steffens operation is the residual molasses of the main operations and is treated, therefore, at no additional cost for raw material.

APPENDIX E

MEASUREMENT OF MAN-HOURS EXPENDED IN PROCESSING PULP

The second byproduct in the manufacture of beet sugar is pulp.¹ Pulp is produced in three major forms: wet, pressed, and dried (which includes molasses pulp).

Varying amounts of labor are required to process each of these three forms. Wet pulp requires a relatively insignificant amount of labor, pressed pulp a greater amount, and dried pulp the greatest amount. Of the three forms, only the processing of dried pulp requires an expenditure of labor of more than 0.1 man-hours per ton of beets sliced.

All man-hours allocated to the processing of pressed and dried pulp were removed in order to eliminate from the campaign operating and indirect man-hour totals the labor allocated to the production of this byproduct.² Since no significant increases in personnel in contributing departments are required for the treating of pulp, no adjustments were made for this factor.

VARIATIONS IN PULP MAN-HOURS

It is interesting to note that more pulp man-hours are expended in the drying of pulp per ton of beets in the plants located in the eastern area than in the plants in the western area. This should not be taken as indicating that the eastern plants utilized their labor less efficiently in the processing of dry pulp than did the western plants, but rather that the eastern plants processed their pulp more thoroughly. From table E-1 it can be seen that in 1934 the average standard dry-pulp man-hours expended per ton of beets sliced for plants in the eastern area was 0.25 whereas the average western plant used 0.13 dry-pulp man-hours per ton of beets sliced.

However, an increase in productivity in the processing of dry pulp can be noted as having taken place in the last decade. In 1925 the average number of man-hours utilized for dry pulp per ton of beets by the 13 plants for which data are available was

¹The other byproduct, molasses, is discussed in appendix D.

²The man-hours required to handle wet pulp were considered too small to warrant removal.

**Table E-1. - STANDARD DRY-PULP MAN-HOURS
PER TON OF BEETS SLICED, 1934^a**

| Item | Western factories | Eastern factories |
|---|----------------------|----------------------|
| Average standard dry-pulp man-hour ratios | 0.13 | 0.25 |
| Number of factories | 9 | 13 |

^aStandard ratios for 1934 are unweighted means of the ratios for 1933-35. Man-hours shown represent unweighted means of the standard ratios for individual factories.

0.25 man-hours. In 1935 the average dry-pulp man-hours per ton of beets for 21 reporting plants had declined 28 percent to 0.18 man-hours.³ In both of these years the reporting plants were composed of approximately 60 percent eastern plants and 40 percent western plants.

³These average dry-pulp man-hours per ton of beets were computed by dividing the aggregate number of dry-pulp man-hours for reporting plants by the aggregate quantity of washed beets sliced for the same plants.

APPENDIX F

PRINCIPAL OCCUPATIONS IN THE BEET-SUGAR FACTORY¹

| CLASSIFICATION | DUTY |
|------------------|--|
| BEET END | |
| Unloaders | Receiving beet from field at storage bins at beet dump and storage shed. |
| Flumers | Controlling supply of beet from storage to factory. |
| Trash catchers | Picking stones, trash, etc. from beets before washing. |
| Beet washers | Attending beet washer. |
| Weighers | Automatic beet weighing. |
| Cutter men | Attending beet-slicing machine. |
| Knife filers | Sharpening beet-slicer knives. |
| Knife setters | Adjusting knives in slicing machine. |
| Cell fillers | Loading and attending diffusion battery. |
| Cell dumpers | Discharging pulp from diffusion battery. |
| Pulp handlers | Drying and storing pulp from diffusers. |
| Tank men | Measuring juice to carbonator. |
| Carbonators | Controlling juice, lime, and sulphur mixing at carbonation stations. |
| Filter pressmen | Attending filtering of juice. |
| Laundry men | Washing and repairing filter-press cloths. |
| Evaporators | Attending multiple-effect evaporators. |
| Tank men | Attending juice and sirup tanks after evaporation. |
| SUGAR END | |
| Sugar boilers | Graining sugar at vacuum pans. |
| Crystallizer men | In charge of sugar in crystallizers. |
| Centrifugal men | Spinning white and brown sugar. |
| Sugar melters | Melting brown sugar. |
| Granulators | Operating granulator and drier. |
| Sugar weighers | Automatic sugar weighing. |

¹The following are not included in this classification: administrators, superintendents, foremen, assistants, central- or factory-office workers, clerical employees, etc.

| CLASSIFICATION | DUTY |
|----------------------------------|--|
| SUGAR END-Continued | |
| Bag sewers | Sewing end of bags when filled. |
| Sugar truckers | Trucking sugar from scales to warehouse. |
| Sugar pilers | Piling bags in warehouse. |
| Boilerhouse | |
| Water tenders | Feeding water to boilers. |
| Firemen | Stoking boilers. |
| Flue blowers | Cleaning boilers. |
| Coal passers | Maintaining fuel supply to boilers. |
| Maintenance and Operation | |
| Engine men | Attending steam engines. |
| Oilers | Lubricating machinery. |
| Electricians | Maintaining and repairing electric system. |
| Machinists | Repairing mechanical equipment. |
| Blacksmiths | General ironwork and millwright work. |
| Pipe fitters | General pipe work. |
| Carpenters | General woodworking. |
| LIME KILN | |
| Rock breakers | Preparing lime for kiln. |
| Rock washers | Preparing lime for kiln. |
| Coke men | Attending kiln. |
| Lime shovelers | Loading and unloading lime kiln. |
| Skip men | Conveying lime to kiln. |
| Slaker men | Mixing milk of lime. |
| SULPHUR STATION | |
| Burners | Preparing sulphur for juice carbonation. |
| STEFFENS HOUSE | |
| Weighers | Weighing molasses for process. |
| Cooler men | Attending cooler precipitators. |
| Filter pressman | Attending filter presses. |
| Mixers | Mixing saccharate and juice. |
| Heater men | Attending liquor heater. |

CLASSIFICATION

Duty

LABORATORY

| | |
|----------|--|
| Chemists | Chemical analysis and control. |
| Samplers | Obtaining samples for chemical analysis. |

GENERAL

| | |
|--------------|--|
| Elevator men | Attending elevators and conveyors. |
| Crane men | Operating power cranes. |
| Laborers | Assisting at various stations in minor capacities. |



WORKS PROGRESS ADMINISTRATION

F. C. HARRINGTON
Administrator

CORRINGTON GILL
Assistant Administrator

NATIONAL RESEARCH PROJECT

on

Reemployment Opportunities and Recent Changes in Industrial Techniques

DAVID WEINTRAUB

Director

In cooperation with

NATIONAL BUREAU OF ECONOMIC RESEARCH, Inc.

WESLEY C. MITCHELL, Director of Research

Studies of Productivity and Employment in Selected Industries

Harry Jerome, Director

William A. Neiswanger, Associate Director

PRODUCTIVITY AND EMPLOYMENT IN SELECTED INDUSTRIES

BRICK AND TILE

by

Miriam E. West

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WORKS PROGRESS ADMINISTRATION, NATIONAL RESEARCH PROJECT

In cooperation with

NATIONAL BUREAU OF ECONOMIC RESEARCH

Report No. N-2

Philadelphia, Pennsylvania

February 1939

**THE WPA NATIONAL RESEARCH PROJECT
ON REEMPLOYMENT OPPORTUNITIES AND RECENT CHANGES
IN INDUSTRIAL TECHNIQUES**

Under the authority granted by the President in the Executive Order which created the Works Progress Administration, Administrator *Harry L. Hopkins* authorized the establishment of a research program for the purpose of collecting and analyzing data bearing on problems of employment, unemployment, and relief. Accordingly, the National Research Program was established in October 1935 under the supervision of *Corrington Gill*, Assistant Administrator of the WPA, who appointed the directors of the individual studies or projects.

The Project on Reemployment Opportunities and Recent Changes in Industrial Techniques was organized in December 1935 to inquire, with the cooperation of industry, labor, and governmental and private agencies, into the extent of recent changes in industrial techniques and to evaluate the effects of these changes on the volume of employment and unemployment. *David Weintraub* and *Irving Kaplan*, members of the research staff of the Division of Research, Statistics, and Finance, were appointed, respectively, Director and Associate Director of the Project. The task set for them was to assemble and organize the existing data which bear on the problem and to augment these data by field surveys and analyses.

To this end, many governmental agencies which are the collectors and repositories of pertinent information were invited to cooperate. The cooperating agencies of the United States Government include the Department of Agriculture, the Bureau of Mines of the Department of the Interior, the Bureau of Labor Statistics of the Department of Labor, the Railroad Retirement Board, the Social Security Board, the Bureau of Internal Revenue of the Department of the Treasury, the Department of Commerce, the Federal Trade Commission, and the Tariff Commission.

The following private agencies joined with the National Research Project in conducting special studies: the Industrial Research Department of the University of Pennsylvania, the National Bureau of Economic Research, Inc., the Employment Stabilization Research Institute of the University of Minnesota, and the Agricultural Economics Departments in the Agricultural Experiment Stations of California, Illinois, Iowa, and New York.

WORKS PROGRESS ADMINISTRATION

WALKER-JOHNSON BUILDING
1734 NEW YORK AVENUE NW.
WASHINGTON, D. C.

F. C. HARRINGTON
ADMINISTRATOR

February 16, 1939

Colonel F. C. Harrington
Works Progress Administrator

Sir:

The brick and tile manufacturing industry saw its all-time production peak 30 years ago. Despite the growth in the demand for construction materials since the first decade of this century, the displacement of brick and tile by other types of materials kept the volume of production below former peaks even during the height of the construction boom around 1925. At the same time, technological progress resulted in increased labor productivity and a steady decline in the number of jobs available in the industry. Sharp production cycles, coupled with a high seasonality of operations, helped to make employment conditions in this industry decidedly unstable.

In 1869 the manufacture of 1,000 common brick required more than 27 man-hours of work. During the next 50 years the labor required dropped to less than 13 hours, and by 1925 only 9 man-hours were needed. The 4,215 plants operating in 1909 employed an average of 76,500 wage earners and produced an equivalent of 15.7 billion common brick. In 1925 almost as much brick - 15.4 billion - was produced by 57,600 wage earners in 1,528 plants, while in 1935 only slightly over 17,000 workers were used to manufacture the 3.4 billion bricks in the 708 plants that operated during that year.

The report transmitted herewith analyzes the many factors which have thus affected the job opportunities provided by the brick and tile industry. Recovery of employment in the industry depends, of course, primarily

on an increased volume of construction, but the production prospects are limited by the declining use of brick and tile in construction. Reemployment opportunities are further limited by the fact that an increased degree of plant-capacity utilization is likely to result in a rise of productivity considerably beyond present levels in operating plants and in an increased share of the total output produced in the larger and more efficient plants. Also, if past experience is repeated, a major upturn in activity is likely to be followed by the construction of new, more efficient plants and by the improvement of the equipment of existing plants and the installation of new and improved machines.

Should the 40-hour week become the governing standard in this industry, however, and should the existing deficiency in housing result in a return to even a 1929 level of construction activity, it is probable that the conservativeness of builders, together with the influence of the existing building codes which favor the use of brick, will result in a volume of reemployment sufficient to approach the employment level of 1929.

Respectfully yours,

A handwritten signature in cursive script that reads "Corrington Gill". The signature is written in dark ink and is positioned above the typed name.

Corrington Gill
Assistant Administrator

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PREFACE

Any appraisal of employment prospects in an industry must rest on the outlook for production and the trend of productivity. The outlook for production, in turn, depends upon market possibilities, price changes, the structure of the industry, its economic organization, and its industrial policies. The proper interpretation of the trend in labor productivity presupposes an appreciation of the industry's technology and of prospective changes in its production techniques, and a knowledge of trends in the size, number, and location of plants, as well as of their relative capacities and productivity levels and of existing and prospective degrees of capacity utilization.

It is only rarely that the data needed for such an appraisal can be made available without detailed studies based on field surveys. Yet it is only through the accumulation of such intensive industry studies that prospects for the economy as a whole can be properly evaluated on the basis of the prevailing trends in the economy, the relationship of these trends to the flow of capital into producers' goods and of purchasing power into the hands of consumers, and the effects of changes in the character of that flow on employment opportunities.

This report on brick and tile manufacture is one of a series of studies based on plant records collected through a field survey. It presents a detailed picture of the economics of the industry and analyzes the effects of the operation of a variety of factors on the volume of employment. Such studies, of course, cannot be done for all of the country's industries. But certain industries can be selected and made to serve as illustrations of types of economic situations and their relationship to the question of employment opportunities.

Thus, in the case of the brick and tile industry, the manufacturing plants are scattered throughout the country wherever suitable clay deposits are available and where there is a demand for their products. In the past, concentrations of population in the Middle Atlantic, Eastern, and North Central States have made these regions the largest consumers and, in view of the products' bulk in relation to their value, also the largest producers of brick and tile construction materials. The population trends

of the future may be expected to have a profound effect both on the volume and location of production.

The all-time production peaks were in the years 1906 for common brick, 1909 for vitrified brick (used principally for paving), 1910 for drain tile, and 1925 for building tile and face brick. There is no reason to believe that the trend of demand for drain tile, which depends largely on agriculture, and for paving brick will be reversed; common-brick production even at the peak of the post-war boom was equal to only three-fourths of the 1906 level. Activity in face brick and building tile is closely related to the volume of construction, and here fluctuations in building activity, as well as changes in styles and types of building, have vitally affected the number of job opportunities. During the last 30 years the demand for brick and building tile has been facing the increasing competition of other kinds of building materials.

Another factor which bears on employment prospects is that although the mining of clay and the forming of the brick are highly mechanized in most plants, the handling of the "green" and burned products still generally calls for a large amount of unskilled labor. Labor costs therefore constitute a large part of total costs and exert considerable pressure for further technological improvements.

The nature of the production processes in this industry is such that as output falls away from capacity levels the labor requirements per unit of product increase to an unusual extent. Between 1925 and 1929 the effects of the drop in production on the degree of plant-capacity utilization and on unit labor requirements were barely offset by the improvements in labor utilization made during that period. After 1929 the drastic further decline in production so reduced operations of individual plants that, unlike most other manufacturing industries, man-hour requirements per unit of product actually increased considerably. The productivity level therefore is an important factor in reemployment prospects when viewed from the vantage point of the depression.

These factors and others which must be considered in an appraisal of employment prospects in the brick and tile industry are analyzed in detail in this report. Prepared by Miriam E. West, the report is a product of a cooperative arrangement between the National Research Project on Reemployment Opportunities and

Recent Changes in Industrial Techniques and the National Bureau of Economic Research. The plans for this study were prepared under the general direction of Irving Kaplan, who in his capacity as Associate Director of the National Research Project also coordinated the work of other sections of the Project which contributed to this report. The execution of the study and the preparation of the report were directed by Harry Jerome and William A. Neiswanger. The completed manuscript was edited and prepared for publication under the supervision of Edmund J. Stone.

DAVID WEINTRAUB

PHILADELPHIA

February 14, 1939

INTRODUCTION

This is a case study in industrial change, having as its major objective the attainment of a fuller understanding of the effects of such change upon labor displacement and reabsorption.

The processes by which employment opportunities are enlarged or restricted can by no means be reduced to a few simple rules. Industries differ widely in their economic characteristics, and, in turn, the type, rapidity, and effects of technological change vary with the conditions and characteristics of the industry. Hence, the impact of technological change must, if it is to be understood, be examined under diverse conditions, i. e., in industries having varied economic characteristics.

This report covers one of a group of five industries examined according to a common pattern of analysis. The five selected industries are brick and tile, portland cement, wheat flour, lumber, and beet sugar. These industries were selected chiefly because the principal product of each is relatively standardized. While, except in the lumber industry, the number of workers employed in any one of them is not large, it is also true that the very large industries must, as a rule, be broken down into smaller segments to attain a workable homogeneity of output and economic characteristics. The definition of the scope of the industry and the collection of the necessary data are simpler for a small, relatively homogeneous industry like beet sugar than for an equally homogeneous segment of a larger industry. It is believed that the behavior patterns ascertained for these relatively small industries will be of value as case studies illustrating the way in which changing productivity and employment are probably related in other industries.

The effects of technological change can be studied from many points of view - as revealed in the personal work histories of individual workers or in the economic fortunes of selected occupations upon which a change impinges, as associated with the history of whole communities sharing the fate of a flourishing or a declining industry or with the history of the development and introduction of selected types of machines, or, lastly, as recorded in the output and employment records of individual establishments in selected industries.

The last-mentioned approach is used in the survey covered by this report. The unit of analysis is a single, relatively homogeneous industry. An effort is made to bring to bear on the problem all the available pertinent data, but a major distinctive feature of the survey is the collection of year-by-year time series for individual plants.

As a minimum these plant series cover employment, in terms of man-hours, and output, in standardized units or in a form reducible to equivalent units.¹ For many plants supplementary data were collected showing major equipment changes and their effects, changes in investment in equipment, and changes in the distribution of cost, in the volume of power and raw materials used, and in the unit prices of products. The period of time covered varies. A few records extend back for 25 years or more; for some brick and tile plants data are available for two decades. As a rule a plant was not surveyed unless data could be obtained for at least 7 years. Most of the data were compiled by field agents directly from the company records, supplemented by verbal information from the plant executives.

Two other distinctive features of these productivity surveys should be noted: (a) the attention to the integrated aspects of the industry and (b) the effort to relate the changes in productivity to financial and economic characteristics.

In recognition of the fact that the conditions of operation in one stage of an industry may be closely related to changes in antecedent and subsequent stages, where adequate data are available an effort has been made to appraise the changing labor requirements in the entire vertical structure of the industry, from the extraction or cultivation of the raw materials to the delivery of the finished commodity to the user. In the factory stage of some of the industries surveyed, the two decades just passed have seen a substantial reduction in the labor required per unit of output. It is for this stage that we have been able to obtain the more complete and detailed information, but it is pertinent to inquire whether or not the available evidence indicates that the improvements in productivity in the processing stage have been offset by increasing labor requirements in the preparation of the raw materials used in the factory or in the distribution of the factory products. In the brick and tile

¹See table A-32 for individual plant man-hour ratios derived from the output and employment data.

industry, for most plants, the excavation of the raw materials is integrated with the fabricating plant. The analysis of labor utilized in the plants is supplemented by estimates of labor devoted to the mining and transportation of the coal used for burning, and also the labor devoted to the transportation and merchandising of the finished products.

From the point of view of productivity in the over-all vertical structure of the industry, the problem of changing labor requirements may be stated thus: Does it take more or less labor for the complete production of a good from the initial production of raw materials to the delivery to the consumer? Particularly, are such improvements in productivity as are observed in the fabricating stages of such nature that their result is an increase in the labor required per unit of output in other stages of the vertical structure? It is conceivable, for example, that a reduction in labor requirements in the processing stage may be accomplished by a geographical concentration of production which results in an offsetting increase in the labor required in distribution.

The data available for some of the elements in the vertical structure are so fragmentary and lacking in precision that the picture for the vertical structure can be painted only in broad outlines, although enough is known in general about the changes in the allied segments to reach a conclusion as to whether they limit materially the significance of the more precisely measured changes in the factory-processing stage.

An objective description of the rates of change in employment and productivity in an industry and in its constituent parts is a necessary first step, but we have sought to supplement this minimum objective analysis with whatever information would throw light on the circumstances which have determined the rates of change in total employment and in unit labor requirements.

The general scheme of analysis is to ascertain first what fluctuations in employment have taken place in the industry, then to examine, in chapter III, the extent to which the observed changes in employment are ascribable to changes in total output and what circumstances account for the changes in the level of production. Obviously that portion of the change in employment which is not ascribable to changes in the total volume of output is to be accounted for by changes in the man-hours required per unit of output and this leads, in chapter IV, to a detailed

examination of the information concerning variation in man-hour ratios afforded by the records of individual establishments.

In analyzing these records we have endeavored to differentiate between that portion of the observed improvement which arises from improvements in productivity of plants after they first come into operation and the improvements in the industry as a whole arising from a changing plant constituency. It is conceivable that the over-all productivity of an industry may improve without any change in productivity in the individual plants. This apparent anomaly is readily possible if the more efficient existing plants produce an ever larger share of the total product, if new plants enter the industry at a higher level of productivity than the general average, or if the plants which disappear from the industry are those with high labor requirements per unit of output.

In the effort to appraise the relative contribution of improvements in existing plants and of a shifting industry constituency we are led to examine the variations in man-hour ratios when the plants are classified by size, age, geographical location, percentage of capacity utilized, and process. Aside from their contribution to the immediate problem stated above, the observed differences are of interest for the light they throw on the causes of differences in productivity.

Also, it is pertinent to examine the relative rates of change over time in the man-hour ratios of the several types of plants and the variation in rates of change in periods of active and of less active operation.

Special interest attaches, it is believed, to the estimates made for each plant of attainable capacity in each year and the percentage of capacity actually utilized. It is found that a large part of the short-time fluctuations in man-hour requirements is explainable in terms of the percentage of capacity produced. Hence any estimates of the probable future employment opportunities in an industry must take into consideration not only the trend in unit man-hour requirements but, even more, the probable influence on unit labor requirements of the anticipated volume of output.

Chapter V is devoted to a summary of the observed employment tendencies in the brick and tile industry, particularly the relation between economic characteristics and the change in total employment and in unit labor requirements.

The present survey has been conducted cooperatively by the National Research Project and the National Bureau of Economic

Research and is, in part, a continuation of a survey inaugurated by the National Bureau of Economic Research in 1927 to supplement its studies in the changing mechanization of industry. The initial stages of the survey, hereinafter referred to as the "first survey", were conducted, under the direction of Mr. Jerome, in the summers of 1927, 1928, and 1929, chiefly in portland cement, beet sugar, and lumber in the Pacific Northwest, with a smaller sampling in brick-and-tile and in wheat-flour manufacture. The "second survey" extended the lumber sample into Southern Pine areas and substantially expanded the number of clay-products and flour-milling establishments studied. Data were obtained for as many years as available, covering output, man-hours of labor, and accompanying changes in methods and equipment. The early records resulting from the first survey have made it feasible to extend the present study further back in time than would otherwise have been possible, for in many instances in the intervening period data for the earlier years have been destroyed by the companies or otherwise have become unavailable. The results of the first survey were partly utilized in a report on *Mechanization in Industry* published by the National Bureau of Economic Research² but have never been fully presented.

The general plan for the second survey followed closely that of the first survey, but the subject matter of the inquiry was widened in certain respects, and the broad scope of the National Research Project made it possible to bring much supplemental and collateral data to bear upon the findings of the field study. Plans for the second survey took form under the general direction of Irving Kaplan, who in his capacity as Associate Director of the National Research Project coordinated the work of the other sections of the Project whose studies contributed to this report. Carroll R. Daugherty and J. van Horn Whipple collaborated in the preparation of the schedules pertaining to equipment and process changes.

The basic information concerning the factory-processing stage of the industry was obtained by field representatives from the records of brick and tile companies. The voluntary cooperation of the industry was indispensable to the success of the survey, and special thanks are due to the many executives who gave generously of their time and advice. Their cooperation was so essential

²Harry Jerome, *Mechanization in Industry* (New York: National Bureau of Economic Research, Publication No. 27, 1934).

and significant as to merit special and individual mention, which, obviously, we cannot give without revealing the identity of co-operating enterprises.

The evidence contained in the individual plant histories obtained in the field survey has been supplemented by the available published data pertaining to the industry and by special tabulations of data collected by other Government agencies. We are indebted to the Bureau of the Census for a special tabulation of employment in those plants of the machinery industry making clay-working equipment.

To a larger degree than can be readily indicated, these reports are the cooperative product of many individuals and groups in the National Research Project. Secondary sources were examined by research units under the supervision of Alexander Gourvitch in New York and William H. Dillingham in Washington, D. C. Numerous reports for our use on selected aspects of the development and economic characteristics of the five industries resulted from this work. From the railroad-transportation section of the Project came data on the basis of which was calculated the labor required in the transportation of various commodities. Valuable estimates of changing labor requirements in the production of fuel were prepared by Nicolas Yaworski.

The machine-study section of the Project under the supervision of J. van Horn Whipple and George Perazich made two major contributions to the productivity studies in the five selected industries: (a) a report on the evolution of technique and the progress of mechanization, dealing with each industry,³ and (b) an estimate by years of the labor utilized in the manufacture of machinery for each industry, expressed in the ratio form "man-hours per dollar" selling price of the machines. These estimates are based upon data concerning output and employment obtained from the records of establishments making machinery for the use of the five industries covered by the productivity surveys.

The analysis of the mechanization data was supervised by Alfred J. Van Tassel and the analysis of labor utilized in the manufacture of machinery was supervised by Solomon A. Lischinsky.

It is scarcely feasible to specify all of the members of the staff who in some way have contributed to the meticulous editing

³See report by A. J. Van Tassel and D. Bluestone, *Mechanization in the Brick Industry* (WPA National Research Project, in preparation).

and analysis of the data utilized in this report. William F. Stewart supervised the general editing and statistical analysis of the individual plant histories, assisted by Hans H. Landsberg and others. The computation of the common-brick equivalents of the diverse output of plants making two or more products was supervised by Sidney M. Lerner. Estimates of attainable capacity of each plant were prepared by Bernard Nortman and Myron Schmittlinger. The sample analysis was prepared by Edith H. Handler. Special mention should be made of the contributions of C. D. Bray who, after serving in an important administrative capacity in the field survey, directed the analysis of schedules of equipment changes collected from the plants. Ruth Eisner served as general statistical assistant to Dr. Jerome.

The integration of the evidence obtained from the individual plant histories with the available material from secondary sources, and the preparation of the manuscript of this report are the work of Miriam E. West assisted by Edward G. Manning. The charts were prepared by Edmund W. Jones and Andrew J. Terzuoli. Ruth Kastelansky assisted in the compilation of material from secondary sources, and Joseph P. Cohen, Barbara S. Holmes, and Alice Hirsh assisted in statistical work connected with the preparation of the manuscript. Special mention should be made of the work done by William R. Gray in the final checking of all the data used in the manuscript.

The arrangements for cooperative studies with other government agencies and the work of that portion of the staff engaged in the preparation of the manuscripts integrating the data from the field survey and other sources have been under the supervision of Dr. Neiswanger. Our hearty thanks are due to a number of persons who read portions of the manuscript and submitted helpful criticisms. Among these should be mentioned Ralph P. Stoddard, M. E. Holmes, and Peter A. Stone.

Lastly, the effectiveness of the work of the productivity surveys conducted cooperatively by the National Bureau of Economic Research and the National Research Project has been in large part due to the assistance rendered by David Weintraub, Director, and Irving Kaplan, Associate Director of the National Research Project, and to their helpful advice in the planning and execution of the work.

Harry Jerome
William A. Neiswanger

CHAPTER I

A DESCRIPTION OF THE BRICK AND TILE INDUSTRY

The making of brick is an industry which was carried on in ancient times and was revived in Europe in the medieval period. In this country the colonists early felt the need for brick construction of public buildings and substantial residences. Some brick was imported from England for this purpose because of a lack of skilled brickmakers. The art of brickmaking was soon established in the Colonies, however.¹ Thomas Jefferson, who combined with his devotion to statesmanship and philosophy a deep interest in architecture and building, gives us the details of the labor and money cost of making bricks in his day. Writing in the early years of the nineteenth century, he says:

A demicord of earth (4-foot cube) makes 1,000 bricks. A man will turn up 4 such cubes, or even 5, a day. The price for turning up is 1s. [13.3 cents] (Maryland) the cube, or 1,000 bricks, the laborer finding himself [providing his own maintenance].

A man moulds 2,000 bricks a day. His attendance is a man to temper, one to wheel the mortar to him, and a boy to bear off (Philadelphia).²

Beginning with the *Census of Manufactures* for 1849, at which time there were 17,000 or more "hands employed" in making brick valued at about \$6,600,000, it is possible to follow the development of the brick and tile industry in this country. In 1859 drain tile appeared on the list of clay products. It rapidly assumed importance because of its extensive use in the draining of lands as the population grew and needed more land for agriculture. In the seventies the cities in the Middle West followed the example set by Charleston, West Virginia and began paving their streets with bricks. Philadelphia, in 1887, was the first large city to use bricks for paving.³ Production of paving brick developed very rapidly until the first decade of the present

¹The Department of Research and Education of Colonial Williamsburg, Inc., Williamsburg, Va., has collected some interesting records of early brick-making in the Colonies, especially in Virginia.

²Thomas Jefferson's Manuscript Account Books, Massachusetts Historical Society, as cited in *History of Wages in the United States From Colonial Times to 1928* (U. S. Dept. Labor, Bur. Labor Statistics Bull. No. 499, Oct. 1928), p. 56.

³*Manufactures: 1805* (U. S. Dept. Com. and Labor, Bur. Census, 1908), Part III, "Special Reports on Selected Industries," p. 894.

century, from which time it was as rapidly displaced by the use of cement both for walks and pavements. Today the industry seems to be a declining or stationary one, but it is likely to continue to supply a limited demand for bricks for paving purposes, as well as for walls and surfaces where a hard glazed product is needed.

As cities began to assume importance in the industrial development following the Civil War, machines were invented to make better bricks and ones more suitable for the facing of buildings. To the list of products in the industry there were then added pressed brick, front brick, and fancy colored front brick. The boom of the financial promoters in the early 1900's had its reflection in the building trade which at that time made use of elaborate brick fronts on commercial and industrial buildings.

The nineties ushered in a revolutionary movement in city buildings, which in the twentieth century materially lessened the demand for common brick and initiated the increased demand for hollow building tile and face brick. The introduction of steel-framed buildings eliminated the necessity of brick walls for structural support. Upon the steel frame could be hung a mere curtain of outer walls. Hollow building tile, which had formerly been restricted in use to certain fireproofing functions, now came into demand as suitable backing to outer walls of face brick or stone or other materials in the new skyscrapers which were made possible by the steel frames. Hollow building tile and face brick have therefore displaced common brick to a large extent in certain types of buildings where lightness is demanded of the wall and facing is necessary for all sides.

DEFINITION OF THE INDUSTRY

The five major products - common brick, face brick, paving brick, hollow building tile, and drain tile - have been selected as a sector of the clay-products industries suitable for study. This report attempts to describe and analyze changes in employment as related to changes in the demand for these products and to other factors affecting the volume of their production.

In order to investigate the effects of changing technology upon the volume of employment in the industry, a case study was made of 108 plants distributed throughout the United States. Information, so far as it was available, was obtained in regard to production, man-hours, changing equipment and methods, costs,

prices, and investment over a period of years. Only a few plants could furnish reasonably complete data on all points covered by the survey, but all plants included in the sample furnished data on production and man-hours. These data have been supplemented by material from secondary sources in order to extend the scope of the investigation in respect to time and coverage and in order to relate the changes in employment as revealed by this sample to the totality of changes in employment in the industry and in its allied vertical segments.

The designation "brick and tile" has been chosen to identify the sector of the clay-products industries engaged in the manufacture of the products specified. When used without qualification, it refers to the industry so delimited. There were several reasons for limiting the scope of the investigation to the production and distribution of these five specified products. The most important of the limitations was the necessity of having some unit or units of measurement for use in the determination of productivity, or man-hours per unit of product. The unit adopted for this purpose was that of "1,000 common brick" since common brick is the most important of all the products produced by the clay-products industries and as a unit may be said to be fairly standard. But although a small number of plants produce only common brick, most plants produce face brick or tile, or both, together with common. Not only is this true, but production of the diverse products also is carried on with the same equipment and with the same men in almost all operations so that it is impossible to segregate the man-hours associated with one product. Because essentially the same raw materials, equipment, and processes are used in their production, it is feasible to reach a rough approximation of the number of tile of a given kind, or of face or paving brick, which can be considered comparable, for the purposes of measuring output, to 1,000 common brick. It has therefore seemed reasonable and desirable to take as a segment for investigation those clay products which were made in the same plants by the same processes and with the same equipment as common brick. The field survey revealed that these were common brick, face brick, paving brick and other vitrified brick, hollow building tile, and drain tile. For the purpose of synthesis the quantities of these products have been converted into a unit called a common-brick equivalent.⁴

⁴Discussion of the method used in obtaining the conversion factors is found in chapter II and appendix B, section on "Conversion of Census Production Data Into Common-Brick Equivalents."

There are several possible principles which may reasonably be used in defining an industry for the purpose of investigation. It may be defined in respect to raw materials used, the process of manufacture, or the use to which the products are put. The United States Geological Survey used the first of these principles in its reports on the "Clay-Working Industries" for the years 1895 to 1918. It included the mining of all clay regardless of the use to which it was put and the manufacture of that clay into diverse products. The United States Bureau of the Census has followed the same principle in its classification "Clay Products Industries" which it has used since 1890. Before that time, plants making brick and tile were classified according to the principal product, with no attempt made to combine all clay products into one industrial classification.

Within its broader classification, however, the census has attempted to make subclassifications on the basis of the use to which the product is put. It has always put pottery in a class by itself, and in the years 1889-1909 it had a subclassification called "Brick and tile." This corresponds fairly closely to the definition of the brick and tile industry as used in this study. Unfortunately the definition varied somewhat from census to census, but in the main it included establishments whose major products were one or more of the following: Building brick; fancy, ornamental, and front or face brick; vitrified paving brick; and drain tile. These establishments made a small quantity of other clay products. In certain years establishments whose major products were sand-lime brick and sewer pipe were included. The exclusion of establishments whose major product was hollow building tile, however, marks the main difference between the census definition of this industry for those years and the definition selected for this study. Omission of the establishments whose principal product was building tile was doubtless due to the fact that it was only beginning to come into use as an important structural material.

Beginning with the census of 1914 the classification "Brick and tile" was dropped and the industry was divided into two, one entitled "Pottery" and the other "Brick, tile, and terra-cotta and fire-clay products." The latter designation was changed, in 1923, to "Clay products (other than pottery) and nonclay refractories." Included in the latter group are plants engaged in manufacturing brick and tile of all kinds, some made of materials

other than clay (sand-lime brick is not included), as well as other clay products and nonclay refractories. The United States Bureau of Labor Statistics follows the definition of the census in its collection of employment and pay-roll statistics for the "Brick, tile, and terra cotta" industry. The value of the production of the sector of this industry which has been defined for the purpose of this study as "brick and tile" was only 47 percent of the value of the production of the clay-products industries (excluding pottery) in 1929 and varies from 60 percent to 30 percent in 1914-35. It is evident that very little use can be made of the summary of statistics for this industry made by the Bureau of the Census or of the employment statistics published by the Bureau of Labor Statistics. But in certain years beginning with 1925, the census gives summary statistics for establishments classified by major products, which include common brick, face brick, hollow building tile, vitrified brick or block, and drain tile. These statistics, together with those of the census prior to 1914, are the basic secondary statistics used in this study of changes in productivity and employment in brick and tile. The census definitions have been followed for each of these products. Vitrified brick or block includes paving and other vitrified brick or block; hollow building tile includes partition, load-bearing, furring, book, floor-arch, silo, corn-crib, and fireproofing tile and radial chimney blocks. Excluded are enameled brick and tile, floor tile, wall tile, and many other minor products.

A study of changes in employment should consider the complete vertical structure of the industry, since greater centralization of production may lead to decreased employment in the manufacturing processes but may at the same time increase employment in distribution. Likewise, changes which bring about more efficient uses of fuel may reduce employment in the coal fields, or increased use of machinery may decrease man-hours in the production of brick but increase man-hours in the production of machinery. An attempt has been made, therefore, to study changes in employment in the machinery and fuel-producing industries insofar as the products of these industries are used in the manufacture of brick and tile. Likewise, employment in transportation and distribution of brick and tile is considered as properly belonging to the vertical structure of the industry. This study attempts, therefore, to give a picture of the changes in employment in

the vertical segments of the brick and tile industry, starting from the raw materials of clay and coal and the production of machinery, continuing through the process of manufacture in which these are combined and transformed, through the transportation by trucks, trains, and boats into the hands of wholesalers and contractors, and ending when the products arrive at the place where they are to be used. Needless to say, while a fairly accurate picture may be given of the employment in the fabricating segment of the industry, a much less clear picture can be drawn of the other, not as well defined segments.

DESCRIPTION OF THE PRODUCTION PROCESSES

The operations in the manufacture of brick and tile are relatively simple. Clay or shale is dug or mined or sometimes dredged; it is prepared for shaping into brick or tile by grinding or crushing if necessary and by mixing with water, unless the dry-press process is used. The clay is then shaped into bricks, formerly by hand but today usually by machine. It is either forced into molds and thus formed into bricks or is forced out through a die which, together with the cutting machine, gives it the shape of a brick or the kind of tile desired. The "green" products formed by the machine must then be dried to get rid of the excess moisture. In the dry-press process the molded brick is subjected to high pressure in the mold, and no drying is necessary. The bricks are removed from the drying sheds to the kilns where a baking process fuses the chemical materials in the clay. After being cooled, the brick and tile are ready for drawing from the kilns and sorting into different kinds and grades preparatory to storing or shipping.

There are three different processes used in making brick in the United States: the stiff-mud process, which is used in most plants; the soft-mud process, next in order of use; and the dry-press process. Tile is usually made by the stiff-mud process, although the dry-press process is sometimes used.

The departments in a brick or tile plant can be conveniently distinguished as follows:

1. *Clay Pit* where the clay is dug and from which it is transported to storage or to the machine house.
2. *Machine House* where the clay is prepared and formed into "green" brick or tile.

3. *Drier* where the green-brick products are dried (not necessary in the dry-press process).
4. *Tossing and Setting* the products in the kiln.
5. *Burning* the products.
6. *Drawing and Loading* which includes removing the burned products from the kiln and sorting and loading them for shipment or placing them in storage.

The operations carried out in these different departments may be described briefly.

Clay Pit

Clay is most commonly mined by means of some sort of mechanical shovel driven by steam, electricity, or, more recently, a Diesel motor. The shovel digs the clay and loads it into cars which run by gravity or are hauled to the machine house. Here the cars may be drawn up an incline by cable or other means and their contents dumped mechanically into a hopper or chute leading to the clay-processing machines. In a small number of less-progressive plants the clay is still dug by means of hand shovels and is hauled by wheelbarrows or horse carts to the machine house. Where shale is mined, either drilling and blasting or a specialized machine known as a shale planer may be necessary. In some cases clay is dredged from a river bottom. Some plants have facilities for storing clay to use during the winter months when for 6 or 8 weeks the mining of the clay may be made impracticable by weather conditions. The labor requirement in this department will depend upon several factors - principally, the ease with which the clay can be mined; the degree to which the mining, loading, and transportation have been mechanized; and the distance from the clay deposit to the plant.

Machine House

The equipment used in the machine house varies with the character of the clay, the type of brick produced, and the process used in forming the brick or tile.⁵ In most plants the clay is dumped first into a granulator which cuts it up by means of large steel knives spirally attached. This prepares it for passing through a set of conical rolls which remove the stones. In the

⁵See discussion of "Raw Materials" in chapter III.

stiff-mud and soft-mud processes it then goes to the pugmill, where it is mixed with water to produce a mixture of the proper consistency and texture for the brick machine. While some clays require the use of all of these machines, others go first to the pugmill, and in a few instances the character of the clay is such that it goes directly to the brick machine.

The next operation consists of forming the brick or tile. A different type of machine is used for each of the three processes. In the stiff-mud process the most common type of brick machine is the auger type in which an encased revolving screw forces the clay through a hard-steel die from which it emerges as a ribbon of clay onto a belt conveyor which carries it to the cutting machine. This is synchronized with the brick machine and cuts the ribbon of clay into brick or tile of the desired size. Different dies are used for each type of product. After cutting, the bricks are automatically carried away on an off-bearing belt from which they are removed by the hackers and are set on cars for removal to the driers. These cars have a capacity of from 600 to 1,000 bricks. In the stiff-mud process the machine operations in this department form one continuous automatic process. Hence most of the workers used are hackers who remove the bricks from the belt by hand and place them on the cars which are also moved by manual labor.

The forming of soft-mud bricks usually requires more hand labor. The brick machine forces the clay into molds which have been sanded to prevent the sticking of the clay and which have been placed in the machine by hand. The top surface of the brick is then smoothed by a hand operator, and the molds are ejected by the machine onto a table where they are bumped by hand to loosen the bricks. These are dumped by another man onto metal pallets, placed by yet another worker. The more modern equipment includes automatic sanding, dumping, and ejecting devices which are built into or are attached to the standard type of brick machine. This eliminates all hand labor connected with the operation of forming the brick. Because of the quantity of water added in mixing the clay, the bricks made by this process are too soft to handle by hand and must be carried off on the pallets on which they are dumped. This may be done by an automatic cable conveyor from which the pallets are removed by hand and placed in the drier.

The old-fashioned hand-forming methods are still in use in at least one plant.⁶ Here there is no brick machine, the skilled brickmaker pressing the clay into the molds by hand.

In the dry-press process the clay, after it has been tempered, is conveyed to a rotary mixer from which it drops into a mold box containing 5 to 10 molds. The dry clay is then formed into bricks by a press exerting high pressure. The lifting of the press automatically ejects the bricks from the molds and pushes the bricks out of the machine onto a table from which they are taken by hand and placed on trays which are wheeled directly to the kiln for burning.

Drier

In the soft-mud and stiff-mud processes the next step involves the transfer of the green bricks from the machine house to the driers. In a majority of cases the brick cars are pushed by hand to the drier kilns, usually tunnel-shaped. These kilns may be heated either by utilizing waste heat from the brick-burning kiln, by steam heat, by the direct-heat method which consists of building a fire in pans under the floor of a kiln, or by a combination of these methods. In some cases an open-air method of drying is used; this takes from 5 to 12 days, depending upon climatic conditions. The artificial method requires from 1 to 3 days. Improvements in the drier are designed to eliminate waste due to improper drying and to improve the quality of the product.

Tossing and Setting

After being dried, the bricks or tiles are transferred to the kiln. Either the cars are pulled from the drier and shoved by hand to the kiln, or the bricks are stacked by the wheeler on a truck or wheelbarrow and thence hauled to the kiln. The tossers remove the ware from the car and toss them (if they are brick, usually two at a time) to the setters who set them in proper arrangement to insure the most efficient burning. In some highly mechanized plants the transfer is done by means of cranes and mechanical equipment. This is possible where the scove kiln, a temporary structure, is used, but mechanical setting of brick is not used in the more common type of permanent kiln.

⁶"A 'Two-Horse' Soft Mud Brick Yard," *Brick and Clay Record*, 68, No. 2 (Jan. 1936), 25.

Burning

Most kilns are permanent kilns of one of the following types: The beehive kiln, which is circular in form and has a relatively small capacity; the rectangular kiln, which usually has a larger capacity; the continuous kiln, constructed in sections which can be fired separately but between which are dampers admitting the surplus heat of one section into the next; and the railroad-car tunnel kiln, through which the brick cars are moved slowly while burning takes place. In the Chicago, Hudson River Valley, and St. Louis districts many of the kilns are temporary, rectangular-shaped structures known as scove kilns, which are removed after the kiln has been burned.

The fuel, whether wood, oil, coal, or natural gas, is a big item in the cost of manufacture of clay products and therefore enters in as a factor in the selection of the type of kiln. While the smaller beehive kiln may have greater fuel efficiency if the quantity of products to be burned at any one time is small, the other kilns tend to be more efficient if larger quantities are burned. It usually takes from 7 to 8 days or even longer to burn the brick and an additional 6 to 10 days for the brick to cool sufficiently to be handled. There is great variation in the burning time, and in some plants it has been reduced to 3 days for burning and an additional 3 or 4 days for cooling. The workers used in this operation are principally kiln firemen, burners, and shovelers of coal. Improvements in kilns have for their objectives reduction of fuel requirements, reduction of time required for burning (which reduces man-hour requirements), and better burning of the product by more scientific control of temperature and moisture in the kiln in order to yield a greater proportion of first-grade product.⁷ Conveyors for coal and automatic stokers also reduce hand labor in this department.

Drawing and Loading

When the bricks have cooled from the burning, they are ready for drawing from the kiln. This is usually a hand operation. If there are several types of product, they are sorted as they

⁷ Lawrence E. Biemiller, "Industrial Furnaces for Gas; Kilns for Heavy Clay Products," *American Gas Journal*, 138, No. 1 (Jan. 1933), 16-8; James R. Withrow, "Opportunities for Using Indicating and Recording Control Instruments in the Rock Products Industries," *Rock Products*, XXXVI, No. 2 (Feb. 25, 1933), 32.

are drawn. Bricks are often sorted according to the place they occupy in the kiln. The better-burned brick may be classed as face brick. Face brick may also be sorted according to color. After drawing, the burned products are loaded on wheelbarrows which are run down a runway to trucks, railroad cars, or boats if the bricks are to be shipped; if not, they are wheeled to storage sheds (where the bricks are usually stacked by hand). Sometimes they are loaded from the kiln directly to trucks for delivery. Mechanical loading devices reduce the great amount of hand labor in this operation.⁸ For example, the bricks may be packed in crates which can be loaded and unloaded by cranes.⁹ For the most part, mechanical drawing and loading devices can be used only for common brick, where the product is uniform in size and requires no sorting.

It will be seen from this description that the making of brick and tile requires much handling labor. While some of this labor can be and has been eliminated by mechanical devices, mechanization of additional plants is limited by the fact that much of the mechanical handling is applicable only to common brick and is efficient only in large plants which, because of transportation costs, tend to exist only near big cities. The small plants which are located near their own markets can compete, despite their higher labor costs, with more efficient plants which must send their product from a distance. Since the trend is toward greater diversification of products with its added labor requirements for handling, attention is being given to conveyor systems which will eliminate handling and to a combination tunnel drier and kiln through which the product can be run without the intermediate handling operation.¹⁰

The cost of making brick and tile and delivering it to the consumer has three large components: (1) The labor cost of manufacture which, because of the handling, bulks large in proportion to the value of the product; (2) the cost of coal or other fuel which is required for burning and which, if the labor used in its transportation is included, entails an employment equal to

⁸R. H. Berg, "No Human Hand Touches Our Brick From Kiln to Job," *Brick and Clay Record*, 87, No. 3 (Sept. 1935), 85-8.

⁹"Shipping Brick in Containers Is a Speedy System," *Brick and Clay Record*, 74, No. 2 (Jan. 15, 1929), 85.

¹⁰"What to Consider When Rehabilitating a Clay Products Plant," *Brick and Clay Record*, 88, No. 2 (Feb. 1936), 58; "Is My Plant in Shape?" *Brick and Clay Record*, 88, No. 1 (Jan. 1936), 17-8; 88, No. 2 (Feb. 1936), 59-60.

16 percent or more of that used directly in the manufacture of the product; and (3) the cost of transportation which, because of the relatively heavy weight of the product, adds a labor requirement of 10 percent or more.

GROWTH OF THE INDUSTRY

The development of the brick and tile industry is summarized briefly in table 1. The years 1889, 1909, and 1925 have been

Table 1.- SUMMARY DATA FOR ESTABLISHMENTS WHOSE MAJOR PRODUCTS ARE BRICK AND TILE, 1849-1935^a

(Dollars in thousands)

| Year | Number of establishments | Average number of wage earners ^b | Wages | Value of products |
|------|--------------------------|---|--------|-------------------|
| 1849 | 1,603 | 11,949 | 4,235 | 6,611 |
| 1889 | 3,182 | 30,347 | 11,085 | 30,323 |
| 1889 | 5,828 | 65,020 | 29,709 | 67,771 |
| 1909 | 4,215 | 76,528 | 37,139 | 92,777 |
| 1925 | 1,528 | 57,652 | 70,993 | 179,519 |
| 1929 | 1,307 | 48,076 | 53,465 | 139,606 |
| 1935 | 708 | 17,156 | 12,101 | 33,818 |

^aCensus of Manufactures data.

^bFor methods of estimating, see appendix B, section on "Estimated Employment and Man-hours in Brick and Tile Manufacturing."

shown because they were years of peak production, while 1935 represents the recent depressed condition of the industry. The industry reached its all-time peak of production, measured in common-brick equivalents, in the building boom of the first decade of this century. The production in 1925 was slightly less than in 1909. The increases in dollar value of wages and products which continued after 1909 reflect only changes in wage rates and prices.

The growth and decline of the industry relative to population growth is shown by the fact that the number of bricks per capita increased from 79 in 1869 to 174 in 1909 and then declined to 134 in 1925, the last peak of production in the industry.

Table 2.- PER-CAPITA PRODUCTION OF BRICK AND TILE, 1889-1935^a

| Year | Common-brick equivalents | |
|------|--------------------------|------------|
| | Millions | Per capita |
| 1889 | 3,012 | 79 |
| 1889 | 10,009 | 162 |
| 1909 | 15,743 | 174 |
| 1925 | 15,398 | 134 |
| 1929 | 12,581 | 104 |
| 1935 | 3,426 | 27 |

^aCensus of Manufactures data.

CHANGES IN NUMBER AND SIZE OF PLANTS

Brick and tile have always been produced in small plants. In the first half of the nineteenth century production could be carried on with a small force because of the relatively simple methods used. Since clay suitable for the manufacture of bricks was widely distributed throughout the States, brick plants were erected in all parts of the country but were concentrated about centers of population. The first census figures available are for 1849, at which time there were 1,603 establishments employing 17,345 wage earners during their months of operation.¹¹ This would mean a normal force of about 11 wage earners per establishment. At this time the labor cost constituted 64 percent of the cost of making bricks. During the next 40 years when industries were growing, population increasing, and city population increasing faster than rural population, the brick and tile plants increased both in number and in size. In 1889, a year of much building activity, there were 5,828 plants employing about 104,000 workers during their weeks of operation.¹¹ The average normal force was around 18 workers. From that time on, despite an increasing demand for brick and tile, the number of plants decreased until in 1925 the normal working force was probably around 40 to 45 and the number of plants was 1,528. Some of the larger plants

¹¹The average number of wage earners for the given year as reported in the census from 1849 to 1889 was the aggregate of the averages reported by the plants for their periods of plant operation. Beginning with the census of 1899, the annual average as given in the census was an average of the 12 monthly aggregates of individual plant data.

were employing 100 to 200 workers. One had as many as 378 in 1929, but this was exceptional. Whereas the average number of brick produced per establishment was less than 1 million in the census years previous to 1889, it was nearly 2 million in 1889, nearly 4 million in 1909, and about 10 million in 1925. A few of the largest plants operating today have a capacity of from 60 to 140 million common brick per year, but there are many small plants with a capacity of 5 million or less. It is evident from this that there is no substantial trend toward modern large-scale production. That even the large plants remain relatively small when compared with plants in other industries is probably due to the fact that cost of transportation limits to a large degree the extent of the competitive market; increase beyond a certain size would bring no decrease in production costs.

AVERAGE SIZE OF PLANTS IN 1925

Since 1925 was the last year of peak production in the industry, it was the year chosen for measuring the size of plants. In later years production and employment fell far short of capacity figures. Average employment per establishment, average yearly production, and average man-hours worked per year were used to measure size. For the plants whose major product is one of the five specified as being produced in the industry, the average number of persons employed in 1925 was 38, the average number of man-hours per year was 91,000, and the average amount of product measured in common-brick equivalents was 10 million brick. There is considerable variation among the different types of producing plants.¹² Those whose major product was drain tile averaged less than 11 wage earners per establishment, produced 2.6 million common-brick equivalents, and averaged only 26,000 man-hours per establishment. The common-brick plants were next in size with an average employment of 32 persons, producing 8 million common brick in 77,000 man-hours. The average face-brick establishment was almost twice as large as the average common-brick plant and produced 16 million common-brick equivalents in 142,000 man-hours. Those establishments whose major product was paving (vitrified) brick were the largest and averaged 83 wage earners producing over 22 million common-brick equivalents in 200,000 man-hours per year.

¹²See discussion of factors affecting size in the section on "Raw Materials", chapter III.

Table 3.- AVERAGE SIZE OF BRICK AND TILE ESTABLISHMENTS, 1925^a

| Major product | Average number per establishment per year | | |
|----------------------|---|-----------|--------------------------------------|
| | Wage earners | Man-hours | Common-brick equivalents (thousands) |
| Total | 38 | 91,194 | 10,009 |
| Vitrified brick | 83 | 199,842 | 22,428 |
| Face brick | 59 | 142,129 | 16,008 |
| Hollow building tile | 50 | 121,587 | 15,089 |
| Common brick | 32 | 77,145 | 8,052 |
| Drain tile | 11 | 25,654 | 2,639 |

^aCensus of Manufactures data.

The largest common-brick plants tend to be located in metropolitan areas. In the Chicago and New York areas many plants will be found which produce over 30 million brick per year and which employ 100 wage earners or more.

LOCATION OF THE INDUSTRY

The location of the industry is determined largely by the market for brick and tile.¹³ Common-brick plants are scattered over the country and are concentrated around big cities. The Hudson River Valley was the early center of production for New York City; in Pennsylvania, Philadelphia has been important in the East since colonial times; in Illinois, Cook County has been the center of production for Chicago. As the Middle West became industrialized, Ohio became important as a producer of brick. During the period from 1869 to the present, New York, Pennsylvania, and Illinois have remained the foremost States in the production of common brick; Ohio, New Jersey, Indiana, Massachusetts, Missouri, and more recently California have, in turn, occupied fourth and fifth places. During the census years 1904-31, Illinois, New York, and Pennsylvania accounted for 30 to 40 percent of the total production in the country.

There is greater concentration in the production of face brick than of common brick since face brick has greater value per unit

¹³For further discussion of the factors determining the location of brick and tile plants, see chapter III.

of weight and may therefore be shipped a greater distance. In 1925 Pennsylvania and Ohio together produced almost 50 percent of the face brick, while Indiana and Illinois produced approximately another 10 percent each. It is obvious that even here the markets help to determine the location of the industry.

In 1925 Ohio produced about 30 percent of the hollow building tile; New Jersey, Illinois, Pennsylvania, Indiana, and Iowa accounted for another 40 percent. Although most of the hollow building tile is used as structural material in steel-framed buildings, there is also a demand for it in farm buildings, especially on the western plains where wood is relatively scarce. In this market Iowa assumes importance in the production of hollow building tile. Otherwise the leading States are those which are important in the production of face and common brick.

Drain tile is made largely for an agricultural demand. Four States in the Middle West - Ohio, Iowa, Illinois, and Indiana - produce 80 percent of all this tile.

Over 60 percent of vitrified brick, which is largely used for paving, is made in Ohio, Pennsylvania, Illinois, and Kansas.

Ohio and Illinois outstrip the other States in the production of the five products when measured in common-brick equivalents. In 1925 they produced about 30 percent of the total brick and tile in the United States, production being divided almost equally between them. Illinois led in the production of common brick with 19 percent of the total. Ohio produced about 30 percent of the United States total of vitrified brick, hollow building tile, and drain tile, leading all other States in these three products; 23 percent of the face brick (in the production of which Pennsylvania led); and 4.9 percent of the common brick.

COMBINATIONS AND TRADE ASSOCIATIONS¹⁴

The industry has been characterized by a large number of small plants scattered throughout the country and largely run by the men who own them. The amount of capital necessary to establish a plant is relatively small. When there is much building activity the plants increase in number, only to disappear in depression years. In 1925 at the height of activity in the brick industry

¹⁴The data used in this section are taken from records and reports in the National Recovery Administration files concerning the Structural Clay Products Industry and the Clay Drain Tile Manufacturing Industry and from published sources.

1,528 plants were reported by the Bureau of the Census; in 1935 there were only 708. This number is probably an understatement, since many of the small plants were entirely without clerical employees to make out reports. Some of the plants which suspended operations, however, were probably able to resume operations as soon as business became profitable.

Combinations

The industry, however, is not without its large plants and large business concerns, although they are relatively few in number. Early in the twentieth century when the combination movement was strong in the industrial field, mergers of brick and tile companies also occurred.

During the years 1898-1900 several combinations were formed. Among these were the New England Brick Company, which combined 25 companies operating 34 plants in the vicinity of Boston; the Illinois Brick Company, which was a consolidation of 36 plants operating in Cook County, Illinois; and the Baltimore Brick Company, which combined 28 plants.¹⁵ All of these combinations exist today, and others have been formed in the intervening years. According to lists of members of the Structural Clay Products Industry included in the National Recovery Administration records, there were 1,233 brick and tile companies with 1,500 plants in 1933.¹⁶

The four leading companies in each branch of the industry shipped in 1934 the following percentages of the totals for their respective branches: Common brick, 9.5 percent; face brick, 17.1 percent; paving brick, 43.8 percent; and structural clay tile, 35.6 percent. The firm having the largest shipments in the paving-brick branch represented 21.7 percent of the total and in structural clay tile 24.6 percent, while in common brick the largest firm shipped 3.8 percent of the total and in face brick 6.1 percent.

Illinois Brick Company.— In the common-brick branch of the industry one of the most important mergers was that of the Illinois Brick Company. When it was formed in 1900 it acquired the plants

¹⁵*Twelfth Census of the United States: 1900, "Manufactures" (U. S. Dept. Int., Census Office, 1902), Vol. VII, Part I, p. xc; Victor S. Clark, History of Manufactures in the United States (New York: McGraw-Hill Book Co., Inc., 1929), III, 258-9.*

¹⁶The Structural Clay Products Industry, as defined for purposes of the NRA Code, includes common brick, face brick, hollow building tile, and paving brick.

of most of the operating brick companies in the Chicago area; some of these it operated; others it dismantled and abandoned.

The history of the Chicago market can be studied in the case of the *American Equipment Company vs. Tuthill Building Materials Company*.¹⁷ From the time it was formed, the Illinois Brick Company appears to have been the dominant force in the Chicago market in which it tried various schemes to regulate production and prices, such as the formation of a holding company and then a corporation which received all orders for common brick and distributed them among the various manufacturers. About 1909 the American Equipment Company was formed and apparently successfully controlled the Chicago market over a long period. This company owned a patent on a brick-setting machine and a brick-loading fork, which it claimed could effect a great saving in cost and labor. Through license agreements assigning quotas to the various companies, setting the price of brick, and providing for additional royalties when quotas were exceeded, prices were stabilized. The prevailing market price of common brick in Chicago did not vary from \$12 per thousand during the period September 1921 to May 1931, although the prices of other building materials varied widely and fluctuated continually. Ninety percent of the volume of brick in the Chicago market was controlled by these agreements. Since the Illinois Brick Company continued to buy up other plants, its quota increased from 52 percent in 1911 to 62 percent in 1925. From 1922 to 1930 it usually failed to produce its quota and so received \$678,578 paid by other licensees for overproducing their quotas. The amount received was 95 percent of the total penalties paid. The effect of this control of the market upon demand for brick and hence upon production and employment in the Chicago market will receive consideration in chapter III.

The National Fireproofing Corporation.— In contrast to the control of a local market exerted by the Illinois Brick Company, the National Fireproofing Corporation has been said to control the trade association in the Structural Clay Tile Industry.¹⁸ This company produced 25 percent of the total production of the industry in 1934. The history of the company goes back to 1889 when it was formed as the Pittsburgh Terra Cotta Lumber Company.

¹⁷Case No. 10128, U. S. Dist. Court, Northern District of Illinois, as reported in *Commerce Clearing House Federal Trade Regulations Service*, par. 7036, p. 5124.

¹⁸Letter from J. J. Whitacre, President, Whitacre-Grear Fireproofing Co., to R. J. Fogg, Deputy Administrator, NRA, Oct. 23, 1933, incorporated in *Code Records*, Vol. B, Part III, "Structural Clay Products Industry."

Under the name of the National Fireproofing Company it acquired, in 1902, 15 additional companies with 18 plants. In 1936 it owned and operated 21 plants in 17 separate localities in Massachusetts, New Jersey, Ohio, Indiana, Illinois, and Alabama. It produces a complete line of hollow tile and other special products.¹⁹

The formation of a corporation with plants in various parts of the United States is one answer to the problem of high transportation charges. In this connection it is interesting to note that the building-tile industry has followed the practice of using the basing-point system in quoting prices.

Hydraulic-Press Brick Company.— Similar to the above, in the field of face brick, is the Hydraulic-Press Brick Company of St. Louis, Missouri, which was formed in 1868. In 1907 it absorbed 14 controlled companies, and in 1934 it operated 22 plants in Illinois, Missouri, Indiana, Ohio, New Jersey, Pennsylvania, Virginia, New York, and Maryland.²⁰ Listed as manufacturing all kinds of brick used in building, in 1934 it was the largest producer of face brick in the country, producing 6 percent of the total.

The Metropolitan Paving Brick Company.— In the paving-brick branch of the industry, the Metropolitan Paving Brick Company of Canton, Ohio (incorporated in 1904) occupies a position similar to that of the other three companies in their respective industries. Its main product is paving brick, of which it produced 22 percent of the total in 1934. It produces also some tile and face brick. Its plants are not so widely extended throughout the country, being located in Ohio, western New York, and Pennsylvania.

United Brick and Tile Company.— All of the above-mentioned mergers were formed in the first decade of the twentieth century and each specializes in one field, though making other products, but the United Brick and Tile Company of Kansas City was formed in 1926 as the United Clay Products Corporation to merge 32 plants in Iowa, Kansas, Missouri, and Oklahoma, producing all types of brick and tile. It was hailed by the *Brick and Clay Record* as the "biggest merger ever consummated in the clay products industry."²¹

¹⁹ *Moody's Manual of Investments, American and Foreign: 1936*, "Industrial Securities" (New York: Moody's Investors Service, 1936), pp. 2278-9.

²⁰ *Ibid.*, p. 1075.

²¹ "\$10,000,000 Merger of Clay Plants," *Brick and Clay Record*, 68, No. 2 (Jan. 19, 1928), 106; *Moody's*, *op. cit.*, p. 1403.

Five of the 32 plants have been dismantled. In this western area of long distances and relatively small urban markets, the problem of cross freights has been met by this type of combination. Diversification, rather than specialization, is the answer here to the problem of reducing costs. It is claimed that selling, transportation, and inventory costs may be reduced under such combined management.

Although there are other large companies owning two or more plants, the five described above are typical of the large mergers. According to a list in the NRA files, there were 32 large companies in 1933, 294 middle-sized companies, and 907 small ones.²² The basis for this classification is not known, but some idea can be gained of the preponderance of small companies.

Trade Associations

Trade associations have existed and have been active for some time in the branches of the brick and tile industry producing common brick, face brick, paving brick, and structural clay tile, but for drain tile there seems to have been no trade association of long-continued existence.²³ These trade associations have engaged in the usual activities of promotion and standardization of the products, as well as collection of statistics in regard to price, production, shipments, new orders, and stocks on hand. Since Government agencies must be the main consumers of paving brick, it is natural that the National Paving Brick Association should have its headquarters in Washington and should list as its first purpose the advocacy of, "by honorable, legitimate means, the use of paving brick for street and highway improvements."²⁴

Structural Clay Products Code.— There was a brief period in the industry when it operated under the Structural Clay Products Code Authority, which consisted of eight members, four of whom were the presidents of the four associations. The Code Authority was given power to set mandatory minimum prices, based on average costs of production, for the products of the industry. The evidence is that such prices were set at a considerable height above

²²This list does not include companies producing chiefly drain tile.

²³Brick Manufacturers Assoc. of America, Cleveland, Ohio, estab. 1918; American Face Brick Assoc., Chicago, Ill., estab. 1912; National Paving Brick Assoc., Washington, D. C., estab. 1905; Structural Clay Tile Assoc., Chicago, Ill., estab. 1919.

²⁴"Articles of Association, Constitution and By-laws," adopted June 5, 1931. Incorporated in NRA Code Records, Vol. A, Part I, "Structural Clay Products Industry."

costs of production, and there were complaints that this was a factor deterring any satisfactory revival of consumption of clay products. The code, as adopted, permitted the use of delivered price when customary and also the basing-point system as practiced in the structural clay-tile section of the industry, whereby the price at any given market was set, not by the producer of the shipment in question but by that basing factory which had the lowest combination of base price and freight to that particular market.

Further consideration will be given in chapter III to the effects of these combinations and trade practices upon prices and the demand for the products.

SUMMARY

The brick and tile industry has many peculiar characteristics which make it a subject of considerable economic interest. The raw materials for its products are so widely distributed that plants have been established wherever communities are growing up. Since practically all plants are located at the site of raw materials, the mining of the clay is an integral part of the manufacturing process in the plants. The manufacturing of the products is carried on in plants which are comparatively small whether measured in terms of number of employees, amount of investment, or quantity of products. While the size of the plants has been increasing and the number of plants has been decreasing during the past 50 years, there is no significant trend toward modern large-scale production except in the immediate vicinity of large centers of population, notably New York and Chicago.

With the exception of drain tile, all of the products are used in the construction industries; hence the activity in the brick and tile industry is found to be closely related to construction activity; changes in demand, as well as in styles of building and materials used in construction, tend to affect vitally the employment in this industry. Drain tile, on the other hand, is largely dependent upon agricultural demand.

While the heavy weight and the low unit value of products and the wide distribution of raw materials tend to restrict the development of large drain-tile and common-brick plants, the average paving-brick, face-brick, and hollow-building-tile plants tend to be larger, indicating that they serve larger markets. The

location of these plants tends also to be concentrated in certain areas. With the exception of the Chicago market, there has been little evidence of any concentration of control in the common-brick branch of the industry. Trade associations, however, are active in all branches, with the exception of drain tile, and in the markets for paving brick and hollow building tile certain large companies seem to occupy dominant positions.

Although the mining of clay and the making of green brick and tile are highly mechanized in most plants, there still remains a large amount of handling of green and burned products which calls for unskilled labor; so that labor costs are a large part of total costs. The cost of the principal raw material is a minor item in the cost of brick and tile; the cost of fuel for burning is a major item, however, and the cost of transportation of this fuel and of the finished product bulks large in the price of the product to the consumer. These problems of supply, demand, and cost will be given greater consideration in the chapters which follow.

In chapter II use will be made of census data to give a picture of the fluctuations in employment, relating them as far as possible to corresponding fluctuations in production, while chapter III will deal with some of the economic conditions of supply and demand which brought these about. Chapter IV will be concerned with the more specific problem of the impact of technological and other factors upon the differences and fluctuations in unit labor requirements and, in turn, with the effects of these upon employment opportunities. For this purpose it will rely largely upon data obtained from the field survey of individual plants.²⁵ Chapter V will attempt to relate the effects of all these factors upon the absorption and displacement of labor in the industry.

²⁵Throughout the report, data not credited to another source are derived from the first and second surveys mentioned in the Introduction. For convenient reference these surveys are hereafter cited as the NRP-NBER field survey.

CHAPTER II

THE VOLUME OF EMPLOYMENT IN THE BRICK AND TILE INDUSTRY

MEASUREMENT OF PRODUCTION AND EMPLOYMENT

In order to relate changes in employment to changes in production, it is first necessary to cope with the problems of how to measure production on the one hand and employment on the other. The diversity of the products in the brick and tile industry made necessary the selection of some common unit of measurement: the unit selected was that of 1,000 common brick, into which the units of the other products were converted. As has been pointed out, the processes and raw materials used are essentially the same for all five products. It was therefore assumed that average relative values would roughly represent relative labor requirements for the production of the several types. Over a period of years the fluctuations in values due to fluctuations in the demand factors tend to balance. For example, face brick, which was worth on the average 1.545 of the value of common brick, was converted into common-brick equivalents by equating 1,000 face brick to 1,545 common-brick equivalents. Similarly, a ton of building tile which has an average value of 0.593 of the value of 1,000 common brick was equated to 593 common-brick equivalents. The conversion factors used for converting the quantities of each of the products, as reported by the census, into common-brick equivalents were averages of the values of each product relative to common brick over a period of years during which there seemed to be no marked trend in the relatives.¹ Where the relative value changed during the time under consideration, the period of years was broken up into two or more parts and suitable conversion factors computed for each, or in some instances a trend was assumed in the conversion factor for a period of years.² The conversion factors for 1919-35 are: Common brick, 1.000; face brick, 1.545; vitrified brick, 1.936; hollow building tile (per ton), 0.593; and drain tile (per ton), 0.687 (for earlier years see table A-12).

¹The methods used in the case study of individual plants are discussed in chapter IV and appendix B, section on "Comparability or Conversion of Field-Study Production Data Into Common-Brick Equivalents."

²For details of methods used, see appendix B, section on "Conversion of Census Production Data Into Common-Brick Equivalents."

The ratio used in this chapter to equate face brick to common brick is higher than that obtained by comparing relative labor requirements for face brick and common brick in the individual plants manufacturing both face and common brick. It is possible that the ratio 1.545 includes a scarcity factor not attributable to labor time, as, for example, the quality of clays used or the use of more skilled labor; nevertheless, a comparison of census data on employment in plants whose major product is face brick with that in plants whose major product is common brick for the years 1925, 1927, and 1929 indicates that the average labor requirements for 1,000 face brick relative to 1,000 common brick is considerably greater than indicated by the ratios obtained from individual plants in the NRP-NBER field survey. This is probably due to the fact that in general plants whose major product is face brick use more care in production in order to produce a better quality, while the face brick produced in common-brick plants requires only the additional handling necessary to sort out the better-burned bricks or to sort for color. The error introduced in using these conversion factors based on value would be an overestimation of production in the years since 1909, an error which might amount to as much as 5 percent in 1925. Despite the possible error, it was considered worth while to estimate production by means of these conversion ratios in order to have a production series to compare with the employment series from 1849 to date and to have some measure of the change in productivity over a longer period of time than would otherwise be possible.

Employment is usually measured by the number of persons employed on a certain date, during a given week or month, or by the average number for a given year. The Bureau of the Census asks for the number on the pay roll for the week which includes the 15th day of the month or some other normal week. The average of these monthly figures is given as the average number employed during the year. Each person is counted as one even though he may have worked only a few hours in one day of the pay-roll period. This method tends to overstate the employment for the selected pay-roll period and for the year. It is at best a crude measure, therefore, of the number of man-years of labor. Each year is composed of 12 months, but the average number of working hours in the months may vary from region to region or from year to year. While this measure usually reflects changes in the number of men working in the industry, care must be exercised in concluding

that increases or decreases in the reported average number of wage earners correspond to actual changes in the number of wage earners employed.

Man-hours furnish a better measure of the quantity of labor used than the average number of men employed. In order to estimate the number of man-hours of labor in the plants, census data on prevailing hours of labor per week were corrected to make allowance for the difference between prevailing and actual hours worked. The correction used was a reduction of 11 percent in prevailing hours.³ Allowing 6 days, or 1 week, for holidays, the corrected number of hours worked per week was multiplied by 51 to yield average hours worked per wage earner per year. This figure, multiplied by the average number of employees, gave an estimate of the total number of man-hours in the plants for the census years for which data on prevailing hours were available. For other years, average prevailing hours of work were obtained by interpolation.⁴

TRENDS

Table 4 and figure 1 make possible a comparison of the changes in employment and production. Production increased at the almost uniform rate of 40 to 50 percent per decade up to 1909, with the exception of the decades of the eighties and nineties. From 1879 to 1889 production more than doubled, while from 1889 to 1899 there was a small increase; hence the average of the two decades more than kept up the normal rate of increase. Employment, as measured by the average number of wage earners, increased at the average rate of 53 percent per decade up to 1889, slowing down to an average of 8 percent per decade from 1889 to 1909. The year 1909 marked a change in the behavior in both series. If cyclical influences are ignored, production may be said to have reached a sort of plateau, while employment began a declining trend. From 1909 to 1929 there was an average decrease of 21 percent per decade or 2.3 percent per annum in the average number of wage earners. A comparison of the relative trends of

³Based on computations made of the ratio of average hours actually worked in a pay period to average full-time hours, using data found in the following sources: Allan H. Willett, *Industrial Survey in Selected Industries in the United States, 1919* (prelim. rep.; U. S. Dept. Labor, Bur. Labor Statistics, Bull. No. 265, May 1920); William F. Kirk, *Productivity Costs in Common-Brick Industry* (U. S. Dept. Labor, Bur. Labor Statistics, Bull. No. 356, Oct. 1924).

⁴For details of methods used, see appendix B, section on "Estimated Employment and Man-hours in Brick and Tile Manufacturing."

production and employment reveals an increasing spread between the movements of the two during the period beginning with the decade 1869-79. This reflects the tendency toward a displacement of labor, which was counteracted by increasing production up to 1909. After this there was no important counteracting factor. Declining demand for brick and tile and improved technology combined during this later period to reduce the demand for labor.

The man-hours trend is similar to that of employment, except that a decline in the length of the normal working week caused the relative movement of man-hours and production to diverge at a somewhat faster rate than employment and production. In other words, the shortening of the working week retarded to some extent the displacement of labor measured in man-years.

**Table 4.- PRODUCTION, EMPLOYMENT, AND MAN-HOURS
IN BRICK AND TILE PLANTS, 1849-1935**

(Index numbers, 1914=100)

| Year | Production ^a | | Average number of wage earners ^b | | Total number of man-hours ^b | |
|------|-------------------------------------|-------|---|-------|--|-------|
| | Common-brick equivalents (millions) | Index | Number | Index | Thousands | Index |
| 1849 | 1,419 | 11 | 11,949 | 19 | n. a. | - |
| 1859 | 2,032 | 16 | 14,426 | 23 | n. a. | - |
| 1869 | 3,012 | 23 | 30,347 | 48 | 82,463 | 51 |
| 1879 | 4,505 | 34 | 40,592 | 64 | 110,304 | 68 |
| 1889 | 10,009 | 76 | 65,020 | 103 | 173,193 | 107 |
| 1899 | 10,603 | 81 | 65,822 | 104 | 173,836 | 107 |
| 1904 | 12,948 | 99 | 70,246 | 111 | 184,536 | 114 |
| 1909 | 15,738 | 120 | 76,298 | 121 | 199,214 | 123 |
| 1914 | 13,098 | 100 | 63,189 | 100 | 162,080 | 100 |
| 1919 | 9,155 | 70 | 46,549 | 74 | 115,162 | 71 |
| 1921 | 8,752 | 67 | 41,361 | 65 | 100,838 | 62 |
| 1923 | 14,275 | 109 | 58,981 | 93 | 142,911 | 88 |
| 1925 | 15,388 | 117 | 58,050 | 92 | 138,275 | 85 |
| 1927 | 14,708 | 112 | 54,721 | 87 | 128,375 | 79 |
| 1929 | 12,581 | 96 | 47,771 | 76 | 110,351 | 68 |
| 1931 | 5,429 | 41 | 25,934 | 41 | n. a. | - |
| 1933 | 2,035 | 16 | 11,165 | 18 | 18,791 | 12 |
| 1935 | 3,426 | 26 | 17,466 | 28 | 33,133 | 20 |

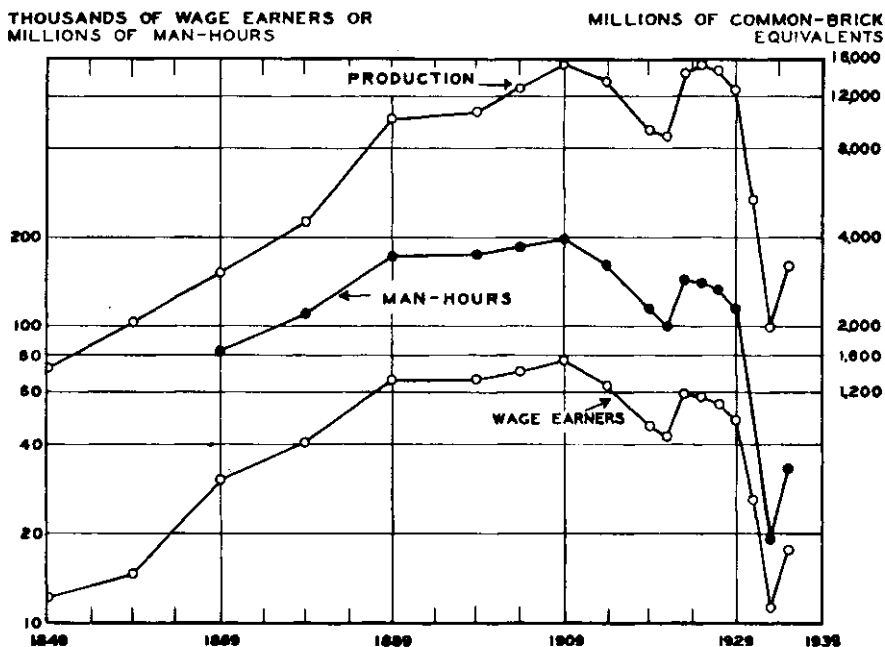
^aFor methods used in converting census units to common-brick equivalents, see appendix B, section on "Conversion of Census Production Data Into Common-Brick Equivalents."

^bBased on *Census of Manufactures* data. For methods of making estimates, see appendix B, section on "Estimated Employment and Man-hours in Brick and Tile Manufacturing."

n. a. Data not available.

Figure 1.- PRODUCTION, EMPLOYMENT, AND MAN-HOURS IN BRICK AND TILE PLANTS, 1849-1935

(Ratio scale)



Based on table 4

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CYCLICAL FLUCTUATIONS

Figure 1 gives some indication of the major cyclical fluctuations in the industry. Before 1899 these are obscured by the fact that data are available only at 10-year intervals. It is well known, however, that 1889 is approximately the peak of a major cycle. It is followed by a falling off in employment during the nineties and a rise to a new peak in 1909. From 1909 to 1935 the cyclical fluctuations are evident, with a low period from 1914 to 1921 from which employment rises to a peak during the years 1923-25. It then falls off to a low point in 1933 at which time it is the lowest on record during the 86 years under survey.

The period 1879-89 was one of great industrial growth and expansion with its attendant increase in city population and building activity. Production of brick and tile increased 5.5 billion common-brick equivalents or 122 percent, while employment increased 24,400 or 60 percent. This period was followed by a depressed condition during the nineties from which the industry

did not recover until the turn of the century. Comparing 1899 with 1889, there is little change in either production or employment.

The period of industrial mergers, with the growth of corporations after 1900, was accompanied by a new period of building activity, during which the hand methods in the brick and tile plants were rapidly replaced by mechanical methods. Production increased 5.1 billion common-brick equivalents in this decade, or 48 percent, to its all-time high in 1909, while employment increased 10,500, or only 16 percent. This was followed by a depressed condition in the industry, accentuated during war times by restriction on building, in which production and employment fell off at much the same rate.

During the boom in building which followed the World War and the depression of 1921, production again increased much faster than employment. It had increased 6.6 billion, or 75 percent, by 1925, while employment had increased 16,700, or 40 percent. After 1925 production and employment fell off, the latter reaching an all-time low in 1933, with production and man-hours falling at about the same rate but with average employment holding up somewhat more than man-hours because of the decreased length of the working week.

It is evident from figure 1 that the great advances in production over employment, which were noticed in the comparison of the relative trend movements of these curves during the period 1869-1935, took place in waves and that these coincided with the cyclical upswings of production which occurred between 1879 and 1889, 1899 and 1909, and 1921 and 1925. During the downswings, little relative change took place between the curves of production and employment, but employment tended to fall off less than production. In other words, technological changes which tend to displace labor seem to have had their pronounced effects during periods of cyclical expansion so that the net effects have been a relative slowing up in the absorption of labor into the industry. During periods of depression in the industry, the displacement of labor has been somewhat less than the decline in production. We can therefore see that because of major cycles in the industry, which have been increasing in amplitude since 1889, employment has been characterized by years of marked absorption of labor into the brick and tile plants, followed by years of displacement. From 1849 to 1889 it is probable that these cycles were marked only by a slowing up in the increase in production and employment.

During the nineties the depression in the industry was doubtless marked by a falling off in employment, as remarked upon by contemporary writers, but by 1899 the industry had recovered sufficiently so that the only evidence the chart gives of this is the absence of any marked change over 1889. After 1909 when the downward trend of employment accentuated the decline due to cyclical fluctuations, the falling off in employment is marked. In 1897, at the low point in production, employment was probably less than 20 percent below that of 1889; in 1918, perhaps 50 percent below the peak of 1909; and in 1933, 81 percent below the 1925 peak.⁶

The industry has gone through three stages of development since 1849. The first, 1849-1909, was one of rapid growth. This was followed during the next 20 years by a period of relative stability with respect to trend, after which there was a period of declining production. In the first period the growth factor overshadows all tendencies toward declining employment; in the second, labor is displaced whenever general conditions of demand react upon the demand for brick and tile, but reemployment returns with a favorable change in the demand situation; in the third period displacement of labor takes place with the falling off in demand, and reemployment tends always to be at a lower level with the return of favorable conditions of demand. In a later chapter there will be a discussion of the relation between increasing productivity and this failure of returning demand to reabsorb the workers into the plants.

SEASONAL FLUCTUATIONS

The seasonal fluctuations in the production of brick and tile are doubtless due to two causes: seasonality in the demand for the products and weather conditions which make production difficult during certain months of the year.

The determination of a typical seasonal index for brick offers many difficulties, among which is the measurement of production. Probably the most common point in the production process for measuring production is where the green bricks leave the machine. This measure of production is commonly known as machine production or green-brick production, and the production of burned brick is

⁶The estimates for employment in 1897 and 1918 are based on census data on production and estimated man-hours required to produce 1,000 common brick in these years, which were interpolated between estimates for man-hours per thousand common brick made for census years. See table 27 for the man-hour ratios for census years.

often estimated from this by subtracting a constant percentage for loss in handling, drying, and burning. The time elapsing between the output of green brick and the drawing of burned brick may be anywhere from 10 days to a month or more. It may, in fact, be several months if the bricks are stored in the kiln at the end of the operating year. In some plants in the Chicago area the bricks are not burned until orders are received, and in most plants they are only drawn when needed for shipment, except when stocks are being built up.

The process of brick production is not a continuous one in the sense that brick flows in a stream from clay mining to storage or market. Plants tend to have much greater machine capacity than drier and kiln capacity. Both driers and kilns, as well as storage sheds, can act as storage facilities for brick. The flow from the machine may be speeded up during certain weeks or months and then shut down while the brick flows at a slower rate through the rest of the plant. Admitting these limitations of the data on machine production as a measure of the final output, it is nevertheless possible to use these data, combined with those of shipments and stocks, to give a picture of the seasonality of the flow of products through the plants to the market.

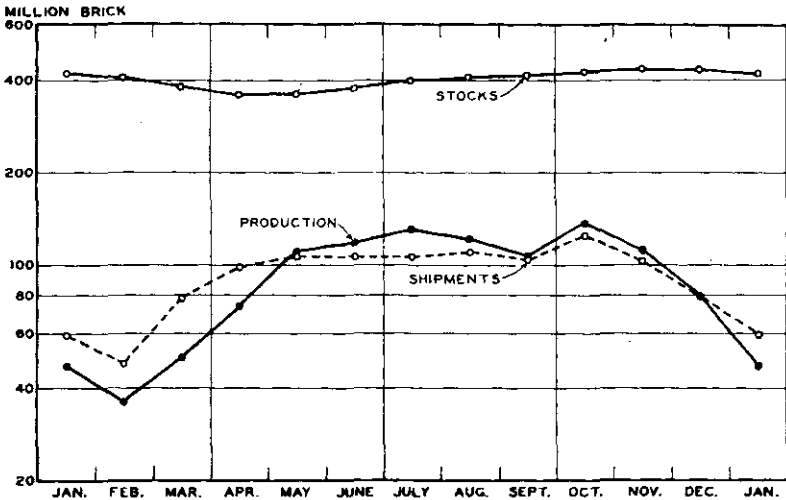
December, January, and February tend to be extremely low months in machine production, many plants shutting down during this time. There are several reasons for this: Snow, freezing temperature, or heavy rains may make mining of the clay difficult; when drying is in the open air, plants cannot operate during winter months; shipments may be impossible because transportation is closed, as on the Hudson River or on the Great Lakes in the winter; and the demand for brick tends to fall off in winter because of a decline in building activities.

An examination of table 5 and figure 2, presenting the seasonal fluctuations in production, shipments, and stocks of common brick, shows that shipments tend to run ahead of production during the first 4 months of the year, stocks being drawn down in plants which have not started operations. By May most of the plants are in operation, and from then on through November production runs ahead of shipments. The plants which operate only during the summer or for part of the year build up stocks for the winter months.

There appear to be two peak months of machine production, one in July when plants are in full operation filling the summer

Figure 2.- SEASONAL PRODUCTION, SHIPMENTS, AND STOCKS OF COMMON BRICK, 1934-36

(Ratio scale)



Based on table 5

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Table 5.- SEASONAL PRODUCTION, SHIPMENTS, AND STOCKS OF COMMON BRICK, 1934-36

(Thousands)

| Month | Production ^a | Shipments ^b | Stocks ^b |
|-----------|-------------------------|------------------------|---------------------|
| | (1) | (2) | (3) |
| January | 46,917 | 58,923 | 420,215 |
| February | 35,893 | 47,699 | 408,209 |
| March | 49,614 | 77,626 | 380,195 |
| April | 74,191 | 98,204 | 356,182 |
| May | 110,625 | 106,622 | 360,185 |
| June | 117,893 | 105,687 | 372,191 |
| July | 129,699 | 105,687 | 396,203 |
| August | 122,369 | 110,363 | 408,209 |
| September | 107,818 | 103,816 | 412,211 |
| October | 137,334 | 125,328 | 424,217 |
| November | 110,685 | 102,861 | 432,221 |
| December | 79,499 | 79,499 | 432,221 |

^aShipments adjusted for changes in stocks since preceding month. Figures represent machine production.

^bBased on data compiled by the U. S. Department of Commerce, Bureau of the Census, from reports received from 437 plants which produced 54 percent of all common brick in 1933. Data are published in *Survey of Current Business* (U. S. Dept. Com., Bur. For. and Dom. Com.), "1936 Supplement," p. 137; 16, No. 12 (Dec. 1936), p. 56; and 17, No. 4 (Apr. 1937), p. 53. The seasonals were computed by multiplying the 1934-36 monthly averages by the respective seasonal indexes (table 6).

demand for brick and the other in October when shipments have a peak due to the fall seasonal in city building and the necessity for an adequate supply of bricks for the winter months. For many plants October machine production must be large enough to build up any deficit in stocks which may be necessary to fill orders coming in during the winter months. It will be seen that the stocks on hand at the end of December are large enough on the average to cover the next half-year's shipments.

The seasonal in machine production gives too discontinuous a picture of the actual plant operation either to represent the production of burned brick or to give a picture of the demand for labor. In table 6 a 2-month moving average centered on the middle of the second month has been applied to the seasonal indexes of production in order to distribute the production more uniformly and to center it nearer to the point of final production, that of drawing the brick. It will be noticed that in the picture now presented in figure 3 production gradually works up to a peak in August, a month later than in the previous series; then there is a slackening in production, followed by a high point

Table 6.- SEASONAL INDEXES OF PRODUCTION, SHIPMENTS, AND STOCKS OF COMMON BRICK, 1934-36^a

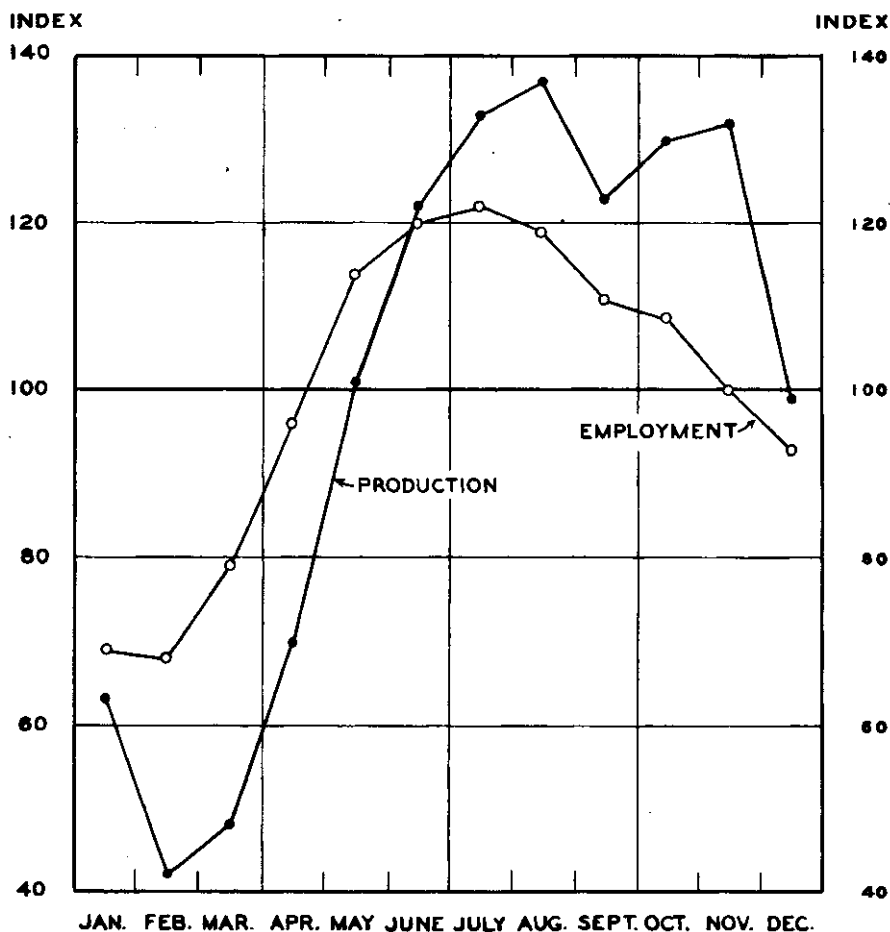
(Average=100)

| Month | Production | Shipments | Stocks |
|-----------|------------|-----------|--------|
| January | 63 | 63 | 105 |
| February | 42 | 51 | 102 |
| March | 48 | 83 | 95 |
| April | 70 | 105 | 89 |
| May | 101 | 114 | 90 |
| June | 122 | 113 | 93 |
| July | 133 | 113 | 99 |
| August | 137 | 118 | 102 |
| September | 123 | 111 | 103 |
| October | 130 | 134 | 106 |
| November | 132 | 110 | 108 |
| December | 99 | 85 | 108 |

^aComputed from data in *Survey of Current Business* (U. S. Dept. Com., Bur. For. and Dom. Com.), "1936 Supplement," p. 137; 16, No. 12 (Dec. 1936), p. 56; 17, No. 4 (Apr. 1937), p. 53. Monthly production figures were obtained by adjusting shipments for changes in stocks since preceding month. Seasonal relatives were computed separately for each year and adjusted for trend indicated by the figures for January of the given and succeeding years. The indexes for shipments and stocks were computed from the averages, for each month, of the adjusted seasonal relatives for the three years. The index for production was obtained similarly, but is shown as a 2-month moving average centered in the second month.

Figure 3.- SEASONAL INDEXES OF PRODUCTION AND EMPLOYMENT
IN BRICK AND TILE PLANTS, 1935

(Average=100)



Based on tables 6, 7

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in November which is somewhat lower than that in August.⁶ This peak and the subsequent decline may be exaggerated, as the burning and drawing of the October machine production may be distributed over several months.

In figure 3 the seasonal index of production of common brick is compared with that of employment in brick and tile plants for the year 1935. The employment index runs a smoother course because much handling of the brick may take place at periods

⁶Cf. Simon Kuznets, *Seasonal Variations in Industry and Trade* (New York: National Bureau of Economic Research, 1933), pp. 22, 403, for seasonal indexes of shipments, production, stocks, and new orders for 1921-31.

when there is no machine production, e. g., when the kilns are being set after drying has taken place and again when bricks are being put in storage after they have been drawn. In fact, when bricks are loaded directly from the kiln to trucks for shipment, less labor is required than when they must be loaded onto wheelbarrows or hand trucks to be taken to storage sheds and there unloaded and stacked. The effect of this is to keep up the employment for labor during the slack time in late summer when there is a slowing up in shipments. It will be noticed also that the rise in employment tends to precede production by about a month and to fall off before production falls off, which is what would be expected when the length of the brickmaking operation is taken into account.

Figure 4 and table 7 give a picture of the declining amplitude of the employment seasonal from 1899 to 1935. In 1935 the amplitude is represented by a peak employment in July (22 percent above the average) and a low point in February (32 percent below the average). It is reasonable to believe that the seasonal is not so marked during years of more normal production, but there are no monthly data for employment for the years between 1909 and 1935. The declining amplitude is doubtless due to the lengthening of

**Table 7.- SEASONAL INDEXES OF EMPLOYMENT IN
BRICK AND TILE PLANTS, 1899-1935^a**

(Average=100)

| Month | 1899 | 1904 | 1909 | 1935 ^b |
|-----------|------|------|------|-------------------|
| January | 33 | 39 | 50 | 69 |
| February | 34 | 40 | 51 | 68 |
| March | 51 | 57 | 67 | 79 |
| April | 105 | 95 | 102 | 96 |
| May | 149 | 136 | 127 | 114 |
| June | 157 | 147 | 135 | 120 |
| July | 156 | 150 | 137 | 122 |
| August | 152 | 147 | 133 | 119 |
| September | 140 | 138 | 129 | 111 |
| October | 108 | 116 | 110 | 109 |
| November | 69 | 79 | 87 | 100 |
| December | 47 | 57 | 72 | 93 |

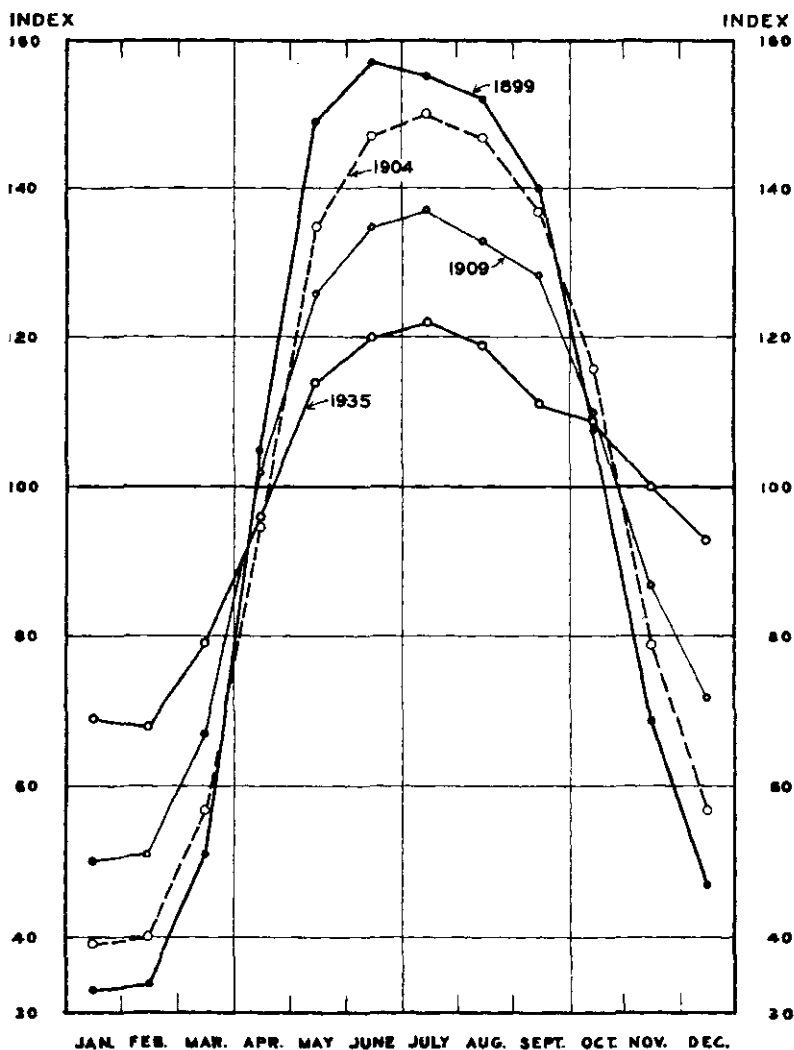
^aBased on *Census of Manufactures* data, which refer to the census classification of "Brick and tile" except for 1935 when they refer to the classification "Clay products (other than pottery) and nonclay refractories."

^bUnlike preceding years, figures for 1935 showed a noticeable trend. A rough adjustment was made to remove this trend.

the period of operation during the year. A modern plant can operate 12 months in the year at capacity production if the demand keeps up. Weather conditions no longer prevent winter building to the extent that they formerly did. Thus the handicap of weather conditions has been overcome to some extent both from the demand and supply sides.

Figure 4.- SEASONAL INDEXES OF EMPLOYMENT IN BRICK AND TILE PLANTS, 1899-1935

(Average=100)



Based on table 7

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**EMPLOYMENT AS AFFECTED BY FLUCTUATIONS IN MAN-HOURS
PER WAGE EARNER PER YEAR**

During the interval from 1869 to the present time there were several factors which brought about fundamental changes in the number of hours worked per wage earner per year. For a long time the making of brick and tile was considered a summer industry. Illustrative of this is the plant which imported French-Canadian workers from Canada to New Jersey to make brick during the summer and sent them back to Canada where they engaged in lumbering during the winter. In 1889 the average of the actual weeks worked per year per wage earner was 31.2; this probably corresponded to 35 weeks of continuous plant operation. It would be fairly typical of the industry during the period when buildings and equipment were primitive, when much of the production was by a crude hand-molding process, and drying was in the open air. From 1879 to 1909 there was a great increase of machinery and equipment in the plants and an increase in the buildings, which accompanied substitution of artificial drying for outdoor drying and of artificial tempering of the clay for natural tempering. This change made possible continuous operation for a longer part of the year. Today, while many of the plants can operate during 12 months of the year, other plants are closed down 6 to 8 weeks or longer.

While the above factor has tended to increase the number of man-hours worked per wage earner per year, this tendency has been offset to some extent by a decrease in the number of hours worked per week. Before 1890 the normal length of the working week was 60 hours or more, but from that time it gradually decreased until in 1919 it was 54 hours. The hours continued to be high up to the period of the NRA, when they were reduced to around 40 per week.

The changes in average hours worked per wage earner due to the lengthening of the year of plant operation are obscured in table 8 by the use of the yearly average of the monthly figures for the number of wage earners. The table reflects only changes in the length of the working week, while the lengthening of the operating year would be reflected in a larger average number of wage earners relative to the number of persons employed during peak operation or relative to the number of jobs offered in the plants.

According to the table, each census year since 1879 reveals a shortening of the average number of hours worked per year with

**Table 8.- AVERAGE MAN-HOURS PER WAGE EARNER PER YEAR
IN BRICK AND TILE PLANTS, 1869-1935^a**

| Year | Man-hours | Year | Man-hours | Year | Man-hours |
|------|-----------|------|-----------|------|-----------|
| 1869 | 2,705 | 1909 | 2,611 | 1925 | 2,382 |
| 1879 | 2,705 | 1914 | 2,565 | 1927 | 2,346 |
| 1889 | 2,652 | 1919 | 2,474 | 1929 | 2,310 |
| 1899 | 2,641 | 1921 | 2,438 | 1933 | 1,683 |
| 1904 | 2,627 | 1923 | 2,423 | 1935 | 1,897 |

^aBased on *Census of Manufactures* data. For methods used see appendix B, section on "Estimated Employment and Man-hours in Brick and Tile Manufacturing." Figures are equivalent to the total number of man-hours divided by the average number of wage earners.

the exception of 1935, when the weekly hours of work actually increased. If more data were available on hours actually worked, fluctuations in this seemingly regular rate of decrease might be observable. It is probable that the ratio between prevailing hours and actual hours worked would show fluctuations due to cyclical changes in production.

Averages of monthly figures, used for all yearly data, fail to give an idea of the number of persons actually involved in the employment in the plants and industries covered. For example, 100 people might be employed in a plant for 6 months of the year and be idle for 6 months because of the shutting down of the plant, or 50 people might be employed for 12 months of the year. In either case the average number employed for the 12 months would be 50 people. In the first case a labor supply of 100 would be necessary and in the second case only 50. While in the first case the labor income derived from the plant would be divided among 100 and if no other jobs were available would constitute their annual income, in the second case a labor supply of 50 is sufficient and the labor income would be divided among the 50. This rests of course on the assumption that the daily wage is unaffected by the seasonality of the work and would not be reduced as the period of work is lengthened. In other words, the average annual income for persons employed would be twice as great as in the former case. From the point of view of the industry concerned, it may make little difference whether 100 persons are employed for 6 months or 50 persons for 12 months, provided the labor supply is there, but from the point of view of the individual labor income it is very important.

There are doubtless more wage earners attached to the industry than the figures for average number of wage earners in table 4 would indicate. The earlier censuses throw some light on this matter. From 1849 to 1889 the schedules asked for the average number of "hands employed" during the months of operation. In 1869 the number of weeks of actual work was 31.2. In table 9 a comparison is made between the average number employed and the average number employed during the months of plant operation. The latter figure is an estimate of the average number of wage earners who might consider themselves attached to brick and tile plants. Peak employment may have accounted for another 11 percent drawn from those who make up the surplus labor supply considered necessary for satisfactory operation of the manufacturing industries.

Table 9.- AVERAGE NUMBER OF WAGE EARNERS ATTACHED TO BRICK AND TILE PLANTS, 1869-1935

| Year | During year ^a | During months of operation ^a | During peak operation ^b | Temporarily attached (3)-(2) |
|------|--------------------------|---|------------------------------------|------------------------------|
| | (1) | (2) | (3) | (4) |
| 1869 | 30,347 | 44,051 | 48,897 | 4,846 |
| 1879 | 40,592 | 58,923 | 65,405 | 6,482 |
| 1889 | 65,020 | 94,383 | 104,765 | 10,382 |
| 1899 | 65,822 | 95,244 | 103,406 | 8,162 |
| 1904 | 70,246 | 96,097 | 105,369 | 9,272 |
| 1909 | 76,298 | 97,661 | 104,605 | 6,944 |
| 1935 | 17,468 | 19,702 | 21,212 | 1,510 |

^aThe yearly average reported by the census is for the average number employed during the months of plant operation for 1869-89 and for the 12 months of the year for the period 1899-1935. For the years 1869-89 the average number for the 12 months of the year as given in this table was estimated assuming the same length of year of plant operation as in 1869; for the years 1899-1935 the average number during months of operation as given in the table was estimated. See discussion in text.

^bFor 1869-89 this is estimated as 111 percent of the average number employed during months of operation. See *Fifth Census of the United States: 1870, "Wealth and Industry"* (U. S. Dept. Int., Census Office, 1872), p. 375, where it is estimated that 111 percent is the ratio between maximum and average number of persons engaged in all branches of industry taken together. For 1899-1935 it is the number employed during the month of peak employment.

After 1889 the reports of the census offer little information in regard to the average length of the operating year, but another method may be used to determine the number of persons attached to the industry. Monthly data on employment in brick and tile are available for 1899, 1904, 1909, and 1935. From an examination of the seasonals in figure 4, the average of the employment in the

two months of May and September seemed a reasonable estimate of the average during the months of plant operation. This has been inserted in column (2) of table 9 for the above years.

It will be noticed that the number of wage earners during peak operation and the average number attached to the industry during the months of operation remain fairly stable from 1889 to 1909. The average number during the months of operation appears to vary little more than 2 percent between any 2 census years and increases only 3.5 percent from 1889 to 1909, while when the average is spread over the 12 months, there appears to be an increase of 17 percent in employment during the same period. This means that the plants did not offer jobs for more persons but rather that they offered more weeks of work per wage earner attached to the plants.

To the extent that these estimates represent the true conditions in the plants, the labor force needed for normal operation was 45 percent above the average for the year in 1899 and only 13 percent above the average in 1935. For peak employment another 9 to 13 percent was taken from the surplus labor reserve during these census years. These estimates would indicate that the average number of weeks of plant operation increased from 35 in 1899 to 40 in 1909 and to 45 in 1935. This would be the average length of the working year for those normally attached to the plants. Figure 4, showing the decline in the amplitude of the seasonal, represents graphically the effect of this change in the length of the year upon the aggregate monthly employment in the industry.

Too great confidence must not be placed in the accuracy of these figures since they are only rough estimates based on inadequate data. They serve, nevertheless, to indicate approximately how large a number of wage earners is affected by changes in the demand for labor in the production of brick and tile. The results may be translated into numbers which may be said to approximate normal operation at present by an average of 50,000 wage earners per year which was the average employment for the decade 1919-29, the last decade which can be considered normal in any degree. To bring about this average for the year, there would be an average of approximately 56,500 employed during the months of operation and 4,500 more temporarily attached to the plants during the period of peak operation.

In discussing labor displacement, a distinction should be made between three rather different concepts. The annual average number of workers based on an average of monthly employment figures is a measure of the number of man-years of employment composed of 12 months each, irrespective of the number of working hours in the month. Aggregate man-hours is a measure of actual hours worked. Man-hours and average number of workers are measures of working time, the former being a more accurate measure of that factor than the latter. The number "attached" to the plants or the number employed during peak operation, however, measures the number of persons or number of jobs rather than hours, months, or years of work. Unfortunately most data on employment are quite inadequate for the purposes of the latter measure. Thus, in measuring displacement of men, it is necessary to make some estimate of the number of persons displaced, while a measure of displaced labor time requires the use of either man-hour data for an accurate measure or the average number of workers employed for a less accurate one.

From 1899 to 1909 the average number of wage earners increased 16 percent, and the number of man-hours increased 15 percent. This might lead to the conclusion that persons were being absorbed into the plants. A glance at table 9, however, reveals the fact that the number of wage earners attached to the plants remained relatively stable. The tendency toward displacement of men by improved techniques and lengthening of the year of plant operation was only just offset by the increase in production. This period in which the industry attained its growth is the only period of relative stability in employment. Since 1909 men and man-hours have been displaced because of improved techniques and falling off in production. The decrease in the average normal working week, from 57.7 hours in 1909 to 51.0 in 1929, had little counteracting effect on this tendency toward displacement. The shortening of the week was largely offset by the lengthening of the operating year. When in 1933 the normal working week was reduced to around 40 hours, the displacement of men by the lengthening of the working year was more than offset. Since the NRA period there has been some return to longer hours of work, but in 1935 the average of actual hours worked per week was only 36.5.⁷ It seems likely therefore that, should the plants operate at 70 to

⁷An estimate based on the U. S. Bureau of Labor Statistics' figures for the "Brick, tile, and terra cotta" industry. This corresponds to a normal working week of about 42 hours.

80 percent of capacity again, hours would be shorter than they were in 1929 so that at least some of the displacement of wage earners due to improvement in technique would be offset by the factor of shorter hours. Over 30 percent more wage earners per unit of production were attached to the industry in 1935 than in 1929. This was due in part to decreased efficiency as a result of operation at a small fraction of capacity, but the shortening of the working week was a more important factor.

**VOLUME OF EMPLOYMENT IN ALLIED VERTICAL SEGMENTS
OF THE INDUSTRY^a**

Salaried Employees

The production of brick and tile creates auxiliary jobs as well as jobs for workers in brick and tile plants. When the

**Table 10.- ESTIMATED EMPLOYMENT IN BRICK AND TILE PLANTS
1899-1935^a**

| Year | Total persons employed ^b | | Salaried employees | | |
|------|-------------------------------------|------------------|--------------------|------------------|-------------------------|
| | Average number | Index (1914=100) | Average number | Index (1914=100) | Percent of wage earners |
| 1899 | 75,432 | 111 | 9,610 | 193 | 14.6 |
| 1904 | 79,799 | 117 | 9,553 | 191 | 13.6 |
| 1909 | 85,530 | 125 | 9,232 | 185 | 12.1 |
| 1914 | 68,181 | 100 | 4,992 | 100 | 7.9 |
| 1919 | 51,389 | 75 | 4,840 | 97 | 10.4 |
| 1921 | 45,580 | 67 | 4,219 | 85 | 10.2 |
| 1923 | 64,289 | 94 | 5,308 | 106 | 9.0 |
| 1925 | 63,507 | 93 | 5,457 | 109 | 9.4 |
| 1927 | 59,865 | 88 | 5,144 | 103 | 9.4 |
| 1929 | 52,500 | 77 | 4,729 | 95 | 9.9 |
| 1931 | 28,605 | 42 | 2,671 | 54 | 10.3 |
| 1933 | 12,348 | 18 | 1,183 | 24 | 10.6 |
| 1935 | 19,317 | 28 | 1,851 | 37 | 10.6 |

^aBased on *Census of Manufactures* data. Methods used in estimating employment are explained in appendix B, section on "Estimated Employment and Man-hours in Brick and Tile Manufacturing."

^bWage earners and salaried employees.

^cEmployment as used in this section necessarily refers to the average number of persons employed during the year and is a rough measure of man-years rather than of persons attached to the industry. See p. 24.

question of employment is discussed, attention usually centers upon statistics in regard to the wage earners. However, within the plant there are also those classes of employees usually known as salaried workers. Since 1929 these employees numbered, on the average, 10 percent of the number of wage earners. There were 4,729 in this class in 1929 and 5,457 at the height of production in 1925 (table 10). From 1899 to 1914 there was a rapid decline in the number of salaried employees, both absolute and relative to the number of wage earners. This reflects the trend toward larger plants as well as the effects upon this class of employee of a certain number of corporate mergers which took place during this period. The ratio of this class to wage earners decreased from 15 percent in 1899 to 9 percent in 1923. During the depression it rose to 10.6 in 1933, probably because of the fact that with the decline in production it was not found either possible or desirable to lay off salaried workers in the same proportion as wage earners.

Producing Fuel

It has been pointed out that fuel for drying and burning the brick is an important item in the cost of making brick. Added to this is the fuel used for power. Coal, coke, oil, and natural gas are used for burning, with coal by far the most important. In table 11 are presented the estimates of the average number of wage earners employed in the production of coal and coke for the industry. During the period 1909-19, the production of coal

Table 11.- AVERAGE NUMBER OF WAGE EARNERS PRODUCING FUEL FOR BRICK AND TILE PLANTS, 1909-29^a

| Year | Manu- facturing brick and tile | Producing fuel for brick and tile plants | | | | | |
|------|---|--|-------|------|--|------|------|
| | | Total | Coal | Coke | Percent of number manufacturing brick and tile | | |
| | | | | | Total | Coal | Coke |
| 1909 | 76,298 | 7,967 | 7,886 | 81 | 10.4 | 10.3 | 0.1 |
| 1914 | 63,189 | 7,456 | 7,373 | 83 | 11.6 | 11.7 | .1 |
| 1919 | 48,549 | 5,344 | 5,304 | 40 | 11.5 | 11.4 | .1 |
| 1929 | 47,771 | 3,757 | 3,719 | 38 | 7.9 | 7.8 | .1 |

^aFor methods of computation and sources see appendix B, section on "Estimated Employment and Man-hours in the Vertical Structure of the Industry."

added 10 to 12 percent to the number of wage earners employed in the plants. By 1929 this percentage was reduced to 7.8 percent because of a more efficient use of coal in the industry and because of a decrease in the number of man-hours required to produce a ton of coal. The percentage for other fuels was probably never more than 0.5 percent. It is estimated that it took 4,429 employees to transport this fuel to the brick and tile plants.⁹ It would therefore be safe to say that for every 100 men working in the plants 8 men are employed in the production of the fuel and 8 men in the transportation of it.

Producing Machinery

The production of machinery used exclusively for working the clay and making the brick employs another 250 to 500 men in years of normal operation (table 12). Except for the abnormally low depression years, there are 5 to 8 wage earners employed in the manufacture of clay-working machinery for every 1,000 employed in the brick- and tile-manufacturing plants. But this takes no account of the employment in the manufacture of such equipment as trucks of all sorts, locomotives, power shovels, and types of

Table 12.- AVERAGE NUMBER OF WAGE EARNERS MANUFACTURING CLAY-WORKING MACHINERY, 1914-35^a

| Year | Manufacturing brick and tile | Manufacturing clay-working machinery | |
|------|------------------------------|--------------------------------------|--|
| | | Number | Percent of number manufacturing brick and tile |
| 1914 | 63,189 | 504 | 0.8 |
| 1919 | 46,549 | 313 | .7 |
| 1921 | 41,361 | 342 | .8 |
| 1923 | 58,981 | 477 | .8 |
| 1925 | 58,050 | 406 | .7 |
| 1927 | 54,721 | 298 | .5 |
| 1929 | 47,771 | 259 | .5 |
| 1933 | 11,165 | 32 | .3 |
| 1935 | 17,466 | 52 | .3 |

^aFor methods of computation and sources see appendix B, section on "Estimated Employment and Man-hours in the Vertical Structure of the Industry."

⁹See appendix B, section on "Estimated Employment and Man-hours in the Vertical Structure of the Industry", for an explanation of the methods used in making this estimate. This includes both salaried employees and wage earners.

machinery not designed exclusively for the working of clay. The actual number employed in manufacturing machinery and equipment for the industry is probably several times the estimate given.

Transporting and Distributing Brick and Tile

After the brick and tile have been produced, there remains the problem of transporting them to market. Approximately 70 percent of the brick and tile was carried by Class I railroads in 1929. Of the employees engaged on these railroads, including both wage earners and salaried employees, the time of 6,630 could be properly allocated to the transportation of the products of this industry. This is equal to 13 for every 100 employees (wage earners and salaried employees) in the plants.¹⁰ From 1929 to 1935 a decrease in employment per ton-mile of freight moved on railroads reduced the number to approximately 7 for every 100 employees in the plants (table 13).

For water and truck transportation there are no satisfactory figures upon which to base an estimate. That the number is considerable for trucking is beyond question. In most cases of shipment by rail there is drayage in addition to railroad transportation, sometimes at both ends. Moreover, somewhat less than

Table 13.- AVERAGE NUMBER OF EMPLOYEES ENGAGED IN TRANSPORTING BRICK AND TILE PRODUCTS ON CLASS I RAILROADS, 1929-35^a

| Year | Manufacturing brick and tile | Transporting brick and tile on Class I railroads | |
|------|------------------------------|--|--|
| | | Number | Percent of number manufacturing brick and tile |
| 1929 | 52,500 | 6,630 | 12.6 |
| 1931 | 28,805 | 3,065 | 10.7 |
| 1933 | 12,348 | 1,026 | 8.3 |
| 1935 | 19,317 | 1,376 | 7.1 |

^a Figures are for average number of wage earners and salaried employees. For methods of computation and sources see appendix B, section on "Estimated Employment and Man-hours in the Vertical Structure of the Industry."

¹⁰ In the two previous sections data were not available for salaried employees; hence a comparison with plant employment was made on the basis of wage earners rather than of the total number of employees.

30 percent of the brick and tile is transported by truck to the local markets. A conservative estimate would be at least another 20 men per 100 employees in the plant for trucking, drayage, and handling of the brick on the way to the markets.

The *Census of Distribution* for 1929 gives 3,484 persons engaged in concerns whose major business was the distribution of brick and tile.¹¹ These establishments doubtless distribute all types of brick and tile as well as other building materials. Hence it seemed reasonable to reduce the number given in the census by the proportion that the value of the five products covered in this study was of the total value of clay products (other than pottery) listed in the census for 1929. Since this was 46.7, the number of persons allocated to this industry was 1,627, or 3.1 percent of the employees in the plants.

Employment in the Vertical Structure of the Industry¹²

Table 14 and figure 5 present data on the average number of persons employed in the vertical structure of the industry in 1929. In this vertical structure there are 69,245 employees (including all those for whom there are any data) as against 52,500 in the plants, that is, 32 employees outside for every 100 inside. That this does not include all of the employment in the industry is evident from the following gaps in the data: Only 70 percent of the transportation is covered; only a part of those engaged in distribution are accounted for; only those engaged in the manufacture of specialized machinery, and not those engaged in making tractors, shovels, and other implements, are included. No data are available on the labor employed in purchased power. Moreover, salaried workers are included only in the brick and tile plants, in railroad transportation, and in distribution. The total would come closer to 80,000 than 69,000 and closer to 50 persons outside of the plants for every 100 within the plants.

The trend of employment relative to the number of employees in the plants is downward both in fuel and railroad transportation. Employment in the plants decreased 63 percent from 1929 to 1935, while employment on Class I railroads allocated to the transportation of these products decreased 80 percent. In the fuel

¹¹*Fifteenth Census of the United States: 1930, "Distribution"* (U. S. Dept. Com., Bur. Census, 1933), II, "Wholesale Distribution," 78.

¹²See fn. 8, p. 41.

Table 14.- ESTIMATED AVERAGE NUMBER OF PERSONS EMPLOYED
IN SPECIFIED VERTICAL SEGMENTS OF THE BRICK
AND TILE INDUSTRY, 1929^a

| Segment | Average number of persons | | Percent of brick and tile manufacturing | |
|---|---------------------------|---------------|---|---------------|
| | Wage earners | All employees | Wage earners | All employees |
| All segments ^b | 69,245 | | 131.9 | |
| Brick and tile manufacturing | 47,771 | 52,500 | 100.0 | 100.0 |
| Transportation of brick and tile ^c | n. a. | 6,630 | - | 12.6 |
| Fuel | 3,757 | n. a. | 7.9 | - |
| Coal | 3,719 | n. a. | 7.8 | - |
| Coke | 38 | n. a. | 0.1 | - |
| Transportation of fuel ^c | n. a. | 4,429 | - | 8.4 |
| Clay-working machinery | 259 | n. a. | 0.5 | - |
| Distribution | n. a. | 1,627 | - | 3.1 |

^aFor methods of computation and sources see appendix B, section on "Estimated Employment and Man-hours in the Vertical Structure of the Industry."

^bIncludes all persons for whom estimates could be made.

^cOn Class I railroads.

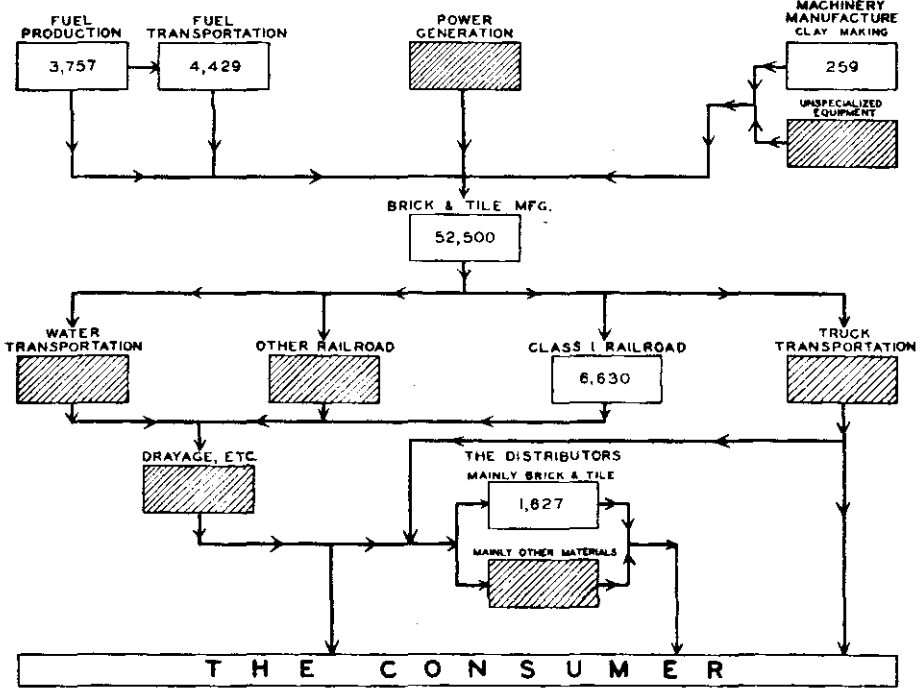
n.a. Data not available.

industries the number of wage earners producing coal and coke to be used in the brick and tile plants decreased 30 percent from 1919 to 1929, while the employment within the plants increased 3 percent. Inasmuch as the productivity in the coal industry continued to improve after this and the trend is toward greater economy in the use of coal, it is likely that this downward trend has continued.

One change affecting employment in transportation should be noted. Formerly the brick from the Hudson River Valley was shipped to New York in barges, a method which involved considerable manual handling from yards to barges, then to docks, and from docks to trucks for delivery at building operations.¹³ It

¹³"Shipping Brick in Containers is a Speedy System," *Brick and Clay Record*, 74, No. 2 (Jan. 15, 1929), 85.

Figure 5.- VERTICAL STRUCTURE OF THE BRICK AND TILE INDUSTRY
With Average Number of Persons Employed in 1929



▨ NO DATA, INSUFFICIENT DATA, OR NOT COVERED

Based on table 14

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was claimed in 1929 that a large part of this Hudson River Valley brick was shipped by railroads in container cars. Containers holding 3,000 bricks are loaded and unloaded by cranes. This must greatly reduce manual handling. It is significant because of the relative importance of the New York market for common brick and because of the importance of the Hudson River Valley plants in that market. Such changes as this, together with a trend toward transportation by trucks for considerable distances, may be reducing the labor engaged in distribution of bricks by reducing the handling. Hence it seems reasonable to conclude that the employment trend in the allied vertical segments of the industry is downward, both absolute and relative to employment within the plants. A declining demand for the products, economy within the plants in the use of fuel and power, and increasing efficiency in production of fuel and machinery and in transportation - all tend to bring about a decline in employment and man-hours in the vertical structure of the industry.

CHAPTER III

CHANGING PRODUCTION AS A FACTOR AFFECTING THE VOLUME OF EMPLOYMENT

In chapter II attention has been centered upon changes in the volume of employment, and these in turn have been related to corresponding changes taking place in production. It is the purpose of this chapter to study changes in production in relation to the factors in the markets where the demand for brick and tile originates and to the factors which influence the owners of the brick and tile plants either to close their plants and thus throw people out of work or to continue the plants in full or part operation and thus maintain employment opportunities for these people.

There are several types of fluctuations which should be analyzed. In the first place, there are the secular changes in production. The effect of these on employment may be less serious than other fluctuations since change tends to take place slowly, and thus adjustments may be made in employment by taking on fewer new people than the number which withdraw from the industry.

The second type of fluctuation is commonly known as cyclical. The brick and tile industry, together with others which supply durable construction goods, is subject to both major and minor cycles. In recent years the major cycles have so dominated the picture that minor cycles may be obscured by them, and the secular trend sinks into relative insignificance. The most serious problems of unemployment are associated with these fluctuations in which expansion in the industry is followed by a long period characterized by part-time or no employment.

The factors determining seasonal fluctuations have been discussed in chapter II and will not come in for special treatment in this chapter.

Another type of change which may be of great importance in respect to displacement of labor is the shifting of areas of production. Total employment in an industry may remain relatively stable or even increase while displacement of labor may be taking place in certain localities. Such shifting results in the depressed areas which are receiving attention today and which are not recovering as industry picks up elsewhere.

The underlying causes which have brought about these various types of fluctuations in production are to be sought in the factors affecting the demand for and the supply of the products of the industry. Causes of fluctuations in demand will be sought in fluctuations in the building and construction industries; these in turn will be related to changes in population. Causes of changes in supply will be sought in various elements of costs, such as labor, transportation, and raw materials. Finally, an investigation of price change and price control reveals the interaction of the factors of supply and demand and the effect of prices upon production.

DIFFERENCES IN DEMAND FOR THE PRODUCTS

An explanation of the trend of the aggregate production of brick and tile must be sought in the demand for the five products which compose the industry. Each of these has its own individual trend (figures 6 and 7).¹ The production of common brick, always the major product of the industry, increased steadily up to its peak of 10 billion in 1906. From that time the trend has been downward, as is clearly revealed by the fact that the peak in 1925 was almost 25 percent below that of 1906.

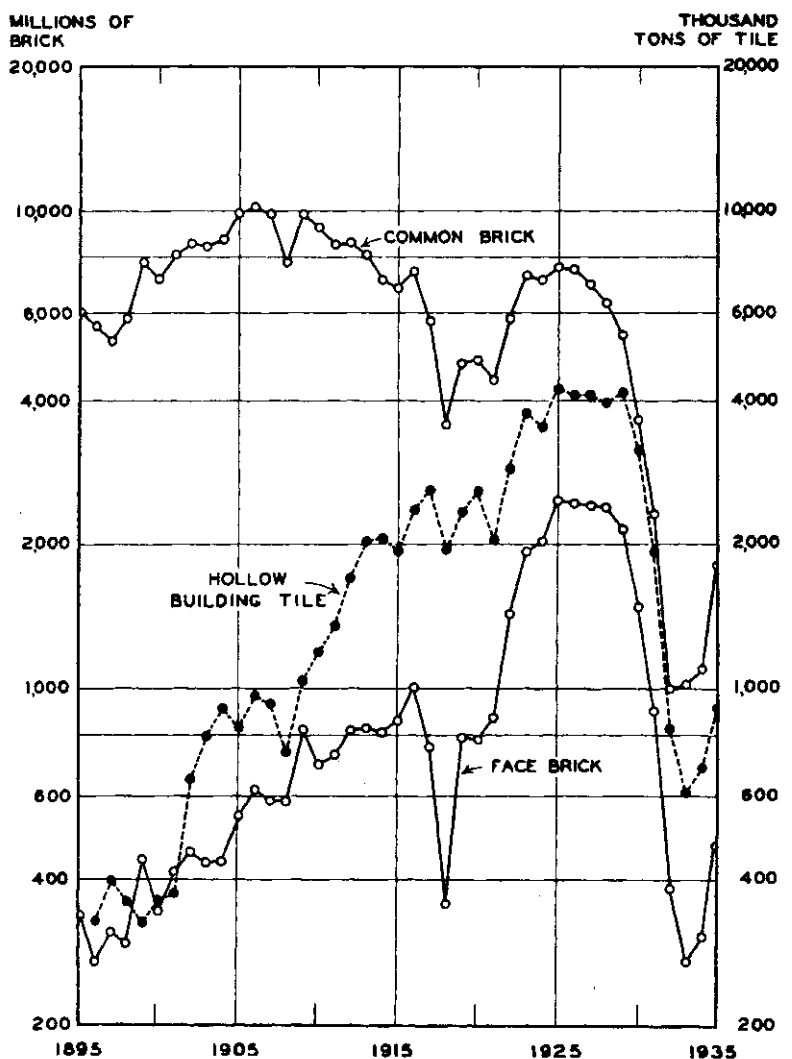
Common brick has been an important building material since early times. It was the outstanding fire-resistant material available for use in city building when industry began to develop rapidly after the Civil War and city population was increasing faster than rural population. Brick walls not only carried their own weight but furnished the load-bearing element in the structure, bearing the weight of the floors and roof. If the building had many stories, massive walls were necessary to support the weight of the upper stories. While pressed brick and fancy or colored brick might be used for the fronts of imposing structures, the better-burned common brick was used for most walls which were exposed to the elements.

During the eighties the first experiments were tried in the erection of buildings in which the weight-bearing element was the steel frame. This made possible the erection of taller buildings. As early as 1900 a census report on the industry

¹See table A-13 for yearly production of each of the five products, 1894-1935.

Figure 6.- PRODUCTION OF COMMON BRICK, FACE BRICK,
AND HOLLOW BUILDING TILE, 1895-1935

(Ratio scale)



Based on table A-13

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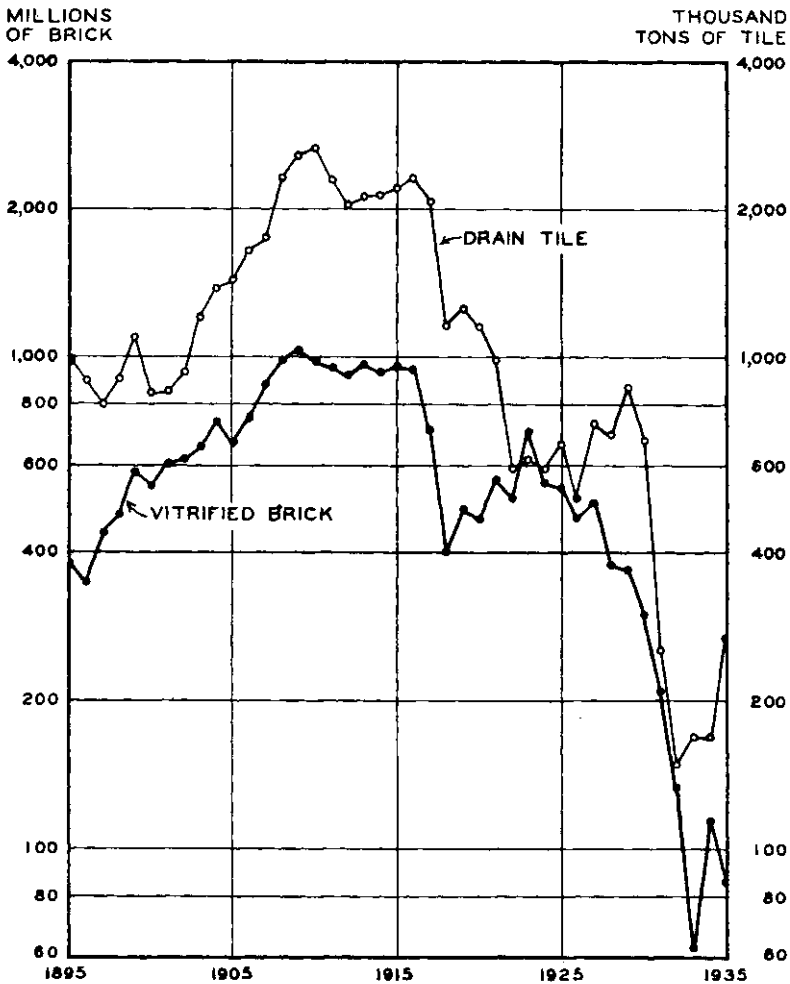
comments on the failure of the demand for brick production to pick up because of the use of iron in building construction.²

The twentieth century has seen common brick gradually replaced by other building materials, especially in tall office buildings, the larger apartment houses, and factories. Concrete is poured

²Twelfth Census of the United States: 1900, "Manufactures" (U. S. Dept. Int., Census Office, 1902), Vol. VII, Part I, p. xcvi.

Figure 7.- PRODUCTION OF VITRIFIED BRICK AND DRAIN TILE
1895-1935

(Ratio scale)



Based on table A-13

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to make the massive foundation; a steel frame supports walls, floors, and roof; the walls, whether made of brick or hollow tile, need only be thick enough to shut out the weather. Concrete floors are made for the purposes of fire protection and support of machinery and other heavy equipment; glass is used to a much larger extent than ever before as a structural material and in the greater space devoted to windows. Changes in architectural style and in the mechanics of construction, as well as the development of substitute materials, have all

contributed to minimizing the use of common brick. Traditions are still strongly in favor of brick, but the trends in modern architecture are toward the use of newer materials such as concrete, stucco, glass, and other materials better adapted to modern forms.

Fires and earthquakes and the evolutions and changes in building codes also have had an important influence on the demand for brick. All great fires, such as the Chicago fire in 1871 and the great fires in Baltimore, Rochester, and San Francisco in the first years of the present century, have been followed by an increased demand for brick and other clay products, not only for purposes of rebuilding but also for the purpose of more nearly fireproof construction in order to avoid similar disasters.³ On the other hand, earthquakes tend to discourage the use of brick as being less able than some other materials to withstand the earth's tremors.⁴

Face brick and hollow building tile, which have been displacing common brick as structural materials, exhibit marked increasing trends during all of this period until their peaks in 1925.⁵ As was pointed out, face brick first came into prominence during the first decade of the twentieth century when the demand for pretentious office buildings and apartments gave rise to the use of fancy brick in order to present a suitable facade. A much greater demand arose, however, when tall buildings presented all sides to view, and face brick was developed to fit in with the architectural demands of modern skyscrapers. Figure 6 shows the steep rate of increase in the use of face brick since 1909, as it rose from 816 million to 2,475 million brick in 1925.

Hollow building tile was first developed as fireproofing material and for various uses which required special shapes. It was not until it began to be used in walls and partitions in place of common brick that rapid growth in demand began. It has several advantages over brick in wall construction. Since it is lighter, it can be used where brick would be too heavy in the high steel-framed buildings; it can be built in faster than brick, and therefore the cost of construction is less; and because of its lighter weight, the cost of transportation is reduced.⁶ Like

³ *Manufactures: 1905* (U. S. Dept. Com. and Labor, Bur. Census, 1908), Part III, "Special Reports on Selected Industries," p. 895.

⁴ The Brick Manufacturers Association of America has developed reinforced brick masonry which is now acceptable under the California building code as earthquake-resistant material.

⁵ Cf. Arthur F. Burns, *Production Trends in the United States Since 1870* (New York: National Bureau of Economic Research, 1934), pp. 155-6.

⁶ Attention should be called to the fact that common-brick manufacturers have developed a hollow brick suitable for use in walls where lightness is essential.

face brick, hollow building tile has shown a steep upward trend since the beginning of the century, rising from 326,000 in 1899 to 4,225,000 tons in 1925.

Vitrified brick has been used largely for paving streets. Its growth, like that of the structural clay products, followed the growth of cities until 1909. Concrete and cement rapidly displaced it, so that the industry has been declining since that time.

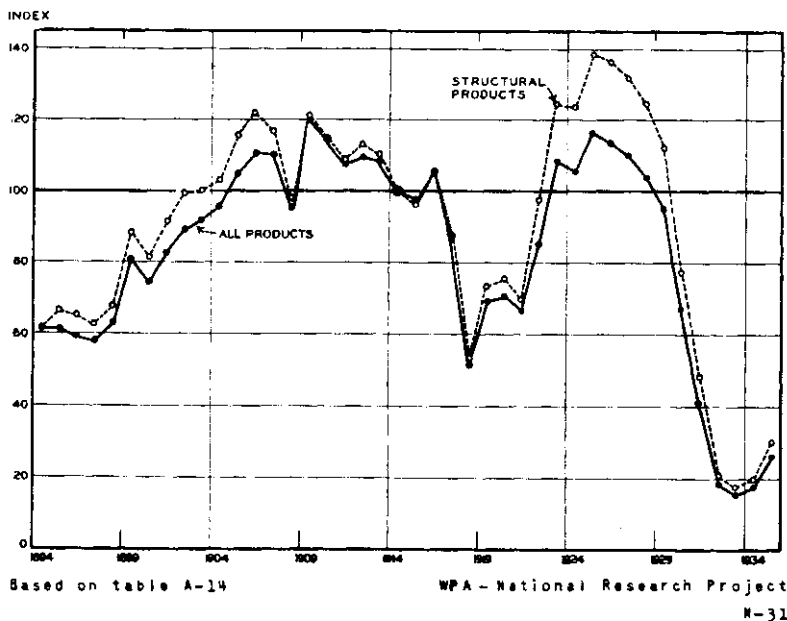
Drain tile, on the other hand, depends largely upon an agricultural demand for its use in draining fields. Its demand seems to come largely from the central agricultural region drained by the Mississippi River and its tributaries. Hence agricultural conditions and, to some extent, the amount of rain during the year determine its demand. As long as the acreage under cultivation was increasing, the demand for drain tile kept up, and year-to-year fluctuations were determined by weather conditions. Since the World War the drop in demand for drain tile reflects the decreasing demand for agricultural lands.

The trend in the industry has reflected the combination of these five trends. Common brick has been the major product of the five, accounting for 40 to 80 percent of the value of the five products since 1890.

Common brick, face brick, and hollow building tile have been combined in one series, designated as structural clay products (table A-14 and figure 8). In contrast to the common-brick series and to the series including all five products, both of which show a declining trend after 1909, this series shows a rising trend marked by a yearly average rate of increase of 0.8 percent between the terminal years 1909 and 1925. Some of the labor displaced by the falling off in the demand for common brick, paving brick, and drain tile has been reabsorbed in the increasing production of face brick and hollow building tile. In figure 8 are compared the fluctuations in production in the industry as a whole with the fluctuations in that part devoted to the production of structural products. The two mark out almost the same pattern, except for the difference in trend which has been pointed out previously. Structural clay products accounted for 78 percent of the production of brick and tile in 1909 and for 90 percent in 1925. This reflects the decreasing demand for drain tile and paving brick relative to the structural products.

Figure 8.- INDEXES OF BRICK AND TILE PRODUCTION, 1894-1935

(1914=100)



BUILDING CONSTRUCTION AND DEMAND FOR STRUCTURAL CLAY PRODUCTS

The outstanding feature observable in all of the series presented is the recurrence of marked cyclical swings of long duration and increasing amplitude. Yearly data permit an accurate picture of only two of these. Figures 9 and 10 compare 7-year moving averages of an index of building activity⁷ and the production of structural clay products. The marked similarity of the two curves lends support to the reasonable assumption that the major cyclical fluctuations in the output of these products are determined by the demand for building. Since the cost of brick and tile is a relatively small part of the total cost of construction, it is unlikely that it plays any important role in determining the major fluctuations in building activity.⁸ In 1929 it was 5 percent of the total cost of all classes of building and 11.5 percent of the cost of the construction materials.⁹

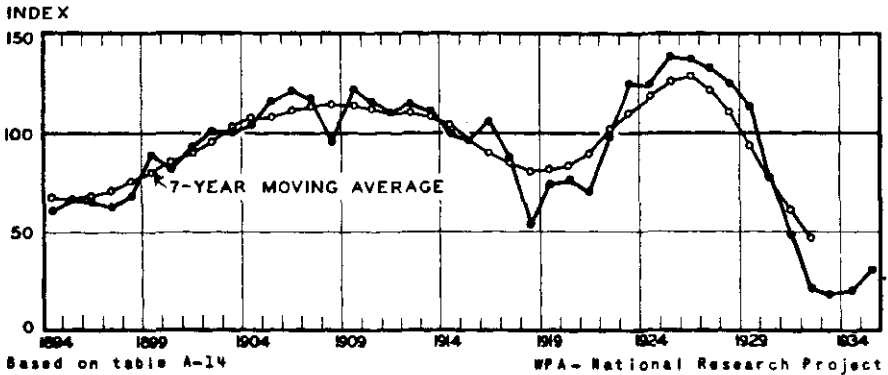
⁷ Adapted from an index constructed by William H. Newman and presented in "The Building Industry and Business Cycles," *The Journal of Business of the University of Chicago*, VIII, No. 3 (July 1935), Part 2, 63-71.

⁸ *Ibid.*, pp. 20-4.

⁹ Based on data in the *Fifteenth Census of the United States: 1930*, "Construction Industry" (U. S. Dept. Com., Bur. Census, 1933), p. 29. Brick and tile include "brick (face, common, fire, paving, etc.)" and "tile (fireproofing)."

Figure 9.- INDEX OF PRODUCTION OF STRUCTURAL CLAY PRODUCTS
1894-1935

(1914=100)



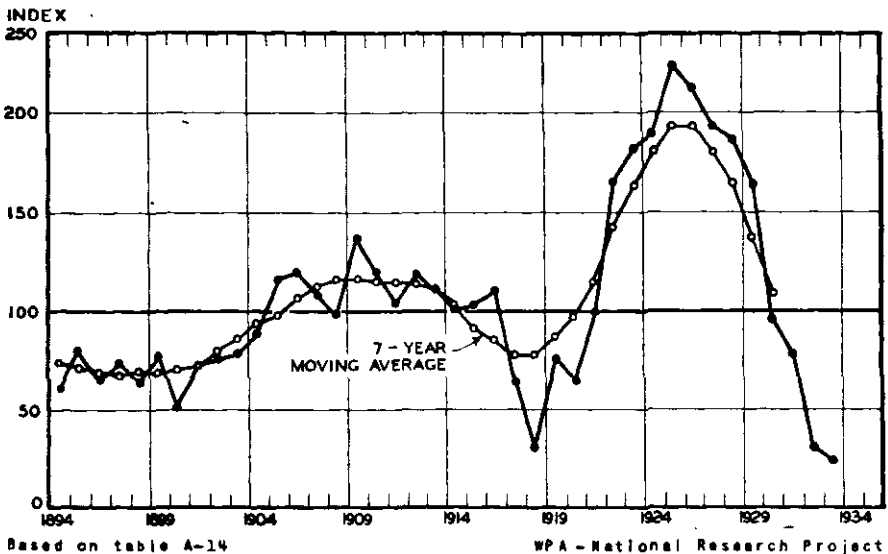
Based on table A-14

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Figure 10.- INDEX OF BUILDING ACTIVITY, 1894-1933

(1914=100)



Based on table A-14

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When a comparison is made of the trend in building activity with that in the production of brick and tile, it is evident that other building materials must have been displacing clay products in 1909-25. An examination of the short-time fluctuations in the production of brick and tile reveals a close correspondence with the short-time fluctuations in building activity.

**Table 15.- MAJOR CYCLES IN THE BRICK AND TILE INDUSTRY
AND IN BUILDING ACTIVITY, 1890-1933^a**

| Item | First cycle | | Second cycle | | Third cycle | |
|-----------------------|----------------|------------|----------------|------------|----------------|------------|
| | Brick and tile | Build- ing | Brick and tile | Build- ing | Brick and tile | Build- ing |
| Peak year | 1890 | 1893 | 1909 | 1909 | 1925 | 1925 |
| Trough year | 1895 | 1898 | 1918 | 1918 | 1933 | 1933 |
| Length of cycle | | | | | | |
| Years between peaks | n.a. | n.a. | 19 | 16 | 16 | 16 |
| Years between troughs | n.a. | 21 | 23 | 20 | 15 | 15 |

^aCycles in building activity adapted from William H. Newman, "The Building Industry and Business Cycles," *The Journal of Business of the University of Chicago*, VIII, No. 3 (July 1935), Part 2, 10.

n.a. Data not available.

The correlation between the deviations from the 7-year moving average in these two series for 1894-1932 gives a coefficient of 0.84 ± 0.05 . This further confirms the assumption of the determining importance, evident both in long-time and short-time cyclical fluctuations, of building activity in the demand for brick and tile.

CHANGES IN POPULATION AND DEMAND FOR BRICK AND TILE

Since population movements play an important part in building operations, such factors as growth, regional distribution, and concentration of population in urban centers must be taken into account in studying the markets and location of the brick and tile industry. The period of most rapid growth in population (1880-1930) includes the period of rapid growth in production of common brick (1880-1909) and the period of rapid growth in the production of face brick and hollow building tile (1909-25). The areas of greatest absolute increase during the period 1890-1930 were the Middle Atlantic and East North Central States, containing in 1920 approximately 40 percent of the population of the United States. In the decade 1920-30 the increase in these States was approximately 8 of a total of 17 million for the United States.¹⁰ It has been in these States also that the largest

¹⁰Cr. Warren S. Thompson and P. K. Whelpton, *Population Trends in the United States* (New York: McGraw-Hill Book Co., Inc., 1933), p. 16.

proportion of the brick and tile has been produced and consumed.

Concurrent with the sharp advance in the rate of increase of total population after 1880 was a rapid growth of urban centers. In the 50 years from 1880 to 1930 the number of people living in towns and cities with a population of 8,000 and over grew from 23 percent to 49 percent of the total population. Expressed in absolute figures, population in such cities increased from 11 million in 1880 to 60 million in 1930, an increase of 450 percent. In the decade 1920-30 the increase in these cities was 14 million, while population in the remainder of the United States increased only 3 million.¹¹

The concentration of population in urban centers creates a greater demand for brick and tile than when the population is more largely rural or is distributed in small cities or villages. An examination of the consumption of brick and tile by construction companies in six of the largest cities (table 16) reveals, in the first place, the large proportion of the construction materials which is consumed in the cities relative to the total consumed in the respective States and, in the second place, the relatively larger use of tile and somewhat larger use of brick in these cities in proportion to other construction materials.

Table 16.- CONSUMPTION OF ALL CONSTRUCTION MATERIALS AND OF BRICK AND TILE BY CONSTRUCTION COMPANIES IN SELECTED CITIES, 1929^a

| City | Value of construction materials consumed (thousands of dollars) | | | Percent of value of total State consumption of - | | |
|-------------|---|-------|-------|--|-------|------|
| | All construction materials ^b | Brick | Tile | All construction materials ^b | Brick | Tile |
| New York | 182,023 | 8,472 | 2,351 | 68.6 | 69.8 | 84.8 |
| Chicago | 117,981 | 5,085 | 2,684 | 80.2 | 79.6 | 94.0 |
| Detroit | 58,413 | 3,853 | 924 | 60.8 | 79.0 | 81.8 |
| Boston | 34,548 | 1,630 | 208 | 52.2 | 55.9 | 59.1 |
| Los Angeles | 53,407 | 1,482 | 221 | 43.6 | 58.6 | 49.8 |
| Cleveland | 35,671 | 2,590 | 454 | 31.4 | 38.8 | 58.6 |

^aFifteenth Census of the United States: 1930, "Construction Industry" (U. S. Dept. Com., Bur. Census, 1933).

^bIncludes only those materials for which the census reports distribution by kind.

¹¹Ibid., pp. 19, 20.

While these construction companies did not operate only in the cities in which they are located, it is nevertheless likely that they did most of their business in the metropolitan areas.

One aspect of the growth of cities has been the increasing functional specialization of buildings and the creation of new types of buildings. With the growth of cities there has developed an increasing number of commercial and industrial buildings, of public institutional buildings, such as hospitals, schools, churches, and social and recreational centers, and in many cases the substitution of apartment houses for private residential dwellings. The wealth of urban communities has made possible the construction of these buildings in a more substantial manner, the utilization of new architectural forms, and an emphasis on beauty and impressiveness. Consequently, brick, stone, terra cotta, concrete, and other building materials have tended to displace the wood construction prevalent in small towns and rural communities. The necessity of protecting lives and property from the hazards of fire and collapse, highly important when people are concentrated in urban centers where large buildings predominate, has forced cities to adopt building codes and fire ordinances. The general effect of these codes has been to decrease the use of lumber in building construction and to increase the use of other materials which conform to the adopted standards of structural strength and fire resistance.

Newman has pointed out that the changes in city population occur in cycles to which the major cycles in building activity correspond closely.¹² Instead of growing steadily, cities tend to have periods when population is growing rapidly, followed by periods of less rapid change; these in turn are followed by periods of rapid growth. The cycles seem to be due to migrations of population which give rise to increases in certain areas or cities, offset by decreases in other areas. An example is the increase in urban populations which arises out of migration of rural population to the cities or migration from cities of declining industrial importance or of declining employment opportunities to centers offering greater opportunities (for instance, the automobile centers during the decade 1920-30). Since buildings are immobile, these changes create a demand for new building which overshadows the demand which is necessary for replacement, a fact due to the relatively long life of structures.

¹²Newman, *op. cit.*, pp. 32-9.

Michigan with its recent growth due to the automobile industry, California (especially Los Angeles) with its recent phenomenal growth connected with the moving-picture industry, and North Carolina with its recent industrialization have all become important users of brick, but the growing metropolitan areas of Chicago and New York surpass all other localities in their demand for brick and tile. In fact, the absolute increases in population in these cities have been greater than the increases in any other cities because of their greater size, but in the decade 1920-30 the increase in Los Angeles was only slightly less than that in Chicago. Detroit was the only other city to increase its population by more than half a million.

The fact that the rapid growth of individual cities or areas may be followed by a period of little change has important bearing on employment. When the demand for brick declines in some eastern States, for example, and grows rapidly in California, the absorption of labor in the West can in no way compensate for the displacement in the East except in the average employment as reported by the census. It is impossible to measure the amount of labor displacement which has occurred because of the shifting of the demand from one area to the other, but without doubt it has been substantial. The effects of these changing centers of demand are shown in an examination of the production trend in different areas. While the trend in common brick in most States has been downward since 1909, there are some geographical divisions which have shown an upward trend. It is noticeable in California where the production of common brick increased from 276 million in 1909 to 429 million in 1925; North Carolina, where the increase was from 188 million in 1909 to 250 million in 1927; Alabama, with an increase from 146 million in 1909 to 189 million in 1925; and Illinois, where the increase was from 1,257 million to 1,436 million from 1909 to 1925. These figures, of course, tell only part of the story because it is evident that while production of common brick was declining, the production of face brick and hollow building tile was increasing, and with the revolution in building, New York, Chicago, and Detroit were using increasing amounts of these materials. The fact that face brick and hollow building tile are shipped longer distances than common brick may have tended to lessen the displacement due to these changes in markets.

PUBLIC CONSTRUCTION AS A SOURCE OF DEMAND

Public construction creates considerable demand for brick. During the depression period some of the plants which were covered in the NRP-NBER field survey were able to operate only because of the Government orders which they received. Public construction during 1925-29 averaged 2.3 billion dollars per year and accounted for 22 percent of the total construction activity in the United States.¹³ Public construction declined during 1930-32 and then rose to 4.8 billion dollars in 1936 under the impetus given by appropriations designed to create jobs for the unemployed. In 1934 public construction rose above its average for the predepression period and reached large enough proportions to perform the function of partly filling in the gaps left by the falling off of private construction. During 1934-36 approximately 62 percent of the construction activity, in terms of the value of the construction, was public, and only 38 percent was private. To a substantial extent, then, the demand for construction materials during this depression period was sustained by public appropriations.

While there are no figures available on the consumption of brick and tile by State and local public-construction works, some data are available on Federal construction. In 1934 the Federal Government spent 5.5 million dollars and in 1935, 8.8 million for brick and tile, which was 25 percent and 26 percent respectively of the total value of the brick and tile produced in these two years.¹⁴ For each thousand dollars spent on Federal construction in 1935, approximately \$4.80 was spent for brick and tile. This compares with \$17.40 spent for brick and tile for each thousand dollars of construction by private companies in 1929.¹⁵ The large difference is probably due to the greater importance of road building in the public-works program. When compared on the basis of materials used rather than the total cost of construction, brick and tile comprised 3.0 percent of the cost of materials for all types of Federal construction work

¹³Based on estimates made by Peter A. Stone, *Construction Expenditures and Employment, 1925-1938* (WPA Division of Research, Statistics, and Records, Construction Statistics Section, mimeo., rev. June 1, 1937), p. 14.

¹⁴Computed from data supplied by the U. S. Department of Labor, Bureau of Labor Statistics, Division of Public Construction and Public Employment. "Brick and tile" includes common brick, face brick, hollow brick, terra cotta, hollow building tile, and roofing tile.

¹⁵*Fifteenth Census of the United States: 1930, "Construction Industry,"* p. 124. This figure for construction includes the public-construction work done by the private companies reporting to the census. If this were omitted, the ratio would be higher.

during the period June 1933-December 1936¹⁶ and 5.0 percent of the cost of materials in all types of construction jobs done by private companies in 1929.¹⁷

If the increase in Government construction is considered as a reabsorption factor in the use of materials and men in the construction and building-materials industries, then the 1.3 billion dollars increase in public construction between 1929 and 1935 should be compared with the decline in the amount spent for private construction. If the assumption is made that the same percentage was spent for brick and tile in State and local public works as in Federal construction in 1934-35, then this increase in expenditures would increase the consumption of brick and tile by about 6.3 million dollars, which would amount to approximately 6 percent of the decline in consumption of brick and tile for private construction for 1929-35. This increase in production may have reabsorbed some 3,000 wage earners into the plants and possibly 5,000 persons into the industry as a whole. This assumes, of course, that the expenditures for public construction in no way affected the amounts that would have been spent for private construction. Public building, in contrast to public-construction work in general (which has included such a large proportion of road building), has used a considerably larger amount of brick and tile for the same expenditure of funds than that used for construction work. Figures are not available, however, for comparing the amount of brick and tile used per thousand dollars of public-building construction with that used in private building. Grants in aid to private construction, especially those designed for slum clearance and construction of new apartment houses, would also bring about a greater reabsorption of labor in the brick and tile industry than does the usual type of Government construction. This discussion is not in any way intended to evaluate the public policies governing the past or future expenditures of public funds for construction but rather to point out the direct relationship between these expenditures and employment in the brick and tile industry. Nor has any attempt been made to evaluate the broader economic effects of these expenditures and their indirect effects upon production and employment in the industry.

¹⁶Data were provided by the U. S. Department of Labor, Bureau of Labor Statistics, Division of Public Construction and Public Employment.

¹⁷Brick and tile comprised 11.4 percent of the cost of materials for all classes of building construction. These percentages are based on data in *Fifteenth Census of the United States: 1930, "Construction Industry,"* p. 124.

**COST FACTORS DETERMINING BRICK AND TILE SUPPLY
AND PLANT LOCATION**

During most of the nineteenth century brickmaking was primitive in technique and organization, and plants were erected in almost every community of any size. Where, however, the elements of superior clay, cheap fuel and transportation, and proximity to extensive markets existed in the same locality, the factory system sprang up. Today the smaller and less-mechanized plants are generally found in outlying regions and produce for local trade. The tendency toward the concentration of the industry geographically and in large plants was furthered by the introduction of brickmaking machinery and the growing demand for special clay products, such as pressed brick, fancy front brick, and paving brick.¹⁸ Thus while there were 5,800 plants reported by the census for 1889, there were only 1,500 plants making brick and tile in 1925 (the most recent peak in the industry). The discovery of natural gas and the use of petroleum for fuel, the opening up of new coal fields near excellent clay deposits, and cheap transportation (especially in the Middle West) led to the establishment of important brickmaking centers away from the urban centers where they had usually been located.¹⁹

Raw Materials

Though clay suitable for making brick and tile is found in all parts of the United States, its quality is not everywhere the same. Common-brick manufacturers can use practically any common clay which is available, while face-brick manufacturers have to be more particular and sometimes combine several clays to obtain the desired shades which are essential in their products. Tile from fire clay is produced in western Pennsylvania and Ohio and is recognized as the best type of tile. The eastern tile which is made from shale and surface clay is considered a product of inferior quality and can be sold only at a lower price. Hence the tile from western Pennsylvania and Ohio is shipped into the eastern markets.

Ohio is the foremost State in both quantity and quality of workable shales.²⁰ Possessing a much greater quantity of these

¹⁸Victor S. Clark, *History of Manufactures in the United States* (New York: McGraw-Hill Book Co., Inc., 1929), II, 493-4.

¹⁹*Ibid.*, II, 258.

²⁰Ellis Lovejoy, *Fundamentals and Economics in the Clay Industries* (Willisville, N. Y.: Randall Pub. Co., 1935), p. 56.

clays than it can use, it has sought distant markets for its clay products, expanding its production of face brick, hollow building tile, and paving brick, while its production of common brick has been declining. Its face brick sells in New York, Chicago, Detroit, and Philadelphia because of the special qualities of the clays from which it is made.

Certain clays are more suitable than others for machine production. These are the clays of the geological formation older than the surface clays which have been generally used in the eastern areas. Up to the time that these clays came into use in the seventies, the industry was almost entirely manual. They can be run through the stiff-mud brick machines at a much greater rate of speed since they are of a more uniform quality. Thus they are more suitable for the manufacture of hollow tile which is made by the stiff-mud process. In evidence presented at the NRA code hearings in 1933 it was said, "Some clays can be forced through a machine at the rate of 150 to 300 thousand [brick] a day, while others will not produce more than 70 thousand a day in the same type of machine, due to the difference in plasticity."²¹

Clays differ also in the length of time they take for burning. Some clays, such as those in the Chicago area, contain a certain amount of carbon, which makes possible the burning of the brick in 48 hours, while others may require 6 days or more for burning. These special qualities of different clays, as well as other special qualifications (such as color and hardness), tend to concentrate the different sectors of the brick and tile industry in certain geographic regions because of the economic advantages associated with different kinds of raw materials. For the most part, plants producing hollow building tile and face brick from inferior grades of clay will be found only in close proximity to their markets.

The average size of face-brick and paving-brick plants is considerably larger than that of common-brick and drain-tile plants. To some extent this is due to the fact that the cost of transportation limits the extent of the market and hence the size of the plants, except where the product, because of a greater scarcity of raw materials (that is, of clay with special properties), has a competitive advantage in a larger market, and hence the plant is able to produce in larger quantities.

²¹ Letter from R. P. Stoddard, Secretary-Manager, Brick Manufacturers Association of America, to General Hugh S. Johnson, May 29, 1933, incorporated in *Code Record*, Vol. A, Part II.

Since drain-tile plants are not dependent upon clays of superior quality, they are usually small and are located in the agricultural regions of the upper Mississippi Valley where drain tile is essential to the farm operations.

Fuel

Fuel is another factor in the location of brick plants. The burning process takes a large amount of fuel, and where coal is used, special grades of coal are required. The cost of the transportation of coal is often greater than the cost of the coal itself. In chapter II attention was called to this fact when it was found that the number of man-hours associated with the transportation of coal was even larger than that associated with the mining of coal. Coal used for burning brick in Philadelphia is brought from western Pennsylvania at a transportation cost exceeding the cost of the coal at the mine. Cheap fuel has been an important factor in the establishment of plants in Ohio, Indiana, and southern Illinois, and cheap coal is one of the reasons for Ohio's present supremacy in brick and tile manufacture. The importance of coal as a cost item is seen in the fact that the cost of materials of which coal is the main item has been about 30 percent of the value of the products from 1925 to 1935. In 1929 the clay-products industries, of which the brick and tile industry composed approximately 50 percent of the total, were the fourth largest industrial consumers of coal. Coal, as would be expected, is shipped long distances to plants in New England and New York and certain southeastern and western States. In Illinois, Indiana, and Ohio, coal deposits are near the beds of fire clay and shale at which the kilns are located, and in certain midwestern States coal and clay are sometimes extracted from the same strip mine. Removal of the coal overburden may supply the fuel for burning the clay which lies beneath.

Some plants in Texas, Illinois, and the Hudson River Valley use oil and gas as fuel, thus saving labor costs because fewer employees are needed, while wood, requiring much labor, is still used in some small New England plants.

Transportation

The transportation costs explain the location of many plants near the markets despite other disadvantages. Face brick and hollow building tile can be transported greater distances than

common brick because of the higher price of face brick and the comparative lightness of the hollow tile. Paving brick must also be transported considerable distances because of the scarcity of raw materials of requisite quality. Transportation cost is, in large part, the limiting factor in the development of large-scale brick and tile plants. To the extent that large plants have been developed, reaching out beyond the market naturally limited by the cost of transportation, these plants have sought access to other markets by the use of the basing-point system or absorption of part of the freight in order to enter or keep in the outside market. This has been true especially in the marketing of paving brick, face brick, and hollow building tile, with the complaint in some instances of the dumping of these products in the larger markets in order to maintain a higher price in the local market.

In 1929 the approximate average revenue per thousand brick carried on the railroads was \$4.55.²² Freight rates on brick from seven shipping points in Ohio to the eastern cities of Boston, New York, Philadelphia, and Baltimore varied from \$3.60 to \$5.50 per thousand brick in the spring of 1937, with a median rate of \$4.55. During the twenties the cost of railroad transportation became serious, and ways were sought to lower or avoid this cost. Intensive advertising was resorted to as a means of selling the products in a market nearer home, but probably more to the point was the development of transportation by truck. Mechanical loading of trucks was installed in many plants; this saved in the cost of handling. The truck could be backed up to the kiln and loaded directly with no intermediate handling by wheelbarrow. By use of special dumping arrangements the truck could be quickly unloaded at the building where the brick was to be used.

That the motor truck is assuming importance in the transportation of brick today is shown in the following paragraph, quoted from an article in *Brick and Clay Record*:

Ten years ago clay products were seldom hauled by motor truck more than 25 miles from the plant, and even of this short haul business much went to the railroads.

But motor truck haulage has progressed much further than the short haul business. Practically all of the

²²Based on data in *Freight Commodity Statistics* (Interstate Commerce Commission, Bur. Statistics, 1930), Statement No. 30100, pp. 7-10. The data used refer to brick shipments originating or terminating on Class I railroads.

everyday business that originates within 50 miles of the average [clay] plant is hauled by motor truck today; a very large proportion of the orders moving as far as 75 miles goes to the truck, and hauls up to a 100-mile radius are not impractical. Practically all less-than-carload business up to 100 miles from the manufacturing center is hauled by motor truck.²³

Labor

Brick and tile plants generally employ a few highly skilled workers and a comparatively large number of common laborers. The percentage that labor cost is of the total cost is larger than for some of the competitive building materials, such as cement. It was approximately 40 percent of the value of the products during 1925-29.²⁴ When wages relative to other prices rise throughout industry as a whole, this factor of labor cost tends to shift the advantage in regard to competitive materials against that product manufactured under conditions of high labor costs. The high level of wages relative to the price level which existed after 1920 may have been one of the factors militating against the consumption of brick in 1920-29.

With the restriction of immigration after the World War and the attraction of labor into other industries, brick and tile plants were faced with the problem of securing an adequate supply of cheap common labor. Two of the ways adopted to meet the problem were the recruiting of Negro labor from the South and the substitution of machines for men. After 1920 Negro laborers entered brickmaking establishments in the North in increasing numbers.²⁵ While New York and New Jersey hired foreigners for the most part, some of the large brickmaking plants brought Negroes from the South and housed them in company towns. In one of the larger plants where open-air drying of the brick persisted until 1929, the Negroes were on call at any time of the night or day to cover the bricks in case of rain. So successful were some of the "industrial agents" who were sent south to recruit Negro labor that some of the Southern States tried to restrict their activities which were forcing employers to raise wages.²⁶ Some

²³"Motor Truck Can Lighten Burden of Clay Products Shipping Costs," *Brick and Clay Record*, 86, No. 6 (June 1935), 199.

²⁴Based on *Census of Manufactures* data.

²⁵Lorenzo J. Greene and Carter G. Woodson, *The Negro Wage Earner* (Washington, D. C.: The Association for the Study of Negro Life and History, Inc., 1930), p. 293.

²⁶"Labor Problems of Hudson River," *Brick and Clay Record*, 87, No. 3 (Aug. 4, 1925), 180.

owners of plants located in small towns maintained their supply of labor intact during periods of nonoperation of their plants by providing the workers not only with houses but also with fuel and food.

The only trade union reported in the industry is the United Brick and Clay Workers of America, affiliated with the American Federation of Labor. The union seems to have controlled the labor market for the common-brick plants in the Chicago area since around 1900. Agreements with the manufacturers in this market brought about an 8-hour day in these plants (when workers in other plants were working 9 and 10 hours) and obtained the highest hourly wage paid in any brick and tile factories in the United States.

When one notes the range of average earnings paid in 1935 in the factories for which data were obtained²⁷ - from 24 to 87 cents an hour - the question arises as to what differences in mechanization and in relative costs of producing brick accompany such marked differences in hourly wages. The relationship between labor costs and productivity will be left for consideration in the following chapter where more attention will be given to mechanization, the manufacturer's second solution to the problem of labor shortage.

TRADE ORGANIZATION AND PRACTICES AS FACTORS IN THE MARKETS FOR BRICK AND TILE

It was pointed out in chapter I that there are strong trade associations in four branches of the industry and a varying degree of control of parts of the industry by large companies. What effects the efforts at organization and the various trade practices, such as trade marks, open-price publication, quoting of delivered prices, and the basing-point system, have had upon the consumption of brick and tile and the supply of the products is problematical.

The outstanding example of market control has been in the Chicago market for common brick, which is of special interest in contrast with other markets for this product. As has been seen, it is a market with high concentration of control of both production and prices. One company has dominated the field. The plants are highly mechanized and the clay in this area has qualities especially advantageous for large-scale and high-speed

²⁷ NRP-NBER field survey.

machine production. In addition, the wage earners in the plants have been organized into a trade union which has controlled working conditions.

The question naturally arises as to what effect this combination of peculiar circumstances has had upon production and employment in the Chicago area. For a number of years prior to 1931 the Illinois Brick Company operated only about 10 of its 42 or more brickyards which it had acquired from 1900 to 1931; furthermore, during the years 1922-30 its production was chronically under the quota assigned to it by the licensing agreements which controlled the market. This may only mean that employment shifted from the plants owned by the Illinois Brick Company to those of other plants in that area. What effect the pegging of the price by these agreements at \$12 per thousand, which produced an average profit of \$1.50 per thousand, may have had upon the consumption of brick in Chicago during this period is difficult to say, but it seems likely that it may have militated against the use of common brick and may have acted in favor of competing materials.

In other local markets for common brick there is little evidence of monopolistic practices aside from some local "gentlemen's agreements" in regard to prices and trade practices. Although the Common Brick Manufacturers Association seems to have instituted open-price publishing before the NRA period, the widely scattered and decentralized nature of the common-brick industry, with its multiplicity of small plants, would make impossible any effective control over prices in this part of the industry.²⁸ Local trade associations have engaged in the usual promotional activities which have included interest in seeing to it that building codes recognized the fire- and earthquake-resistant qualities of brick masonry. In this they have been aided by the national organization, which has also been active in developing types of bricks and brick masonry which meet newer standards of building construction.

The American Face Brick Association seems to have been very successful in stimulating the use of face brick during the period 1920-29. Its open-price publication did not result in any control over prices so far as has been ascertained;²⁹ nevertheless the use of trade marks by some manufacturers has been made possible by the importance of color, texture, and other qualities in face

²⁸U. S. Congress, Senate, Federal Trade Commission, *Open-Price Trade Associations*, S. Doc. No. 226, 70th Cong., 2d sess., 1929, pp. 41, 267-8.

²⁹*Ibid.*, pp. 394-5.

brick. Since certain types of clay are limited in amount and exist only in certain areas, face-brick manufacturers in localities possessing these clays may take advantage of this condition of scarcity to monopolize the source; they may thus control the supply of especially desirable kinds of brick so that, even if there is no evidence of control of supply when this branch of the industry is considered as a whole, the high price quoted for certain types of face brick would indicate a certain degree of monopoly control in parts of this branch of the industry.

It has been stated that the structural clay-tile branch of the industry and the trade association of the same name are dominated by a single company, the National Fireproofing Corporation, and there is little doubt that prices in this branch of the industry tend much more to be carefully administered and are less flexible and more controlled than in most other parts of the industry. The use of the basing-point system of delivered prices is habitual in sales of tile, and such a system can scarcely exist without rather general uniformity among all producers as to their trade practices and their prices.³⁰

Although the National Paving Brick Association is not listed by the Federal Trade Commission as an open-price association, there are quite a few indications that members of the trade work hand in hand through the association. The composition of the industry itself - it is made up of relatively few units concentrated in a small area - favors concerted action. The extensive statistical work that has been carried on by the association for some years and the success of its efforts to standardize the products of the industry³¹ suggest a high degree of cooperation of the members of the industry with each other and with their trade organization.

The practice of quoting delivered prices seems general throughout all parts of the brick and tile industry, as revealed by code hearings and the objections of the members of the industry to the Patman-Robinson Act.³² This practice enables the manufacturers who have favorable production costs but who are at a distance

³⁰ *Ibid.*, pp. 197-8. Cf. Frank Albert Fetter, *The Masquerade of Monopoly* (New York: Harcourt, Brace and Co., 1931), p. 242.

³¹ Summary of April 18, 1936, Revision Conference, "Vitrified Paving Brick: Simplified Practice Recommendation RI-36" (U. S. Dept. Com., National Bur. Standards, 1936), pp. 9-10. This survey was made in cooperation with the Permanent Committee on Simplification of Variety and Standards for Vitrified Paving Brick of that department.

³² "Anti-Basing Point Bills Menace to Industry," *Brick and Clay Record*, 88, No. 5 (May 1936), 183. See also chapter I, pp. 20-1.

from the markets to absorb part of the freight and thus enter an otherwise closed market. During the twenties, large plants were built in Ohio and western Pennsylvania on the expectations of selling at least part of the product in the big markets of New York, Chicago, Detroit, and other cities. The importance of the practice lies in the fact that both direct and indirect costs of production per thousand brick increase inversely to the percentage of capacity utilized. This exerts a pressure either to produce at a high capacity or to close down operations. Typical of the experience of other plants is that of a manufacturer who said in 1933 that he could manufacture brick at \$9.50 per thousand when running at full capacity and at \$11 per thousand when operating at two-thirds of capacity.³³

The large amount of stocks customarily carried in the industry may also result from this necessity for operating at full capacity. The stocks average from two to three times the monthly production in periods of normal production, and some plants may continue to sell brick after they have been closed for more than a year.

When these factors are coupled with the fluctuations in the demand for brick, which tend to bring about a great expansion of the industry in such periods as 1923-27, when there was an abnormally great amount of building activity followed in a few years by a severe contraction in demand, it can be seen how keen the competition may be for the market. In the falling market, the high direct costs of production tend to prevent the lowering of prices and to bring about the closing of many plants. The only plants which are able to operate at a profit are those which have captured enough of the market for capacity or near-capacity operation.

PRICES AND PRODUCTION

A study of the behavior of the prices of the products in this industry may throw some light on the interaction of the forces of supply and demand as they work themselves out in changes in consumption, production, and employment. The factor of demand should be considered from two aspects: the demand for building materials which, as has been pointed out, is dependent upon factors outside the present discussion and the demand for a specific

³³Statement by W. W. Swengel to Malcolm Muir, Deputy Administrator, NRA (1933); incorporated in *Code Records*, Vol. B, Part I, "Structural Clay Products Industry."

building material which may vary because of changes in the prices and supply of materials competing with the one in question. The present inquiry into the realm of prices and production is largely an attempt to investigate the second aspect of this problem. What does the behavior of prices and production tell us about the extent to which changes in production and employment in the brick and tile industry are associated with the competition of brick and tile with other building materials?

The behavior of prices is not only the result of the interaction of the forces of supply and demand, but the prices, once determined, may in turn affect the amount of the products consumed, the supply offered upon the markets, and the amount produced. Unfortunately for the purposes of analysis, fluctuations in the general level of prices, that is, in the value of money, affect the prices of individual commodities. Therefore, in order to analyze the interaction of the forces of supply and demand for an individual commodity, or the effect of prices upon these factors, it is necessary to remove the factor of change in the value of money. For this purpose the price indexes of the individual commodities have been divided by the wholesale-price index of the Bureau of Labor Statistics. The inadequacies of this or any other method of correction for the general level of prices are fully recognized.

Some of the questions to which answers are being sought in the following analysis are: Is there any evidence of inflexibility or rigidity in the prices of these commodities, and, if so, what effect does this have upon consumption and, therefore, upon production in the industry? What information do prices give us in regard to the elasticity of the demand and supply factors and, therefore, in regard to the fluctuations to be expected in employment? What information do prices give us in regard to the competition with other building materials? Is a highly competitive or sensitive market more conducive to stability of employment than a controlled market?

Prices of Brick and Tile and All Building Materials

Before the war the index of wholesale prices of building materials fluctuated around the level of wholesale prices of all commodities (figure 11 and table A-15). From 1919 to 1922 the building-materials index rose to a new level approximately 25

percent higher than before the war and maintained that level relative to the all-commodities index until the depression after 1929, when it declined less than the latter. An examination of the price of common brick in New York City and of the average unit value for the United States reveals a somewhat similar picture but with differences. The price of brick fell in relation to the general price level during the period 1890-1910, doubtless reflecting the improvements in methods of manufacture. The rise in the value of common brick during the war period was greater than the rise in the index of all building materials, which would indicate a certain competitive disadvantage operating against the consumption of common brick. In 1926 the price of common brick was at a level of 105 percent above the 1913 price, while the price of lumber had risen only 85 percent, cement 68 percent, and steel 30 percent.³⁴ After 1920 there is a constant complaint from the brick manufacturers as to their high cost of production relative to competing products, with emphasis on the high cost of labor and of transportation. It will be noticed that during the period 1914-25 building activity increased 123 percent, while the production of common brick increased only 6 percent.³⁵ During this period other building materials were displacing common brick, as is shown in figures 9 and 10 by a comparison of the production curve of structural brick and tile, in which common brick is the principal product, with that of building activity.

The price of common brick in New York City fell after 1923 relative to the general price level; in other words, it declined more than the average for wholesale prices. This was not true, however, of the average unit value of common brick for the United States. Common-brick production in New York increased from 14 percent of the United States total in 1925 to 26 percent in 1931. In 1929 New York City was using a much larger percentage of brick in proportion to other building materials than any other city in the United States. The cost of brick was 19.2 percent of the cost of all materials used by general contractors for building purposes, while in Detroit, the next city in rank, it was 14.7 percent and in Chicago, 13.4 percent.³⁶ It is possible that the relatively greater decline in the price of brick in New York

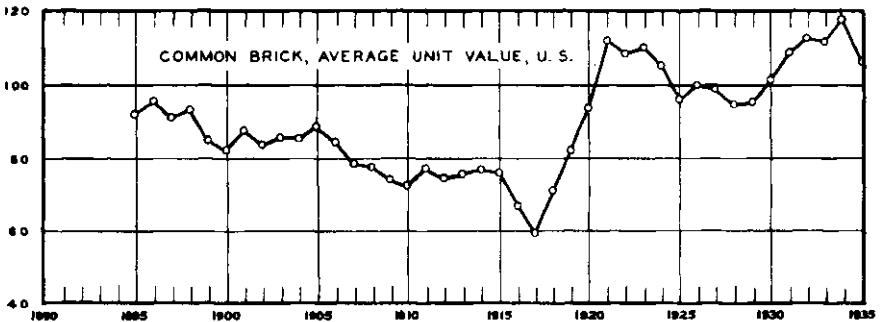
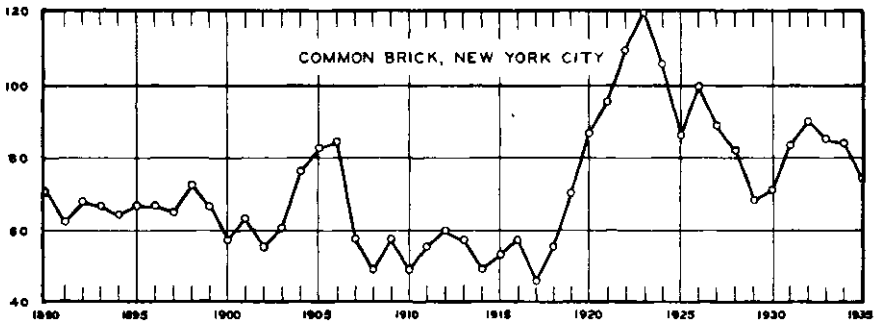
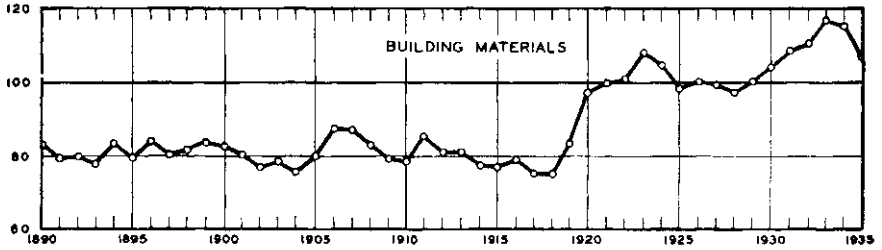
³⁴ *Wholesale Prices, 1913 to 1928* (U. S. Dept. Labor, Bur. Labor Statistics, Bull. No. 493, Aug. 1929), pp. 15, 174.

³⁵ See tables A-13 and A-14.

³⁶ *Fifteenth Census of the United States: 1930, "Construction Industry."*

Figure 11.- INDEXES OF PRICES OF COMMON BRICK AND BUILDING MATERIALS, ADJUSTED FOR WHOLESALE-PRICE LEVEL, 1890-1935
(1926=100)

INDEX



Based on table A-15

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City than in the average for the United States may have had something to do with the greater use of brick in New York City, but differences in building codes should not be overlooked as a cause.

The decline in the average unit value of common brick (corrected for the price level) between 1921 and 1929 and in the price of common brick in New York City from 1923 to 1935 is probably associated with the building of new, larger, and more mechanized

plants and in the installations of more mechanical equipment, especially in plants serving the New York market. Attention should be called to the fact that a low point in average unit value for the United States was the year 1925 when production was at its highest post-war point.

Comparison of Variations in Price and Production of the Different Products

Comparison of the fluctuations in the production of each of the three products, common brick, face brick, and hollow building tile, with corresponding fluctuations in the average value per unit of product deflated by the index of wholesale prices reveals a tendency toward inverse relationship (figure 12 and table A-16). After the war each product attained its lowest average unit value relative to the general level of prices during the years of high production, 1923-29, and, with the exception of hollow building tile, its highest unit value during the period of low production, 1932-35. It will be remembered that hollow building tile shows more evidence of controlled price than the other two products.

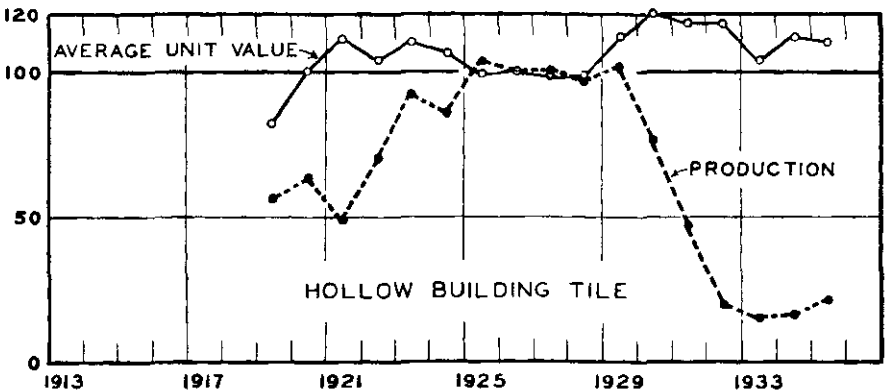
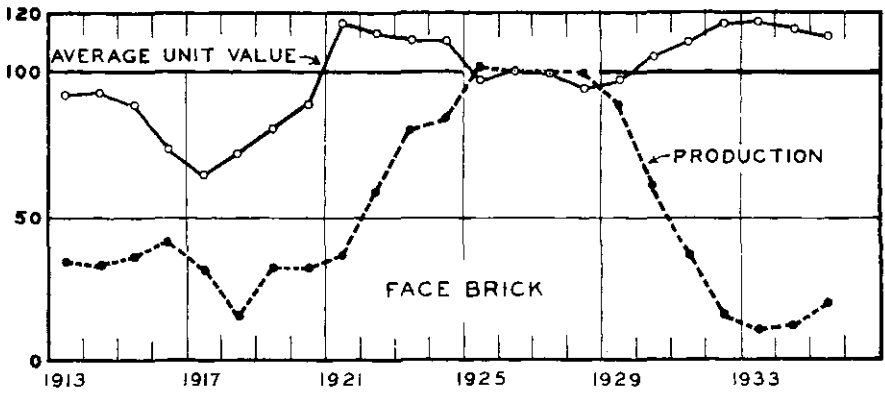
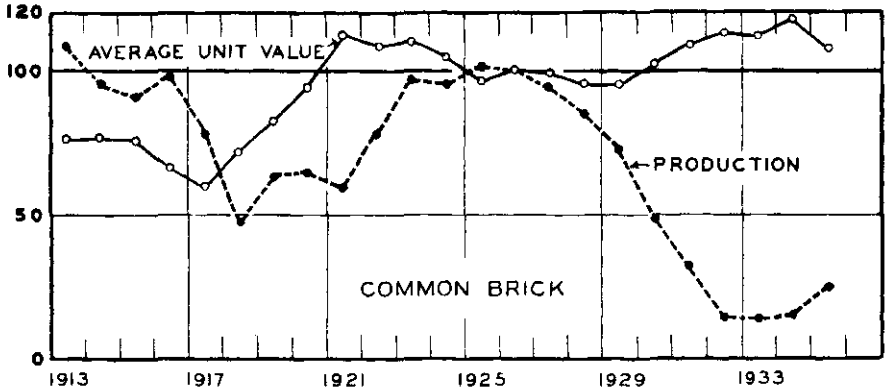
Cost data obtained from individual plant records show a tendency in the direction of increased cost when plants are operating at low capacity. In one large plant which was operating at capacity in 1925, the cost of producing and selling the brick was \$13.54 per thousand, while in 1935 when it was 23 percent below capacity, the cost was \$16.89 per thousand. This tendency of production costs to rise when production is below capacity prevents the fall in prices which might otherwise take place and tends to make the supply curves of individual producers decline abruptly at prices below cost of production at capacity. The supply curve of any given concern probably shifts according to the expectation of operation at capacity or below.

Table 17 presents a comparison of the coefficients of variation in the prices (unit value at the plant) and production of the five brick and tile products. The outstanding common characteristic of these products during this period is the very high coefficient of variation in production, which is over 50 percent for each product except hollow building tile, which is 49 percent. This is not surprising from what we have seen of the behavior of demand for these products, which is relatively inelastic, dependent as it is upon demand for construction. This demand for construction is probably little affected by changes in the cost of these products.

**Figure 12.- INDEXES OF PRODUCTION AND AVERAGE UNIT VALUE
OF STRUCTURAL CLAY PRODUCTS, ADJUSTED
FOR WHOLESALE-PRICE LEVEL, 1913-35**

(1925=100)

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Based on table A-16

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Table 17.- COEFFICIENTS OF VARIATION IN AVERAGE UNIT VALUE AND IN PRODUCTION OF BRICK AND TILE, 1920-35^a

| Product | Coefficients of variation in - | |
|----------------------|--------------------------------|------------|
| | Average unit value | Production |
| Common brick | 17.4 | 51.9 |
| Face brick | 15.3 | 57.2 |
| Vitrified brick | 7.9 | 51.9 |
| Hollow building tile | 18.8 | 49.0 |
| Drain tile | 12.7 | 51.9 |

^aBased on *Census of Manufactures* data on total yearly production of each of the products and average unit value at the plant. The formula used to obtain the coefficients was the standard deviation of the items in the series expressed as a percentage of their arithmetic mean.

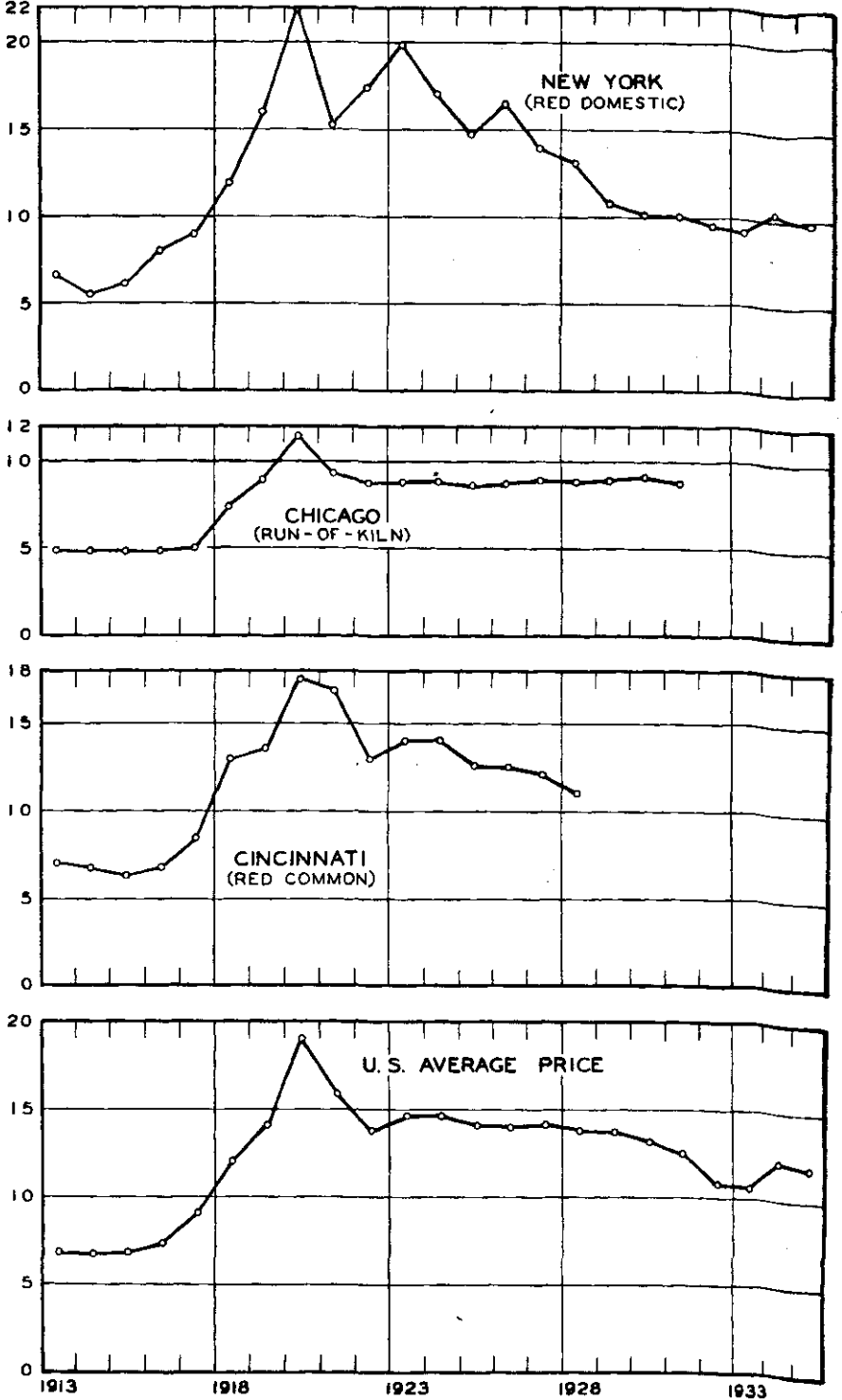
On the other hand, as evidenced by the coefficients the average value per unit is relatively stable. The price of vitrified brick, with a coefficient of 7.9 percent, is the most stable of all five, which might be expected when it is known that four large companies in Ohio and Illinois produced 44 percent of the total paving brick in 1934. The fact that governments are the large consumers of paving brick may make it easier for this branch of the industry to maintain a more stable price than the other branches. The stability of prices of brick and tile products in the face of the severe fluctuations in production seems to indicate a condition of elastic supply or controlled price. As has been noted before, the high direct costs, which rise per unit of value as the capacity operated declines, curtail the supply offered upon the market and keep the price up in face of a declining demand, while when the increase in demand rises to a point permitting near-capacity production, the supply increases more than proportionately and so tends to keep prices down to the near-capacity cost of production. The delivered-price and basing-point practices of the industry may tend to accentuate this tendency toward stability of prices in the face of declining demand and possibly also to accentuate the corresponding decline in production insofar as price stability brings about a displacement of brick and tile by competing materials.

Comparison of New York, Chicago, and Cincinnati Markets for Common Brick

When the prices for common brick in the markets of New York, Chicago, and Cincinnati are examined (table A-17 and figure 13),

Figure 13.- COMMON-BRICK PRICES IN SELECTED MARKETS, 1913-35

DOLLARS PER THOUSAND



Based on table A-17

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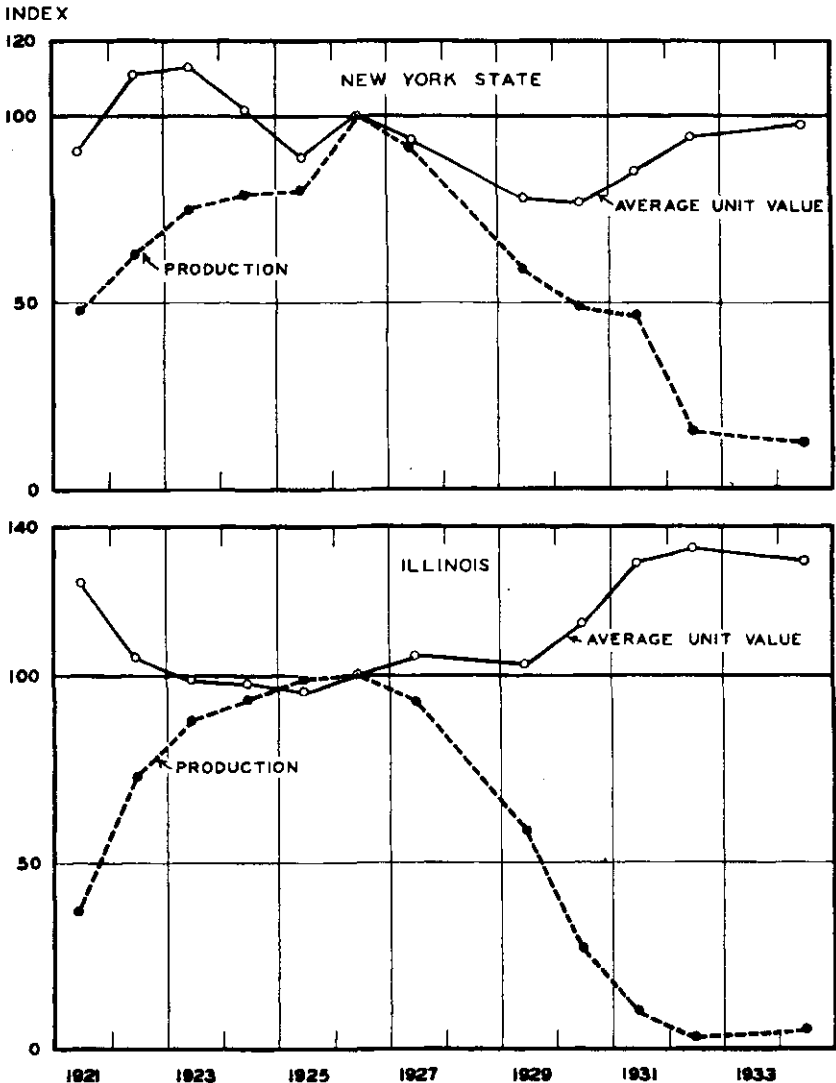
several contrasts appear. Chicago has the lowest price of any of the three markets throughout the period. In this connection it should be noted, however, that the Chicago price is for "run-of-the-kiln" while the other prices are for "red" brick, which would bring about a differential between the prices but possibly not so large a one as exists. In the New York market the price changes are the most marked and have a relatively greater amplitude than in the others. Chicago maintained an almost stable price between \$8.70 and \$9.00 from 1922 to 1931. In Cincinnati prices in this period fluctuated between \$11 and \$14 per thousand; in New York, between \$10 and \$20. The price in Cincinnati is more stable than in New York but less so than in Chicago.

Unfortunately, there are no figures for the consumption of brick in these three markets. In the absence of these it has been necessary to make a comparison between production and unit value, adjusted for general price level, in the States of New York and Illinois, in which, of course, Chicago and New York City are the principal consumers. With the exception of two years, production moves inversely to the average deflated unit value in Illinois, while in New York State the two move together six times from 1921 to 1930 and in opposite directions after that because of a greater fall in the wholesale-price index after 1930 than in the price of common brick. From examination of figure 14 it would seem that production of brick in New York tends to respond to the demand as represented by the price of brick, increasing with demand and a higher price and slowing up as the price declines. Prices reflecting demand tend to perform the function of adjusting production to demand, but in Illinois the evidence seems to point to inflexible prices, making it necessary for all adjustment to take place in production, i. e., resulting in a greater amplitude of the fluctuations in the production curve. This assumption seems warranted when these facts are coupled with what is known about the two markets; the New York market for brick is highly competitive, brick entering that market from plants in New Jersey, the Hudson River Valley, Connecticut, and other States when conditions are favorable; in the Chicago market a group of manufacturers has been tied together by licensing agreements which have fixed prices and production.

In the controlled Chicago market the rigidity of prices seems to result in greater fluctuations in consumption, and hence in production and employment, than in New York, as is shown in the

Figure 14.- INDEXES OF PRODUCTION AND AVERAGE UNIT VALUE OF COMMON BRICK, ADJUSTED FOR WHOLESALE-PRICE LEVEL, IN NEW YORK AND ILLINOIS, 1921-34

(1928=100)



Based on table A-18

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comparison of production for the two States and of price relatives for the two cities (table 18). It may be that part of the reason for the difference between the two markets lies in the difference between construction activity in the two States. Lack of readily available comparable data has prevented further investigation of

**Table 18.- PRODUCTION AND PRICES IN THE NEW YORK CITY
AND CHICAGO COMMON-BRICK MARKETS, 1925-34^a**

| Year | Percent of United States common brick produced in - | | Common-brick price relatives (1926=100) | | | |
|------|--|----------|--|---------|----------------------------|----------|
| | | | Prices in - | | Average unit value in - | |
| | New York State | Illinois | New York City | Chicago | New York State | Illinois |
| 1925 | 13.8 | 19.0 | 89.3 | 98.7 | 91.8 | 98.7 |
| 1926 | n.a. | n.a. | 100.0 | 100.0 | 100.0 | 100.0 |
| 1927 | 17.0 | 19.1 | 84.3 | 102.2 | 88.2 | 99.8 |
| 1929 | 13.9 | 15.2 | 65.2 | 101.7 | 74.1 | 97.8 |
| 1931 | 26.0 | 6.2 | 60.9 | 99.5 | 62.2 | 95.1 |
| 1934 | 14.2 | 6.8 | 62.8 | n.a. | 73.1 | 97.9 |

^aBased on *Census of Manufactures* data and on *Wholesale Prices*, bulletins of U. S. Dept. Labor, Bur. Labor Statistics.

n.a. Data not available.

the reasons underlying these differences between the two markets. Whatever the cause, the greater instability of production in the Illinois market stands out in contrast to the New York market.

The coefficients of variations in price for the three markets of Chicago, Cincinnati, and New York City for 1921-30 are 2.3, 13.3, and 19.4 respectively. Table 19, presents the coefficients of variation in unit value and production for the States of New York, Ohio, and Illinois. New York has a coefficient of variation in average unit value of 19.8 percent, which is above the average for the United States, but a coefficient of variation in production of 44.6 percent, which is considerably below the national average. Ohio, with a coefficient of variation in average unit value of 13.4, somewhat below that of the United States, has a coefficient of variation in production approximately the same as the average for the United States. Illinois, on the other hand, with an extraordinarily low variation of average unit value of 7.0 percent, has the highest coefficient of variation of production, 64.9 percent. Thus in the three markets under consideration there seems to be a clear inverse relationship between price stability and production stability. In other words, great stability in price is associated with severe fluctuations in production, and flexibility in price is associated with less severe fluctuations in production. This would seem to indicate that in the New York market the adjustments between supply and

demand take place through changes in prices, while in the Chicago market adjustments take place in production and therefore in employment.

Table 19.- COEFFICIENTS OF VARIATION IN AVERAGE UNIT VALUE AND IN PRODUCTION OF COMMON BRICK IN NEW YORK, OHIO, AND ILLINOIS, 1921-34^a

| State | Coefficients of variation in - | |
|----------|--------------------------------|------------|
| | Average unit value | Production |
| New York | 19.8 | 44.6 |
| Ohio | 13.4 | 50.7 |
| Illinois | 7.0 | 64.9 |

^aBased on annual *Census of Manufactures* data. The formula used to obtain the coefficients was the standard deviation of the items in the series expressed as a percentage of their arithmetic mean.

As far as the behavior of prices can be interpreted in light of the known facts, the following conclusions may be warranted: (a) Since the demand for the products of the industry is relatively inelastic, marked fluctuations in production associated with fluctuations in building activity are to be expected; (b) there is, however, some elasticity of demand due to the competition with other building materials; hence to the extent that the style of architecture and custom are not counteracting factors, price differences may determine which of two or more competing materials will be used; (c) therefore, where the industry, whether consciously or not, maintains relatively stable prices in the face of a falling demand for building materials, there is a tendency toward the shifting of a portion of the remaining market to competing materials.

SUMMARY

Since the demand for brick and tile is determined largely by construction activity, the industry suffers great fluctuations in employment. Production has been characterized by major cycles of 17 to 20 years in length, corresponding with cycles in building activity. Likewise, the minor fluctuations in the industry have a high degree of correlation with those in building activity.

Production in the brick and tile industry has shown no noticeable trend either upward or downward since 1909, while building

activity has exhibited a marked upward trend. This seems to be due to displacement of some of the brick and tile products by other materials. Building tile and face brick, however, increased at even more rapid rates than building activity during the period 1909-25, while common brick and paving brick have suffered from displacement by other materials.

Concentration of people in cities and migrations of population from the rural districts to cities have an important bearing on the demand for structural clay products. The result has been that the Middle Atlantic and East North Central States have become the largest consumers as well as the largest producers of brick and tile. These migrations tend to bring about fluctuations in the demand for the products in various sections of the country.

While the markets for common brick and drain tile are local and hence tend to be affected by changes in local supply and demand, markets for the other three products are broader so that Ohio and western Pennsylvania serve all the principal markets in the industrial sections of the East and Middle West. With the reaching out for markets, some of the problems of mass production have arisen in these markets, and the usual solutions, such as absorption of freights, the basing-point system, and high-powered advertising, have been tried.

Large-scale production has occurred in common-brick plants located in proximity to large metropolitan centers, but the average size of plants is small. Especially favorable conditions in regard to type of clay suitable for machine production and short burning time and cheap fuel close to the large Chicago market made possible substantial limitations upon competition in that market because it was protected against competition by its relatively low production costs coupled with the high cost of transportation for its competitors. There is little information in regard to similar conditions elsewhere, although informal agreements as to price and practices are known to exist in at least one other large city. This was made possible by the existence of a small number of producers who, possessing clay of superior quality in proximity to the market, were probably also protected from the competition of other producers by lower transportation costs.

The use of the basing-point system by producers of hollow building tile and the domination of the industry by one large concern seem to indicate some degree of monopoly control in that branch

of the industry. Paving brick is more highly concentrated in a comparatively few plants than any other branch of the industry, and the trade association in that branch has brought about a great deal of uniformity with respect to such factors as price and size of brick.

Face brick has probably accomplished much through intensive advertising, which is credited with increasing its sales in the period 1920-27. Unlike common brick which may be sold as "run-of-the-kiln" or in a few standardized classifications, face brick is sold for specific qualities of color and appearance which may be the result of clays of limited supply. While face brick as such may show little evidence of monopoly control, certain types of face brick may be exclusively controlled either by trade marks or by controlling the supply of the clays.

The prices reflect to some extent these factors of control. Before the war the value of common brick tended to fall relative to the general price level, reflecting probably a lower cost of production due to improved methods and greater use of production facilities, but after the war the price of brick assumed a new level with respect to the general price level which was considerably above that before the war. This may have been because labor and transportation costs comprised such a relatively large proportion of the price to the consumer.

In the New York market where competition was active, the price of common brick was not only sensitive to changes in demand but also fell relative to the general price level after 1923. Also, in the New York market the production of brick and tile did not decline to the low point reached in the remainder of the industry. In the controlled Chicago market where prices were stable, production fell off to a much larger extent. It is impossible to say what other factors affected the demand for brick in New York since it seems unlikely that the price of brick could be of major importance as a factor determining demand. It is more likely that building construction held up better in New York than elsewhere and hence that the consumption of brick, which assumes a higher proportion of the cost of building materials than in any other city, held up also. But it is likely, too, that the relatively lower price of brick in New York City may have had something to do with its greater use in that city.

The supply of labor since the war has, without doubt, created a problem that may have exerted a pressure toward technological

change. Much use was made of unskilled immigrant labor before the war, and when this source of supply dried up because of the war and later because of laws restricting immigration, Negroes were in many instances brought from the South to supply this lack. The scarcity of unskilled labor evidently raised the cost of labor and made advantageous the introduction of more labor-saving machinery. In the Chicago area where the hourly wages are the highest in the industry, the workers are strongly organized and control the hours and working conditions in the industry. The common-brick plants here are the most highly mechanized.

The high direct costs for labor and fuel in the brick and tile plants seem to be the limiting factors in the supply of the products and place a limit upon any decline in price. A fall in price tends to result in plants shutting down production. Under competition the industry exhibits great elasticity of supply but relatively inelastic demand, with the result that fluctuations have tended to take place in the supply produced, and these have resulted in large fluctuations in employment in the industry. The practice of the industry to keep on hand large stocks of brick and tile equal to several months' shipments probably accentuates these fluctuations.

While the major cycles of production in structural clay products may be determined by the cycles in building activity, the relative amplitude of these cycles may be a function of the costs of production of brick and tile relative to other building materials. During the period of great activity in building after the war, it is likely that not only changes in architectural styles but also the high cost of brick relative to competing materials brought about the displacement of common brick by other building materials. The rapid rise in production costs as utilized capacity declines tends to prevent any great fall in price with a fall in demand. Hence any stimulation to consumption which might come with the lowered cost is prevented from bringing about any great degree of recovery in the industry.

Prices in the industry are more stable than production, reflecting the relative inelasticity of demand and elasticity of supply which operate drastically when prices fall below the cost of production. The effect of a controlled price in this situation is to accentuate the fluctuations in production which come about with the falling off in demand.

Any adequate solution of the problem of instability of employment in the industry is bound up with the problem of stabilization of construction activity, although minor adjustments may be brought about by improving the competitive advantage of structural clay products over other construction materials. One of the means advocated for this purpose has been the reduction of the cost of labor, which will be considered in chapter IV in the discussion of the relation of changes in productivity to changes in employment.

CHAPTER IV

CHANGING UNIT LABOR REQUIREMENTS AS A FACTOR AFFECTING THE VOLUME OF EMPLOYMENT

TECHNOLOGICAL CHANGES¹

In considering mechanization as a factor influencing the employment of labor in the industry, it is desirable to distinguish between the types of technological change. There may first be considered the fundamental changes in production technique in which the major steps in the production process were converted to a mechanical basis, thus directly increasing the productivity of labor. Second, there may be noted the refinement and improvement of existing equipment and the addition of auxiliary equipment to the principal production units, bringing about improvement in the quality of production and savings in cost of materials, while for the most part only indirectly increasing the productivity of labor.

An examination of the technological history of the brick industry indicates that mechanization of the fundamental production processes was virtually complete by 1920. The changes since that date have consisted of an extension in the use of the machines developed for the mechanical performance of the principal productive operations, their refinement and improvement, and the addition of auxiliary equipment to these machines.

The Seventies and Eighties

Before 1870 there was comparatively little mechanization in the brick plants. The brick machines for both the soft-mud and the stiff-mud processes had been successfully developed in the previous decade; crushers, grinders, and pugmills for preparing and tempering the clay, the mechanical conveyance of the clay in the machine house, and the use of steam for power had all been introduced; artificial drying and the continuous kiln were

¹Based on a report in preparation by Alfred J. Van Tassel and David W. Bluestone on Mechanization in the Brick Industry. This is one of a series of studies conducted by the "Studies in Equipment Changes and Industrial Techniques" section of the WPA National Research Project designed to cover mechanization trends in the industries in which field surveys were made by the "Studies of Productivity and Employment in Selected Industries" section. Source materials include data obtained in an NRP field survey of machinery and equipment manufacturers, data on mechanization obtained in the NRP-NBER field surveys of selected industries, and data from various secondary sources.

known. However, since most of the plants still used the hand processes of manufacture and a simple type of kiln, little displacement of labor by machines had occurred. These changes, nevertheless, set the stage for the development of a mechanized brick industry during the two following decades. The large, centralized plant and specialization of products appeared. Production was increased 50 percent in the seventies and was more than doubled in the eighties.

However, the adoption of the new and more productive machines and methods was inhibited by the abundance of cheap, unskilled labor. Therefore a large number of plants still adhered to older methods employing hand labor. The labor-saving equipment which had been developed was not widely used. Brick setting, the process requiring the most time and skilled labor, was still done by hand. The other heavy labor operations, especially quarrying, were not yet mechanized. Steam power was introduced but was not generally used. The brickworks was still largely a yard rather than a plant, and the number of men employed in yard operations was just as large as before mechanization had taken place. But the mechanization of the clay-preparation and brick-molding operations was the important factor in the 40-percent increase in productivity which took place during the eighties.

1900 to 1920

The depression which extended through the decade of the nineties was followed in the 1900's by another period of rapid technological change, resulting in a great increase in productive capacity. During this decade the use of mechanical equipment became more general, and steam or electric power almost completely supplanted more primitive forms. Clay-pit operations that had formerly been performed by means of picks, shovels, and wheelbarrows began to be mechanized with the introduction of drills and blasting material, horse-drawn cars on rails, and steam shovels. In an increasing number of instances cable and locomotive haulage replaced animal power in the transportation of the clay from the pit to the machine house. Open-air drying began to give way rapidly to artificial drying in heated driers. Brick were hauled from the molding machine to cars which were pushed on rails to the drier and from the drier to the kiln, thus eliminating a separate handling of the brick in the drying process. More attention began to be paid to proper kiln design in an attempt to

reduce fuel costs, and the continuous-burning method was employed in some of the larger plants. In this process kilns were fired in succession and were connected by flues in such a way as to preheat the freshly set brick by means of the heat from the cooling brick.

Between 1900 and 1910 electric power began to replace steam power, with results scarcely less significant than those associated with the introduction of steam during the nineteenth century. Besides reducing the labor associated with power generation, the use of electric power facilitated the introduction of self-propelled transfer cars for the transportation of drier cars from the machine house. This was followed in 1911 by the introduction of a brick-setting machine which in one operation picked up an entire load of about 1,000 bricks and set them in place.

The widespread introduction of this equipment in the plants of the Chicago area in 1911 resulted in a revolutionary reduction in the labor associated with the setting and unloading of kilns. In three plants covered in the NRP-NBER field survey, each installing two cranes, the labor reductions averaged 58 percent. In one case the number of men required per shift was reduced from 48 to 22, in another from 48 to 20, and in a third from 36 to 14. Conveyors which carried pallets of green brick from the soft-mud machine to the drier had a similar though much less pronounced effect on the labor requirements in soft-mud plants.

By 1920 the most advanced plants of the brick industry operated on a highly mechanized basis. Nevertheless, in the smaller plants there was still an extensive use of hand labor. Mechanization was retarded by the abundance of cheap labor up to the period of the war and by a decreased demand for brick as a result of the competition of cement and lumber. Any mechanization that took place in smaller plants was the initial mechanization of the actual brickmaking machine; mechanization in the larger plants took place in the clay pit, in interprocess handling, and in the burning, drying, and power departments, i. e., in processes that demanded speeding up to keep pace with already mechanized processes. During the decade 1899-1909 this increasing mechanization was reflected in a great increase in production with only a slight increase in man-hours, productivity increasing approximately 29 percent. This is the first important displacement of labor associated with technological changes. From 1909 to

1919 the depressed condition of the industry prevented the potential labor savings associated with the introduction of handling equipment and other machinery from having their full effect; consequently, there was little change in productivity in the industry as a whole.

The Twenties and Thirties

The years since 1920 have been characterized principally by an extension to the more backward plants of the techniques and equipment which had been employed in advanced plants prior to 1920. Also notable has been the continual process of improvement and refinement and the addition of relatively inexpensive auxiliary equipment to the principal production units.

The increasing demand for machinery during the period 1920-26 is shown in table 20, which gives the value of the sales of brick and tile machinery by eight manufacturers of this equipment. Sales rose from 1920 to a peak in 1923 and then held a fairly high level until 1926. After a decline in the next year, sales recovered somewhat until 1929 and dropped rapidly thereafter. Machinery sales in 1932 amounted to less than 9 percent of the sales in 1923. The recovery from 1932 to 1936 was sufficient to increase the volume of sales to over three times the 1932

Table 20. - SALES OF MACHINERY TO THE BRICK AND TILE INDUSTRY, 1920-36

| Year | Sales | | Year | Sales | |
|------|-----------------------------------|------------------|------|-----------------------------------|------------------|
| | Thousands of dollars ^a | Index (1920=100) | | Thousands of dollars ^a | Index (1920=100) |
| 1920 | 1,389 | 100 | 1929 | 1,651 | 119 |
| 1921 | 1,197 | 86 | 1930 | 903 | 65 |
| 1922 | 1,771 | 128 | 1931 | 561 | 40 |
| 1923 | 2,208 | 159 | 1932 | 193 | 14 |
| 1924 | 1,776 | 128 | 1933 | 229 | 16 |
| 1925 | 1,942 | 140 | 1934 | 324 | 23 |
| 1926 | 2,040 | 147 | 1935 | 420 | 30 |
| 1927 | 1,462 | 105 | 1936 | 627 | 45 |
| 1928 | 1,569 | 113 | | | |

^aBased on a survey of eight identical plants manufacturing brick and tile machinery, representing 30 to 40 percent of value of output of all clay-working machinery (including pottery and other clay products). The survey was conducted by the "Studies in Equipment Changes and Industrial Techniques" section of the WPA National Research Project.

level, but sales were still only 28 percent of the 1923 level. It is evident that the greatest advances in mechanization in the years covered by these data were made during the years of increasing production up to 1925 and in the years of sustained production at a high level from 1925 to 1929.

That a large part of the sales prior to 1925 was associated with the rehabilitation of old plants is revealed by a separation of the sales of machinery into new machinery and repairs (table 21). During the period for which data are available - 1922-36 - repairs are an important part of the total sales, ranging from 60 percent in the first 3 years to 40 percent in the last 3 and amounting to nearly half of the total sales in the period 1924-30. The large absolute amount of such sales in the years 1922-26 indicates the return to full operation of many plants which had been idle during the previous years of inactivity in the industry.

Table 21.- SALES OF NEW MACHINERY AND REPAIRS TO THE BRICK AND TILE INDUSTRY, 1922-36^a

(Thousands of dollars)

| Year | Total | New machinery | Repairs | 3-year ratio of new machinery to total |
|------|-------|---------------|---------|--|
| 1922 | 767 | 253 | 514 | } 0.419 |
| 1923 | 959 | 404 | 555 | |
| 1924 | 858 | 426 | 433 | |
| 1925 | 941 | 485 | 456 | } .532 |
| 1926 | 985 | 543 | 442 | |
| 1927 | 807 | 426 | 381 | |
| 1928 | 767 | 394 | 372 | } .514 |
| 1929 | 846 | 458 | 388 | |
| 1930 | 460 | 213 | 247 | |
| 1931 | 346 | 195 | 151 | } .563 |
| 1932 | 102 | 49 | 53 | |
| 1933 | 137 | 85 | 51 | |
| 1934 | 226 | 146 | 81 | } .618 |
| 1935 | 293 | 182 | 110 | |
| 1936 | 475 | 286 | 189 | |

^aBased on a survey of three identical plants manufacturing brick and tile machinery. The survey was conducted by the "Studies in Equipment Changes and Industrial Techniques" section of the WPA National Research Project.

The substantial amounts of new machinery sold during the earlier years reflect both the demand for increased capacity and the need for reduction of labor costs. The autobrick machine installed in many of the larger soft-mud plants accomplished both of these ends. It performed mechanically the work of sanding the mold, striking off the excess clay, and bumping the mold to loosen the formed clay, so that the labor associated with its operation was about 50 percent of that required by the non-automatic equipment and output was roughly doubled. The sale of 130 of these automatic machines between 1921 and 1936 greatly lessened the labor cost in a large number of plants. Ninety percent of these machines were installed in 1921-28.

In the larger plants also a great saving of labor occurred with the mechanization of the handling operations involved in the transfer of the brick throughout the plant. Instances of the replacement of hand-operated cutters by automatic cutters and the installation of automatic devices for conveying the green brick from the brick machine through the drier to the kiln were often noted in the field reports of the NRP-NBER survey.

By the use of automatic setting and loading machines a tremendous saving in the labor occurred. In one plant, 1 skilled operator and 12 men using automatic equipment did the work of 30 skilled setters. Improved mechanical methods of drawing, loading, and conveying the finished product from kiln to storage to shipping point by belt conveyors, cranes, and electric trucks - instead of the wheelbarrows commonly used in 1920 - slashed another of the greatest labor-cost items. The electric belt conveyors carrying brick from kiln to railroad cars cut in half the labor cost for that operation. The new methods of sorting, storage, and handling saved one-third on hand labor where they were installed. Many plants in the Chicago area had mechanized most of these handling processes by 1911; other plants in this vicinity and in the Hudson River district, not until the twenties. In the Hudson River district, the largest soft-mud brick-manufacturing center, a highly mechanized process dispensed with almost all manual labor in one of the largest plants. The introduction of the unit container, of cranes, of forks with electrically operated fingers, and of trucks with detachable bodies meant that 3,000 brick could be loaded by hand (the only manual handling necessary) in a unit container in the kiln, swung by crane to freight car, barge, or truck, and the whole deposited at the job, still in

the same unit container. This cut the labor cost from \$6.25 per 1,000 brick for hand loading to \$2.50 for mechanical loading, and the labor force from 350 men in 1901 to 140 men in 1923.² In another Hudson River plant there was a decline from 14.6 man-hours per 1,000 brick in 1919 to 6.0 in 1930, but 1919 was a low-capacity year. A fairer picture is the change from 10.3 man-hours per 1,000 brick in 1920, operating at 24-percent capacity, to 6.0 in 1930, operating at 28-percent capacity. This marked increase in productivity followed extensive mechanization in 1919 and succeeding years, including installation of autobrick machines, automatic conveying and storing devices, tunnel driers, and scove kilns with automatic setting and loading equipment.

Likewise of great importance in reducing labor costs was the extension of mechanical methods in the quarry. A survey of common-brick plants in 1922³ showed that 27 percent of the plants operated without the use of mechanical excavating equipment. The large sales of excavating equipment to the brick and tile industry during the 1920's (table 22) appear to have reflected the extension of mechanical methods to the bulk of the remaining unmechanized plants, for subsequent surveys in 1927 and 1936⁴ indicated that only a very small percentage of the plants operated without the aid of mechanical equipment in those years. The significance of this extension in mechanical methods is indicated by the fact that plants covered in the 1936 survey reported labor reductions of from 40 to 90 percent as a result of this change.

One of the striking improvements in excavating machinery has been the introduction of internal-combustion and electric motors for power shovels. This shift in power has been productive of economies in labor costs through the elimination of the work associated with the firing of the steam-power shovels. The extent of this shift is indicated by the fact that 93 percent of the shovels used in common-brick plants surveyed in 1922⁵ used steam power, while only 59 percent⁶ of those employed in plants surveyed in 1927 and 48 percent of those employed in plants surveyed in 1936 were so powered. The introduction of the crawler

²*A Revelation on the Hudson River, "Brick and Clay Record", 63, No. 4 (Aug. 21, 1923), 262.

³William F. Kirk, *Productivity Costs in Common-Brick Industry* (U. S. Dept. Labor, Bur. Labor Statistics, Bull. No. 356, Oct. 1924), pp. 51-2.

⁴*Clay Pit and Mine Methods, "Brick and Clay Record", 70, No. 13 (June 21, 1927), 1002-25; and NRP-NBER field survey, 1936.

⁵Kirk, *op. cit.*, p. 51.

⁶*Clay Pit and Mine Methods, " p. 1011.

Table 22. - SALES OF EXCAVATING EQUIPMENT TO THE BRICK AND TILE INDUSTRY, 1920-35^a

| Year | Power shovels and locomotive cranes | | Year | Power shovels and locomotive cranes | |
|------|-------------------------------------|------------------------------|------|-------------------------------------|------------------------------|
| | Number of units | Value (thousands of dollars) | | Number of units | Value (thousands of dollars) |
| 1920 | 45 | 650 | 1929 | 18 | 308 |
| 1921 | 11 | 146 | 1930 | 5 | 83 |
| 1922 | 28 | 409 | 1931 | 5 | 82 |
| 1923 | 39 | 577 | 1932 | 0 | 0 |
| 1924 | 37 | 568 | 1933 | 1 | 19 |
| 1925 | 28 | 532 | 1934 | 1 | 13 |
| 1926 | 28 | 413 | 1935 | 2 | 32 |
| 1927 | 22 | 329 | 1936 | 2 | 47 |
| 1928 | 14 | 232 | | | |

^aBased on a survey of three identical plants manufacturing excavating equipment. The survey was conducted by the "Studies in Equipment Changes and Industrial Techniques" section of the WPA National Research Project.

treads on power shovels in place of railway or traction wheels has eliminated the service of men formerly required for the laying of rails or mats.

One of the most important phases of technical advance was the increase in the use of electric power.⁷ Electric motors accounted for less than one-third of the total installed horsepower of the industry in 1919, but by 1929 they provided two-thirds of the total horsepower. Replacement of steam engines by electric motors effected a sharp reduction in labor costs associated with the maintenance of the clumsy and complicated mechanical transmission system required for steam power. Plant-labor productivity also was increased indirectly since the elimination of mechanical transmission permitted greater flexibility in plant lay-out.

Substitution of electric power for steam either reduced or eliminated the personnel associated with power generation by the centralization of power generated at the plant or the elimination of plant power generation through the purchase of electricity. A tendency to purchase electricity was evident throughout the period. The horsepower of electric motors driven by purchased energy increased from 79 percent of the total horsepower of all electric motors in 1919 to 93 percent in 1929.

⁷Material on type of power is based on data from the *Census of Manufactures*.

During the period prior to the 1925 production peak in the industry the emphasis was upon the expansion of production to meet increasing demand and at the same time to reduce labor cost; in the later years emphasis was on the reduction of all costs and the improvement of quality to meet the pressure of increased competition in the face of falling demand and declining prices. Both types of change are usually accompanied by increased labor productivity. The introduction of de-airing equipment in the stiff-mud process in 1932 was the outstanding improvement during this period. De-airing equipment attached to the auger removed occluded gases from the clay, resulting in the production of a stronger, denser brick which was less likely to suffer breakage or lamination; consequently, the number of marketable brick per 1,000 burned was generally increased in plants employing de-airing equipment. Indirectly, therefore, the introduction of de-airing equipment frequently brought an increase in labor productivity as well as an improvement in the quality of the product. Recognition of the advantages of de-airing is indicated by the almost geometric rapidity with which the sales of this equipment increased after its introduction in 1932. Sales of such equipment to stiff-mud plants by two companies manufacturing machine-house equipment amounted to \$18,000 in 1932, \$48,000 in 1933, \$41,000 in 1934, \$141,000 in 1935, and \$154,000 in 1936.⁸ De-airing equipment accounted for 80 to 90 percent of the sales of all machine-house equipment in the years 1933-36.

In the drying and burning departments much attention has been given to the problems of improving the quality of the brick by more precise methods of temperature and humidity control and of more efficient use of fuel. These changes have increased the productivity of labor in many cases by decreasing the waste due to improper burning and therefore increasing the proportion of first-class products, or by reducing the time required for burning.

In the drying department there was a significant reduction in drying time through the more widespread use of artificial drying; 20 percent of the common-brick plants surveyed in 1922⁹ employed open-air drying, while all of the plants included in the 1936 survey employed artificial drying. Similarly, there was

⁸Based on a survey conducted by the "Studies in Equipment Changes and Industrial Techniques" section of the WPA National Research Project.

⁹Kirk, *op. cit.*, p. 55.

an extension in the use of tunnel kilns, the number increasing from 3 in 1915 to 23 in 1926 burning heavy clay products.¹⁰

The drying and burning departments have been the center of the most widespread introduction of auxiliary equipment involving relatively small capital investments. Induced-draft fans, which speed up the drying process, were installed in a large number of plants during the 1920's; by 1936, 65 percent of the stiff-mud plants covered in the survey were equipped with such fans. The use of these fans has also been associated with the development of waste-heat drying in which the heat from the cooling brick in the kilns replaces heat obtained from the combustion of additional fuel. The increased use of waste-heat drying during the 1920's is indicated by the fact that only 15 of the 39 stiff-mud common-brick plants surveyed in 1922¹¹ employed waste heat, while 17 of the 22 stiff-mud plants reporting on the type of heat employed in 1936 indicated the use of waste-heat drying.

Forced-draft fans have also played an important part in increasing the fuel efficiency of the burning department and have both reduced burning time and increased daily output of kilns. Portable blowers, forcing a current of cold air over the cooling bricks, have cut cooling time by 1 to 2 days in a number of instances.¹²

Instruments for measuring and recording temperature and humidity have been used in the drying department of a few plants and in the burning department of a considerable number. Pyrometers, which aid the operator in the control of kiln temperature, were employed in one-third of the plants surveyed in 1936.

The use of pulverized coal and of the mechanical stoker, as well as the substitution of oil or gas for coal in the firing of kilns, has produced a saving in firing labor. In 1927 it was estimated that about one-half of all the country's common-brick production was burned with oil, although coal was still employed at 72 percent of the plants, oil at 18 percent, and natural and producers' gas at 10 percent of the plants.¹³ This

¹⁰Clay Products Cyclopedia and Equipment Catalog, 1926 (3d ed.; Chicago: Industrial Publications, Inc., Jan. 1, 1928), p. 160.

¹¹Kirk, *loc. cit.*

¹²Fans - and Fan Practice in Clay Industry, "Brick and Clay Record", 75, NO. 5 (AUG. 27, 1929), 278-89. "A Romance in Industry," *Brick and Clay Record*, 62, NO. 11 (MAY 29, 1923), 959. "100,000,000 Face Brick Annually," *Brick and Clay Record*, 63, NO. 4 (AUG. 21, 1923), 254.

¹³Fuel in Clay Industry, "Brick and Clay Record", 70, NO. 7 (MAR. 29, 1927), 535, 540.

indicates that the savings associated with the use of these fuels have been limited principally to the larger plants.

The effects of all these technological changes on the labor requirements in the industry during the period 1919-25 are shown in figure 1 by the relatively small increase in man-hours and wage earners as compared with the great increase in production. The extension of mechanized equipment to unmechanized portions of the industry and the achievement of a completely mechanized process for the soft-mud plants comparable to that already achieved in the stiff-mud sector of the industry were probably major factors in a 43-percent increase of productivity from 1919 to 1929 as compared with a 29-percent increase for the first decade of the century. The ensuing depression, however, obscured the effects upon productivity of such changes as took place after 1929.

THE SAMPLE USED FOR THE STUDY OF INDIVIDUAL PLANTS

From a study of census data it has been possible to ascertain certain facts about the brick and tile industry in the United States, about the industry in different regions, and about parts of the industry. From periodic census reports on employment, production, and value of products, it has been possible to obtain a statistical picture of the behavior of the industry considered as a whole. In order to know why the industry behaves as it does, information is needed in regard to how the individual units, or plants, behave. This may enable one to give answers to such questions as the following: Do the large or the small plants tend to be more responsible for instability of employment? Does the industry become more efficient through new plants coming in, through old plants dropping out, or through improvement of plants already existing? The answer to such questions may throw light on whether stability in numbers employed reflects real stability of employment or displacement of employment in some plants and absorption in others and as to how and why the productivity of the industry changes.

Since most of the plants in the industry are small, considerations of time and expense made it necessary to restrict the survey to a smaller sample than would be necessary to give a proportionate representation to the smaller plants and to all areas. A total of 108 plants was surveyed by the National Research Project in

cooperation with the National Bureau of Economic Research.¹⁴ Only 83¹⁵ of these are satisfactory for inclusion in the sample used for statistical analysis of labor requirements; the remaining plants have, however, been used in other analyses and in treatment of other aspects of the industry. The years 1917-35 have been chosen as the period for this statistical analysis since the plants reporting man-hours and production previous to that time are too few to represent even a small sample.

Of the 22 reports on plants which have not been included in the statistical analysis of labor requirements, 2 are special engineering reports which furnish information on technological changes, supplementing that in the other reports; 17, while valuable for purposes of general information, have no satisfactory data on production and man-hours, in some cases because the problem of a satisfactory measure of production has proved insurmountable; and 3 are from plants which have not been operating since 1916.

The largest number included in the sample as operating in any given census year was 68 in 1929.¹⁶ It must be remembered, however, that the plants not operating in 1929 and in the depression years following are in reality a part of the sample and furnish information as to the behavior of the individual plants in the industry, showing what types of plants closed down during depression and giving information on causes of changes in unit labor requirements. Tables 23 and 24 present a summary of the sample data showing the changing size of the sample from 1919 to 1935 and giving information in regard to certain of its characteristics relative to the universe. Since the census data include only operating plants, all comparisons with census data are necessarily restricted to data from operating plants.¹⁷

In 1935 the 64 operating plants constituted 9.0 percent of the brick and tile plants in the United States; they produced 13.2 percent of the brick and tile in the industry and utilized 11.6 percent of the man-hours. The production per establishment

¹⁴This includes a number of plants previously surveyed by the National Bureau of Economic Research. See Introduction.

¹⁵Three other plants, in which the problem of measurement of production in units comparable with other plants has proved insurmountable, have been included in the analysis of year-to-year changes of individual plants but excluded from all aggregates of man-hours and production.

¹⁶Two sand-lime plants are excluded since sand-lime brick is included under a separate classification in the census.

¹⁷For further information on the analysis of the sample see tables A-1 to A-11 and appendix B, section on "The Sample Analysis."

**Table 23.- ANALYSIS OF SAMPLE OF BRICK AND TILE PLANTS:
TOTAL PRODUCTION AND MAN-HOURS, 1919-35^a**

| Year | Common-brick equivalents (millions) | | | Man-hours (thousands) | | |
|------|--|-----------------------|-------------------------------------|--------------------------|-----------------------|-------------------------------------|
| | Sample | Universe ^b | Sample as percent of universe | Sample | Universe ^b | Sample as percent of universe |
| 1919 | 337 | 9,155 | 3.7 | 2,374 | 115,162 | 2.1 |
| 1921 | 296 | 8,752 | 3.4 | 2,335 | 100,838 | 2.3 |
| 1923 | 1,006 | 14,275 | 7.0 | 7,007 | 142,911 | 4.9 |
| 1925 | 1,263 | 15,388 | 8.2 | 7,730 | 138,275 | 5.6 |
| 1927 | 1,251 | 14,708 | 8.5 | 9,759 | 128,375 | 7.6 |
| 1929 | 1,270 | 12,581 | 10.1 | 10,450 | 110,351 | 9.5 |
| 1931 | 566 | 5,429 | 10.4 | 5,242 | n.a. | - |
| 1933 | 246 | 2,035 | 12.1 | 2,327 | 18,791 | 12.4 |
| 1935 | 454 | 3,426 | 13.2 | 3,856 | 33,133 | 11.6 |

^aData for universe from *Census of Manufactures*.

^cTable 4, cols. (1) and (5).

n.a. Data not available.

**Table 24.- ANALYSIS OF SAMPLE OF BRICK AND TILE PLANTS:
NUMBER OF ESTABLISHMENTS OPERATING AND PRODUCTION
AND MAN-HOURS PER ESTABLISHMENT, 1925-35^a**

| Item | 1925 | 1927 | 1929 | 1935 |
|--|-------|-------|-------|------|
| Number of establishments | | | | |
| Sample | 36 | 52 | 68 | 64 |
| Universe | 1,528 | 1,395 | 1,307 | 708 |
| Sample as percent of universe | 2.4 | 3.7 | 5.2 | 9.0 |
| Common-brick equivalents (millions) produced per establishment | | | | |
| Sample | 35 | 24 | 19 | 7 |
| Universe | 10 | 11 | 10 | 5 |
| Ratio of sample to universe | 3.5 | 2.3 | 1.9 | 1.5 |
| Man-hours (thousands) per establishment | | | | |
| Sample | 215 | 188 | 154 | 60 |
| Universe | 90 | 93 | 85 | 46 |
| Ratio of sample to universe | 2.4 | 2.0 | 1.8 | 1.3 |

^aBased on table A-11. Figures refer to establishments whose major product is one of the five specified products of the brick and tile industry.

in the sample was 1.5 times the average in the United States, while the labor utilized per establishment was only 1.3 times the average. The sample is evidently composed of plants larger than the average both in respect to production and utilization of labor; also the productivity of the plants is somewhat higher than the average, since the percentage utilization of labor is somewhat less than the percentage of production.

During the period covered by the survey, the sample of operating plants increases in relation to the universe, and the representative character improves. This is to be expected since any sample selected as representative in 1935 would tend to be less so in 1925, especially when it is remembered that more than 50 percent of the establishments operating in the industry in 1925 were closed in 1935 and that therefore few of them could be included in the sample. Moreover, the sample as selected was overweighted with large plants which were not operating in 1935 but were operating in 1925, and during the period after 1925 it was increased by the inclusion of a number of small- and medium-size plants for which data were not available in 1925. These factors all combined so to improve the representative character of the sample that, whereas the productivity of the operating plants in the sample was approximately 45 percent greater than that of the universe in 1925, it was only 14 percent greater in 1935, and in 1933 the two exhibited approximately the same level of productivity. Moreover, whereas in 1925 the average size of the operating establishments in the sample was 2.4 times the average for the United States if measured in man-hours and 3.5 times the average if measured by production, by 1935 the sample had so improved that the size was only 1.3 times the average for the United States if measured in man-hours and 1.5 times if measured by production. These facts must be taken into consideration when trends in the sample data are noted, since these trends may be due to the trend in the representativeness of the sample.

The year 1929 has been chosen for an examination of the sample in respect to its several products and to the regional break-down, since it is the year in which there is the largest number of operating plants. In this year the establishments in the sample were only 5.2 percent of the brick and tile plants in the United States, but they produced 10.1 percent of the total output and

utilized 9.1 percent of the total man-hours. The average production per establishment was twice as great as the average for the industry as a whole, and the average establishment employed 1.7 percent as much labor as the average in the industry.

The sample of common brick, which covers 12.6 percent of the production in the United States, is more widely distributed throughout the various States than the sample for the other products, but this is also characteristic of the universe.¹⁶ The plants in the sample in the Illinois region produced almost one-third of the common brick for that region; in Pennsylvania 19 percent of the production is covered; but the important New York and New Jersey region is represented by only 6.6 percent of its total production.

**Table 25.- INDEXES OF PRODUCTION OF BRICK AND TILE
IN THE UNITED STATES AND IN SAMPLE PLANTS
1919-35**

| Year | Production in United States | | Chain index of production in sample plants ^b (1929=100) |
|------|---|---------------------|---|
| | Millions of common-brick equivalents ^a | Index (1929=100) | |
| 1919 | 9,155 | 72.8 | 68.1 |
| 1920 | 9,322 | 74.1 | 85.1 |
| 1921 | 8,752 | 69.6 | 47.7 |
| 1922 | 11,200 | 89.0 | 109.2 |
| 1923 | 14,275 | 113.5 | 131.7 |
| 1924 | 13,872 | 110.3 | 146.2 |
| 1925 | 15,388 | 122.3 | 151.3 |
| 1926 | 14,978 | 119.1 | 143.3 |
| 1927 | 14,708 | 116.9 | 132.0 |
| 1928 | 13,706 | 108.9 | 120.9 |
| 1929 | 12,581 | 100.0 | 100.0 |
| 1930 | 8,832 | 70.2 | 69.7 |
| 1931 | 5,429 | 43.2 | 39.3 |
| 1932 | 2,458 | 19.5 | 22.5 |
| 1933 | 2,035 | 16.2 | 17.6 |
| 1934 | 2,313 | 18.4 | 21.9 |
| 1935 | 3,426 | 27.2 | 27.5 |

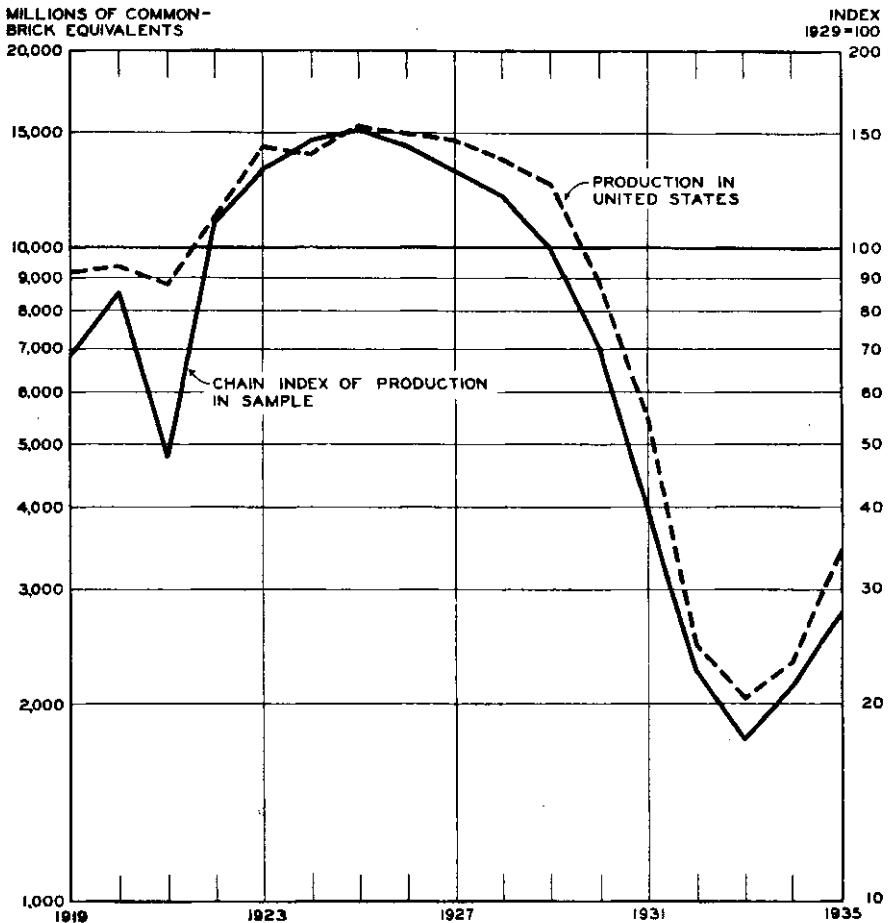
^aTable A-13, col. (1).

^bTable A-19, col. (2).

¹⁶See table A-1.

Figure 15.- PRODUCTION OF BRICK AND TILE IN THE UNITED STATES AND IN SAMPLE PLANTS, 1918-36

(Ratio scale)



Based on table 25

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Vitrified brick is so concentrated in large plants that it was possible to get a sample of 21.8 percent of the production in the United States. All of the four important regions, except Kansas, are well represented.¹⁹

The sample for face brick is inadequate, covering only 8.0 percent of the production in the United States. Pennsylvania and Ohio, the largest producers of face brick, are represented by a sample covering only 5.8 percent and 6.9 percent respectively

¹⁹See table A-3.

of the production of these States, while the region including Illinois and Indiana is represented by a 20.3-percent coverage.²⁰

Hollow building tile, like face brick, has inadequate representation, with the exception of the Illinois region which has a 20.9-percent coverage and the region of the western plains which has a 13.7-percent coverage. The first of these probably supplies the Chicago market while the other may supply the agricultural demand of the western States. The important Ohio production is practically unsampled. The sample covers 6.6 percent of the national production.²¹

Of the four important States producing drain tile, only Iowa is well represented, and the plants in the sample account for only 5.2 percent of the national production.²²

The sample for the industry as a whole may be said to be reasonably good from 1928 through 1935. The Illinois-Indiana district, serving the Chicago market, is adequately represented, with Pennsylvania and the New York region less so. The serious gap in the sample, however, is in Ohio, the most important region in the United States when all products are considered.²³

An examination of figure 15 and table 25 will give an idea of how adequately the fluctuations in production in the United States are represented by the changes in production in the sample plants. The production index for the sample is based on a changing number of plants. The change in production for any one year over the preceding year was computed by finding the percentage increase in production for all the plants for which data were available for both years. Using 1929 as a base, the production index was computed by chaining together these percentage links.

From 1916 to 1919 the percentage change was based on a sample of 8 plants or less, but beginning with the index number for 1920, the number of plants represented was 22 or greater.²⁴ Unfortunately, the sample in 1921 was heavily weighted with a group of plants whose fluctuations in production have been greater than the average for the United States. From 1921 to 1925 the rise in production in the sample was relatively greater than in the universe, and from 1925 to 1931 the fall was greater. In

²⁰See table A-2.

²¹See table A-4.

²²See table A-5.

²³For discussion of the differences between geographical regions see pp. 122-4.

²⁴See table A-19.

other words, the changes in production in the sample were greater than the corresponding changes in the United States as a whole. This must be considered in the use of sample data as representative of the universe.

Figure 16 and table 26 present the relation of changes in the man-hours in the sample to those in the universe. Care must be taken in interpreting these figures, since the man-hours for the universe were estimated from inadequate data; especially is this true of 1919 and 1923.²⁵ Man-hours in the sample and in the universe rose relatively less than production from 1921 to 1925 and fell less after 1925 (figures 15 and 16). From 1921 to 1925 the man-hours in the sample rose more rapidly than in the universe, and from 1925 to 1929 the man-hours in the sample declined more rapidly than in the universe, doubtless because of a greater decline in production; but between 1929 and 1933 there was a greater relative decline in the man-hours in the universe, indicating a greater tendency toward increased productivity in the universe than in the sample, or less tendency toward decreased productivity. This is partly due to the large number of small plants in the universe which ceased operation between 1929 and 1933, but a more important factor is that 11 of the largest plants

Table 26.- INDEXES OF MAN-HOURS USED IN PRODUCTION OF BRICK AND TILE IN THE UNITED STATES AND IN SAMPLE PLANTS, 1919-35

| Year | Man-hours in United States | | Chain index of man-hours in sample plants ^b (1929=100) |
|------|----------------------------|------------------|---|
| | Thousands ^a | Index (1929=100) | |
| 1919 | 115,162 | 104.4 | 69.4 |
| 1921 | 100,838 | 91.4 | 55.5 |
| 1923 | 142,911 | 129.5 | 123.3 |
| 1925 | 138,275 | 125.3 | 136.2 |
| 1927 | 128,375 | 116.3 | 120.7 |
| 1929 | 110,351 | 100.0 | 100.0 |
| 1931 | n. a. | - | 44.6 |
| 1933 | 18,791 | 17.0 | 19.3 |
| 1935 | 33,133 | 30.0 | 31.2 |

^aTable 4, col. (5).

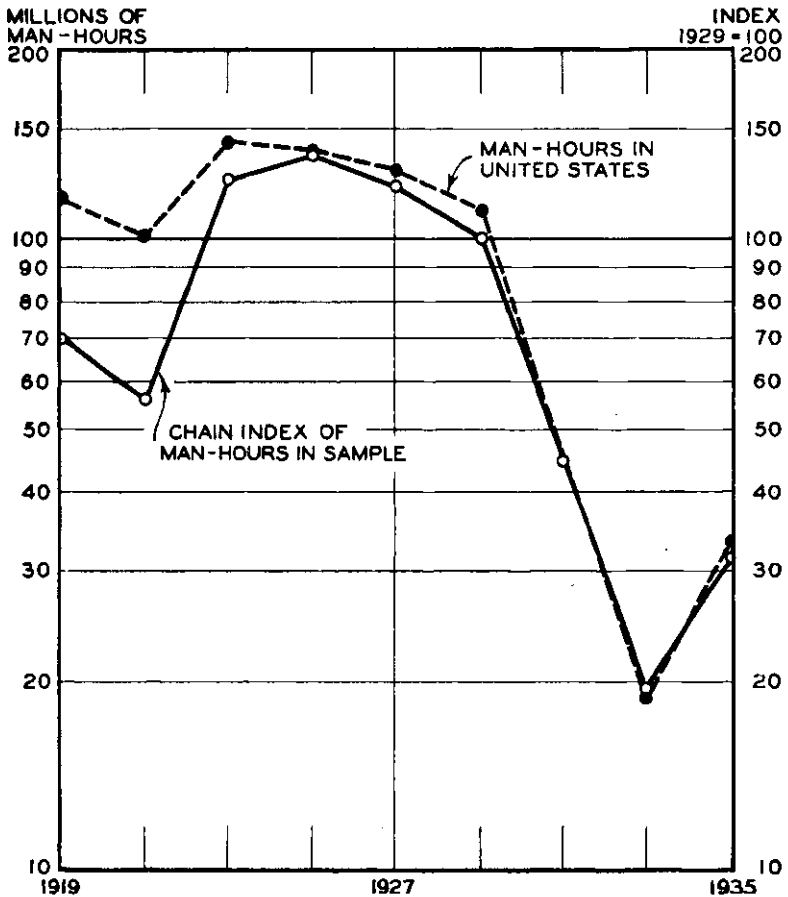
^bTable A-19, col. (3).

n. a. Data not available.

²⁵See appendix B, section on "Estimated Employment and Man-hours in Brick and Tile Manufacturing."

Figure 18. - MAN-HOURS USED IN PRODUCTION OF BRICK AND TILE IN THE UNITED STATES AND IN SAMPLE PLANTS, 1919-35

(Ratio scale)



Based on table 26

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in the sample were not operating in 1933. These facts will be considered later in connection with the analysis of changes in the man-hour ratios in the sample.

STATISTICAL PROBLEMS OF MEASUREMENT

Man-hour Ratio

Productivity may be measured either by the number of units of a given product produced per man-hour or by the number of man-hours used in producing a unit of the product. For the purpose

of this study the number of man-hours per unit of product has seemed the preferable measure. This enables one to divide the vertical structure of the industry into its various segments and departments and to determine the man-hours per thousand brick for each segment and department. Since the denominator used is the same for all segments (that is, the number of bricks produced), the sum of the man-hour ratios equals the man-hour ratio for the whole of the vertical structure. As this study is concerned with the absorption and displacement of labor, the question that should be answered is: How many man-hours of labor are required, displaced, or absorbed? This type of measure is readily adaptable for that purpose.

To this measure has been given the name "man-hour ratio" or "man-hours per unit of product." Usually the term "man-hour ratio", with no qualifying phrase, is intended to refer to the man-hours of operating and indirect plant labor required to produce 1,000 common brick or common-brick equivalents. For other labor some qualifying word or phrase will be used to designate the type of labor or the part of the industry in which the labor is used, such as office man-hours and man-hours per thousand brick in the machinery industry.

Problem of Comparability

One of the most difficult problems in the measurement of productivity is that of determining a unit of measurement of production which is applicable to all the products of the industry. When the study was originally undertaken, it was hoped that it might be limited to plants producing only brick, but when it was found that this limitation would necessarily and perhaps rather arbitrarily exclude a large part of the industry, it was decided to include also the other products made in brick plants.

In an analysis of the field data two problems of comparability presented themselves. First, there was the problem of internal comparability, that is, of converting all products within one plant into some common base unit; and second, there was the problem of external comparability, that is, of converting the products of all plants into some one base unit. The first problem was met by the selection of some base product for each plant and the estimation of the ratio of the labor time required to make each product to the labor time required to make the base product. Each

output figure was multiplied by its appropriate ratio, and the total of these converted figures was thus expressed in terms of the base unit. Since it was usually impossible to isolate the labor time associated with any one product, in some departments, such as clay mining, it was allocated on the basis of the weight of the clay consumed in the products produced; in other departments where handling was important, the number of units handled, as well as the weight, was considered in making the allocation of labor time; or if piece rates were available, they were used as a basis for estimates of labor time.

Since the product usually selected as the base product was the one produced in the greatest quantity in the plant, the problem of external comparability still remained. This was met by the use of conversion factors derived from the internal-comparability ratios and considered fairly typical of the industry. Inasmuch as most of the output had been converted into common-brick equivalents in the process of solving the problem of internal comparability, it was decided to treat all common-brick equivalents as directly comparable. For face brick the ratio of 1.25 was used, and for building tile the ratio varied according to the size and kind of tile used as the base product. This ratio for face brick is considerably lower than the ratio used for census data, probably because most of the face brick produced in the factories in the sample was produced in connection with common brick and differed from it less than the average.²⁶

Some plants made such a variety of tile products that it proved impossible to reduce them to any base product. Several produced 50 or more different kinds of brick and tile. Others made very specialized types of tile, producing comparatively few of any one kind. In some of these cases it was possible to solve the problem of internal comparability and thus compute a man-hour ratio in terms of the base product within the plant, but it was found impossible to convert this product into common-brick equivalents. In these instances link relatives were computed showing the changes in the man-hour ratio from year to year, and these in turn were used in computing a chain index from the median link relatives. In all series involving aggregates of production, however, such plants had to be excluded.

²⁶For further details in regard to methods used, see appendix B, section on "Comparability or Conversion of Field-Study Production Data into Common-Brick Equivalents."

Indexes of Man-hour Ratios

Three types of indexes were used to measure year-to-year changes in the man-hour ratios: (1) Index of weighted means of man-hour ratios; (2) chain index of median link relatives; and (3) chain aggregative index.

When production and man-hours were available for an identical group of plants over a period of years, an average man-hour ratio for each year was computed by dividing total man-hours utilized by all the plants in the given year by the total production of these same plants. If the plants were not operating, they were considered as belonging to the group, but any man-hours expended were excluded as not properly utilized for production. To the average man-hour ratio was given the name "weighted mean of man-hour ratios" since it was equivalent to an arithmetic mean of individual plant ratios weighted by production. This series of yearly mean man-hour ratios, converted into an index by selecting some year as a base, gives a measure of the changes in the mean of the man-hour ratios for the group of plants over a period of years.

The sample includes a changing number of plants from year to year. In order to use these data to measure change, it is necessary to construct some sort of chain index. For this purpose the second and third types of indexes were used: (a) the chain index of median link relatives and (b) the chain aggregative index. For the chain index of median links, yearly link relatives were computed for each plant, measuring the percentage change in each ratio from the preceding year. These links for the individual plants were arrayed, and the median link was selected as representing the typical percentage change from the preceding year. Chained together, these median links give a measure of median year-to-year changes in the individual plants over the period of years in question. This index gives equal weight to all plants irrespective of the size of their production.

To measure changes in employment, however, it is necessary to have an index which weights the changes according to the amount produced in the individual plants. For this purpose weighted mean man-hour ratios were computed for identical groups of plants for each successive pair of years, the group being composed of all plants for which data were available for the 2 years in question. From the man-hour ratios of these paired groups, link

relatives were computed showing the changes in the man-hour ratio from one year to the next. These links were then chained to form an index to which was given the name of "chain aggregative index of man-hour ratios", since the links were based on man-hour ratios computed from aggregates of man-hours and production. To the extent that the year-to-year fluctuations in those sample plants for which data are available in both years are representative of the fluctuations in brick and tile plants in the United States, this index measures the changes in the ratio of the aggregate man-hours in all plants to the aggregate production. In other words, it is comparable to the series of man-hour ratios computed from census data for 1869-1935 (table 27 and figure 17). These various indexes will be found in table 29.

Table 27. - PRODUCTION, MAN-HOURS, AND MAN-HOUR RATIOS FOR BRICK AND TILE PRODUCED IN THE UNITED STATES, 1869-1935^a

| Year | Production ^b (millions of common-brick equivalents) | Man-hours | |
|------|---|------------------------|------------------------------|
| | | Thousands ^c | Per thousand common brick |
| | (1) | (2) | (3) |
| 1869 | 3,012 | 82,463 | 27.4 |
| 1879 | 4,505 | 110,304 | 24.5 |
| 1889 | 10,009 | 173,193 | 17.3 |
| 1899 | 10,603 | 173,836 | 16.4 |
| 1904 | 12,948 | 184,536 | 14.3 |
| 1909 | 15,738 | 199,214 | 12.7 |
| 1914 | 13,098 | 162,080 | 12.4 |
| 1919 | 9,155 | 115,162 | 12.6 |
| 1921 | 8,752 | 100,838 | 11.5 |
| 1923 | 14,275 | 142,911 | 10.0 |
| 1925 | 15,388 | 138,275 | 9.0 |
| 1927 | 14,708 | 128,375 | 8.7 |
| 1929 | 12,581 | 110,351 | 8.8 |
| 1933 | 2,035 | 18,791 | 9.2 |
| 1935 | 3,426 | 33,133 | 9.7 |

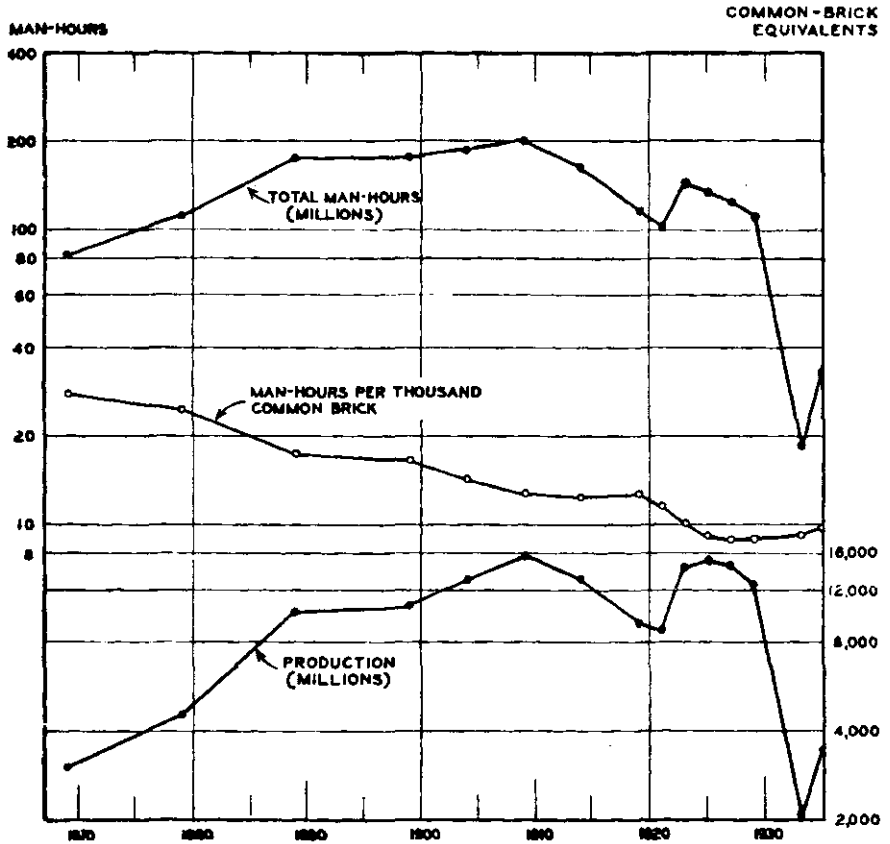
^aBased on Census of Manufactures data.

^bTable 4, col. (1).

^cTable 4, col. (5).

Figure 17.- PRODUCTION, MAN-HOURS, AND MAN-HOUR RATIOS FOR BRICK AND TILE PRODUCED IN THE UNITED STATES 1889-1935

(Ratio scale)



Based on table 27

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Capacity

Even from a superficial examination of man-hours and production in brick and tile plants it is evident that the man-hours per unit of product for any plant tend to fluctuate inversely with the amount produced. Consequently any study of the changes in man-hour ratios must take into consideration this factor. For this purpose a measure of the capacity which the plants actually attained in their months of highest production seemed better than some measure of rated capacity. Hence capacity of a plant was considered to be the total possible annual output based on the performance of the plants in peak months, allowance being

made for ordinary and usual interruptions and the assumption being made of a continuous demand, adequate fuel supply, and favorable labor and transportation conditions. Capacity was considered to remain constant from year to year, unless some additions were made to equipment and machinery increasing the capacity or unless the production series gave decided evidence indicating a trend in capacity.²⁷

Standard Man-hour Ratios

A comparison between plants for the purpose of relating various plant characteristics to differences in productivity requires some measure of productivity from which have been eliminated various fluctuations due to unusual conditions of operation of one or more plants in a given year. For this purpose it was necessary to select a man-hour ratio in which the factor of changes in utilized capacity of operation was minimized. An average was computed of the man-hour ratios for each plant for those years between 1925 and 1935 in which the capacity utilized was 70 to 89 percent. This average was called the standard man-hour ratio and has been used for comparison of the productivity of different plants. In cases where the plant did not attain this percentage of capacity within these years, adjustments were made in the average man-hour ratio at some attained capacity on the basis of observed relationship between the percentage of capacity utilized and changes in the man-hour ratio.²⁸

CHANGES IN MAN-HOUR RATIO FOR PLANT LABOR

Census Data for 1869-1935

The investigation of the relationship of changes in employment to changes in productivity should begin with a measurement of the changes which have taken place in the man-hours required to produce 1,000 brick over a period of time. Fortunately it has been possible to make an estimate of the total production of the industry and the man-hours utilized in this production in the brick and tile plants for census years since 1869.²⁹ These

²⁷For a description of the methods of estimating plant capacity, see appendix B, section on "Capacity of Brick and Tile Plants."

²⁸For further details in regard to the methods used, see appendix B, section on "Standard Man-hour Ratios."

²⁹For methods used in making these estimates and the limitations of the data used, see appendix B, sections on "Production and Average Value per Unit of Product", "Conversion of Census Production Data into Common-Brick Equivalents", and "Estimated Employment and Man-hours in Brick and Tile Manufacturing."

are presented in table 27 and figure 17, together with the man-hours utilized per thousand common-brick equivalents which were derived from these two series. From examination of the chart it is evident that the years 1879-89, years of great activity in building and of an increase of over 100 percent in production of brick and tile, showed a marked decrease in the man-hour ratio, that is, an increase in productivity. The next decade, 1889-99, was a depression period, and there was relatively little change either in production, total man-hours, or the man-hour ratio. This period was followed by another sharp increase in production of approximately 50 percent between 1899 and 1909 and a second period of decline in the man-hour ratio. The period was one of great commercial and building activity, of a rich man's boom which brought forth many ornate business blocks, and of industrial combinations which spread, as has been seen, even into the field of brick and tile. A recession occurred in the industry from 1909 to the World War, and during the war there were restrictions on all but necessary building. After the war the census speaks of the occurrence of "a veritable orgy of construction", which was again followed by a recession beginning around 1929.³⁰ Once more the increase in production was accompanied by a marked improvement in productivity, that is, a fall in the man-hour ratio. Too much reliance, however, must not be placed on the data for the period 1914-23 because of the fact that during this period the census gave no separate data on employment either in "Brick and tile" or for the separate products included under brick and tile. But even making allowance for these deficiencies, it seems reasonable to assume an improvement in productivity during this period, since when 1909 and 1925 are compared - years for which the data on employment are more adequate - a marked decrease in the man-hour ratio is noticeable. Whatever change took place after 1925 was in the direction of an increase in the man-hour ratio.

Over the period 1869-1925 the man-hour ratio decreased from 27.4 man-hours per thousand brick to 9.0 man-hours, or approximately two-thirds. If these two terminal years only are considered, the annual geometric rate of decrease was 2.0 percent.

The outstanding characteristic of the changes in the man-hour ratio is the fact that there are periods of rapid change with intervening periods of little change. These periods of rapid

³⁰*Fifteenth Census of the United States: 1930, "Construction Industry"* (U. S. Dept. Com., Bur. Census, 1933), p. 2.

change, that is, rapid decrease in the man-hour ratio, so far as can be determined from census data, occur during the periods of increasing production, while the periods of low production following these are periods of no improvement in productivity.

Attention has been called in chapter III to the fact that the industry is characterized by marked cycles of long duration. From figure 17 it is evident that the improvement in the man-hour ratio has taken place during the upward swings of these major cycles of activity. Comparison of the curve of production with the curve of man-hour ratios makes evident the inverse relationship between the two; likewise, an examination of the behavior of the man-hour ratios for individual plants in the field study reveals the same inverse relationship between capacity utilized

Table 28.- MAN-HOUR RATIOS FOR BRICK AND TILE PRODUCED IN THE UNITED STATES, CORRECTED FOR PERCENTAGE OF CAPACITY UTILIZED, 1889-1935^a

| Year | Percentage of capacity produced ^b | Percent that actual is of capacity man-hour ratio ^c | Man-hour ratio | |
|------|--|--|---------------------|------------------------|
| | | | Actual ^d | Corrected ^e |
| | (1) | (2) | (3) | (4) |
| 1889 | 100 | 100 | 17.3 | 17.3 |
| 1899 | 85 | 109 | 16.4 | 15.0 |
| 1904 | 92 | 105 | 14.3 | 13.6 |
| 1909 | 100 | 100 | 12.7 | 12.7 |
| 1914 | 84 | 110 | 12.4 | 11.3 |
| 1919 | 59 | 119 | 12.6 | 10.6 |
| 1921 | 57 | 120 | 11.5 | 9.6 |
| 1923 | 93 | 105 | 10.0 | 9.5 |
| 1925 | 100 | 100 | 9.0 | 9.0 |
| 1927 | 96 | 103 | 8.7 | 8.4 |
| 1929 | 82 | 110 | 8.8 | 8.0 |
| 1933 | 13 | 130 | 9.2 | 7.1 |
| 1935 | 23 | 123 | 9.7 | 7.5 |

^aBased on *Census of Manufactures* data. For explanation of method used, see appendix B, section on "Corrections in the Man-hour Ratio for Percentage of Capacity Utilized."

^bBased on table 27, col. (1).

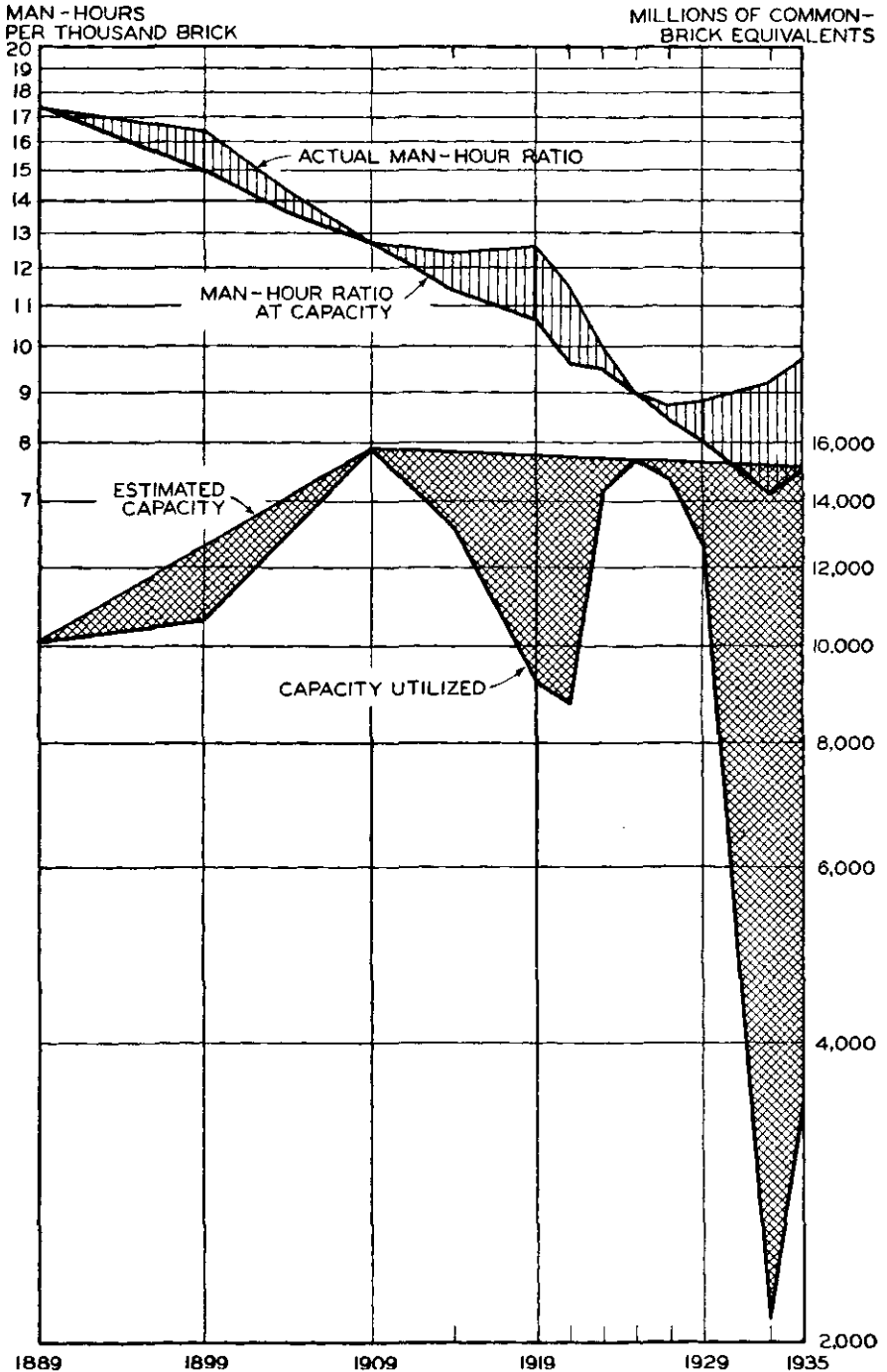
^cFor methods used in obtaining these figures, see appendix B, section on "Corrections in the Man-hour Ratio for Percentage of Capacity Utilized."

^dTable 27, col. (3).

^eCol. (3) ÷ col. (2), x 100.

**Figure 18.- MAN-HOUR RATIOS FOR BRICK AND TILE PRODUCED
IN THE UNITED STATES, CORRECTED FOR PERCENTAGE
OF CAPACITY UTILIZED, 1889-1935**

(Ratio scale)



Based on tables 27, 28

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and the man-hour ratio.³¹ The man-hour ratio declines as production increases and increases as production declines.

The question arises as to what degree of productivity might have been expected in a given year, provided the plants had been operating at or near capacity. In the absence of any figures for capacity the peak years of production were taken as years of near-capacity production.³² Capacity for the intervening years was estimated by a geometric interpolation between peak years. Likewise, the man-hour ratio at peak production was considered to be the man-hour ratio at capacity, and capacity man-hour ratios for intervening years were estimated by geometric interpolation between these man-hour ratios at successive peak years. There was a high degree of inverse correlation between the deviations of the actual man-hour ratios from the estimated trend of capacity man-hour ratios and the deviations of actual production from the trend of capacity production. A freehand line of regression between these two variables was used to correct the actual man-hour ratios for capacity utilized.³³ The man-hour ratios corrected for the factor of proportion of capacity utilized is shown in column (4) of table 28 and in figure 18. It will be noticed that the trend of the corrected man-hour ratios is steadily downward at the average geometric rate of about 1.8 percent per year from 1889 to 1925 (computed between the two end years).

There are some exceptions to a regular and constant rate of decrease, but they are not marked, with the exception, perhaps, of the increase which took place between 1933 and 1935. This is also evident in the individual plant ratios and may be due to the operation of NRA code provisions during a depression period.

Field Study Data for 1917-35

In figure 19 a comparison is made between the fluctuations in the percentage of capacity utilized in the reporting plants and the changes in the indexes of man-hour ratios. The striking characteristic demonstrated by the curves in the chart is the inverse relationship existing between the capacity utilized and

³¹See table A-32 for the man-hour ratios for individual plants.

³²It is recognized, of course, that peak production for the industry may be considerably under what has been defined as capacity production. For example, the plants in the sample produced at 80 percent of capacity in 1925, the peak year of production. But for the purpose of this computation, it does not matter that the production attained was less than capacity.

³³For details of the method used, see appendix B, section on "Corrections in the Man-hour Ratio for Percentage of Capacity Utilized."

the indexes of man-hour ratios. The fluctuation in capacity utilized is so great that it obscures any tendency toward increased productivity which might have existed. In fact, the indexes of the man-hour ratio declined from a high point in 1918, corresponding to a low point in production, to low points in the years 1922 through 1928, when production reached its highest level. From these points they rose to 1932, as production declined to a low point.

The median link index fluctuated less abruptly than the chain aggregative index (figure 19 and table 29), which would seem to

**Table 29.- INDEXES OF MAN-HOUR RATIOS FOR SAMPLE
BRICK AND TILE PLANTS, 1917-35**

(1929=100)

| Year | Sample plants | | | | | United States, weighted mean index ^d |
|------|-----------------------------|--------------------|-------------------------|--------------------|--|---|
| | Chain median link relatives | | Chain aggregative index | | Weighted mean index ^c (37 identical plants) | |
| | Number of plants | Index ^a | Number of plants | Index ^b | | |
| 1917 | 4 | 112.7 | 5 | 109.3 | n.a. | n.a. |
| 1918 | 4 | 125.4 | 5 | 127.7 | n.a. | n.a. |
| 1919 | 12 | 113.6 | 8 | 101.8 | n.a. | 143.2 |
| 1920 | 19 | 108.6 | 22 | 100.7 | n.a. | n.a. |
| 1921 | 21 | 108.7 | 25 | 116.5 | n.a. | 130.7 |
| 1922 | 23 | 103.1 | 27 | 91.2 | n.a. | n.a. |
| 1923 | 29 | 101.9 | 31 | 93.8 | n.a. | 113.6 |
| 1924 | 33 | 101.1 | 35 | 89.9 | n.a. | n.a. |
| 1925 | 34 | 99.8 | 35 | 90.2 | n.a. | 101.1 |
| 1926 | 35 | 101.3 | 35 | 92.5 | n.a. | n.a. |
| 1927 | 42 | 99.5 | 42 | 91.7 | n.a. | 100.0 |
| 1928 | 51 | 99.0 | 50 | 93.4 | 91.3 | n.a. |
| 1929 | 56 | 100.0 | 57 | 100.0 | 100.0 | 100.0 |
| 1930 | 69 | 99.8 | 72 | 103.4 | 106.7 | n.a. |
| 1931 | 65 | 108.1 | 73 | 113.2 | 130.6 | n.a. |
| 1932 | 65 | 116.9 | 78 | 115.8 | 152.3 | n.a. |
| 1933 | 57 | 111.8 | 78 | 109.9 | 127.6 | 104.5 |
| 1934 | 59 | 115.7 | 79 | 111.1 | 119.8 | n.a. |
| 1935 | 66 | 115.4 | 79 | 113.6 | 120.9 | 110.2 |

^aTable A-22, col. (3).

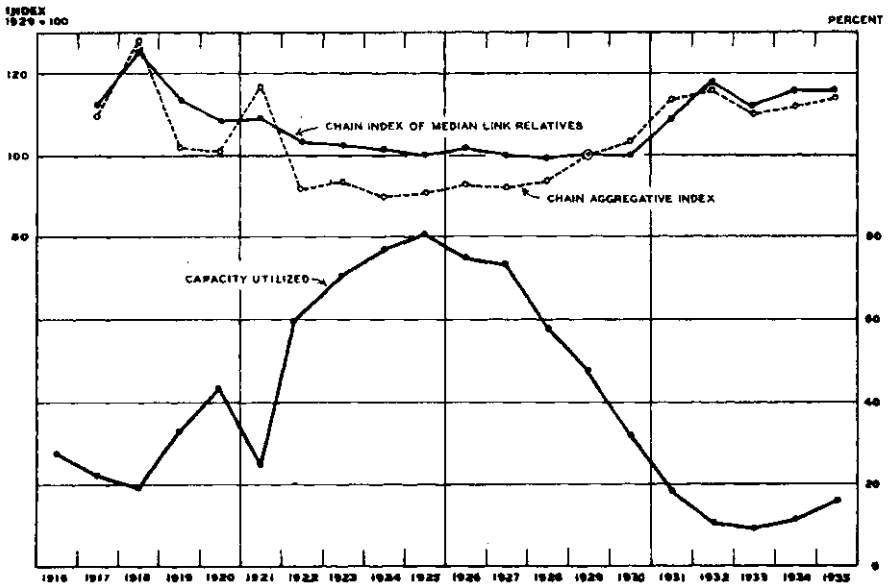
^bTable A-21, col. (5).

^cTable 36.

^dComputed from table 27, col. (3).

n.a. Data not available.

Figure 19. - INDEXES OF MAN-HOUR RATIOS AND PERCENTAGE OF CAPACITY UTILIZED FOR SAMPLE BRICK AND TILE PLANTS 1916-35



Based on tables 29, A-20

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indicate that the man-hour ratios of large plants fluctuate more violently than do those of small plants, or that the production of these plants fluctuates more violently, or that both conditions exist. It seems likely that the aggregative index tends to over-emphasize the fluctuations in the industry at large. This is evident in the low point to which this index fell during the years 1922-28. An examination of the man-hour ratios in the individual plants (table A-32) reveals the same characteristics as are shown in the average for all plants, which increases in the years of low production, 1917-21, decreases to low ratios in the years 1922-28, and then rises to abnormally high ratios as production falls off during depression. There are exceptions, of course, and the behavior of individual plants tends to be erratic, but curves for individual plant ratios and for percentage of capacity utilized show a marked inverse relationship.

A scatter diagram showing the inverse correlation between variations in percentage of capacity utilized by all reporting plants and variations in the chain aggregative index is presented in figure 20. This correlation is also evident in table 30 which

gives median and mean man-hour ratios for the various classes of percentage of capacity utilized during the years 1916-35. Low ratios are associated with high percentage of capacity utilized, while high ratios are associated with low percentage of capacity utilized. The linear correlation between the two variables in figure 20 was found to be -0.86 ± 0.06 . But, since the relationship seems to be curvilinear, a freehand curve was also drawn, and the deviations of the points from the curve were used as additive adjustment factors for correcting the index of man-hour ratios for percentage of capacity utilized.³⁴ The corrected and uncorrected indexes are shown in figure 21 and table A-23 for 1920-35. There seems to be little evidence of any declining trend. The explanation for this must await the analysis in the next section of the different types of plants of which the sample is composed and their behavior during the periods of rising and falling production. Any improvement in the average man-hour ratio for all the plants in the industry, which may have taken place as a result of plants with high man-hour ratios shutting down during this period, would not be reflected in the chain index for the

Table 30.- AVERAGE MAN-HOUR RATIOS FOR SAMPLE BRICK AND TILE PLANTS AT VARYING LEVELS OF UTILIZED CAPACITY 1916-35^a

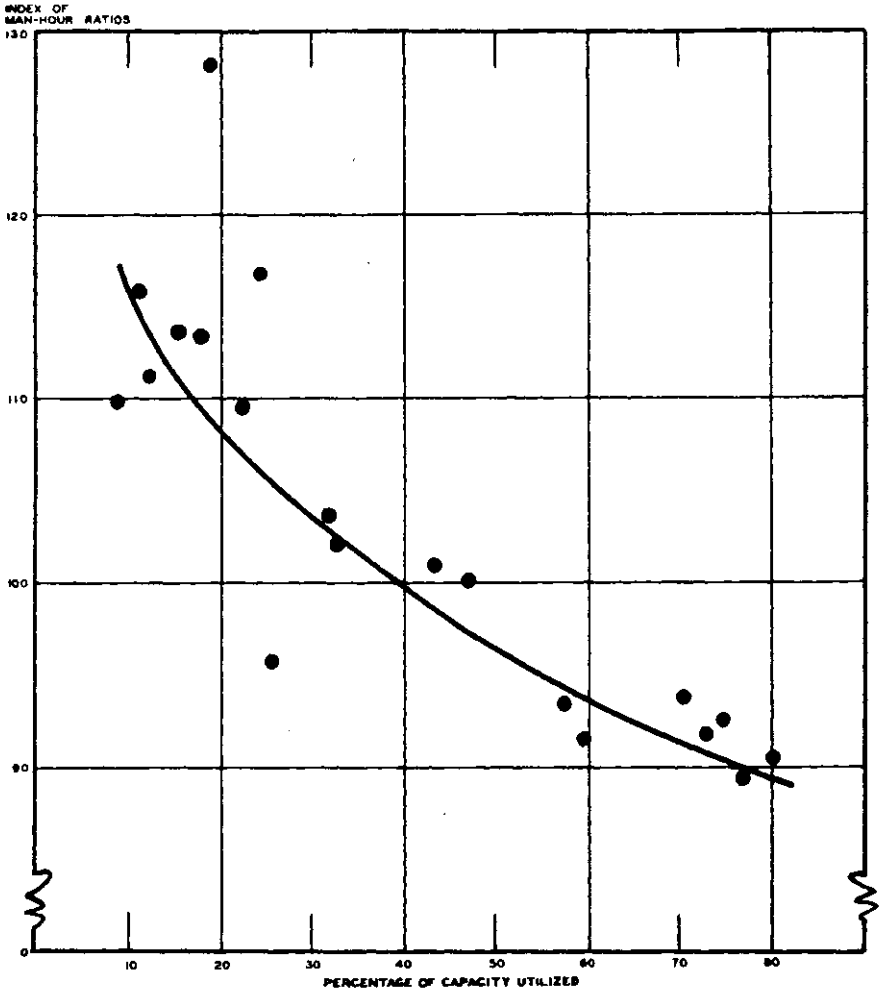
| Percent of capacity utilized | Man-hour ratio ^b | | Number of years in specified class |
|------------------------------|-----------------------------|-----------------|------------------------------------|
| | Median | Unweighted mean | |
| All classes | 8.57 | 8.79 | 20 |
| Less than 20 | 10.46 | 10.78 | 6 |
| 20-29.99 | 9.41 | 9.48 | 3 |
| 30-39.99 | 8.30 | 8.30 | 2 |
| 40-49.99 | 7.85 | 7.85 | 2 |
| 50-59.99 | 7.30 | 7.30 | 2 |
| 60-69.99 | - | - | 0 |
| 70 or over | 7.19 | 7.18 | 5 |

^aExcludes plants for which no capacity estimate is available.

^bComputed from averages for years falling in specified capacity class. The yearly averages are from table A-20, col. (4).

³⁴For details of the method, see table A-23 and appendix B, section on "Corrections in the Man-hour Ratio for Percentage of Capacity Utilized."

Figure 20.- REGRESSION OF CHAIN AGGREGATIVE INDEX OF MAN-HOUR RATIOS ON PERCENTAGE OF CAPACITY UTILIZED, FOR SAMPLE BRICK AND TILE PLANTS, 1916-35



Based on table A-23

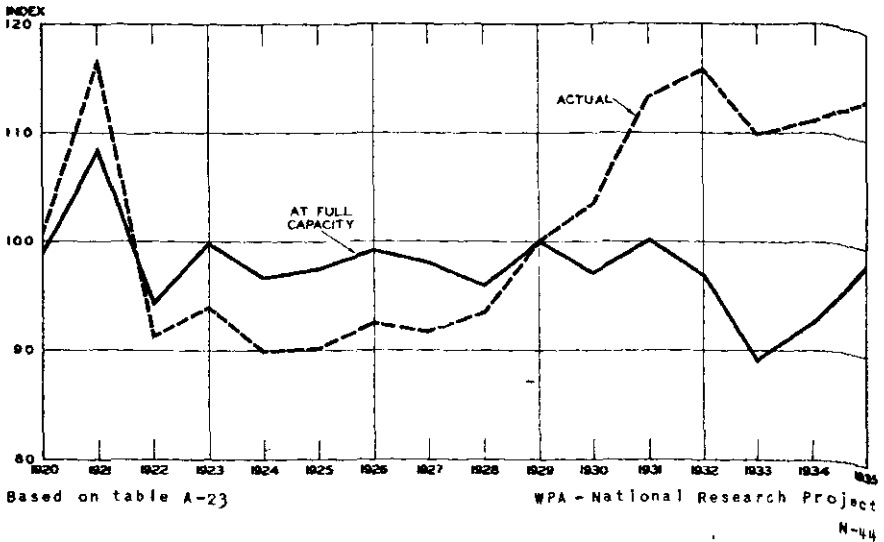
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sample. It is known that during the period 1920-29 there were improvements of individual plants which brought about decreases in their man-hour ratios. But it is possible that the improvements took place in regions for which the sample data are inadequate, or that the sample is overweighted by plants which made little or no improvement.

**Figure 21.- CHAIN AGGREGATIVE INDEX OF MAN-HOUR RATIOS
FOR SAMPLE BRICK AND TILE PLANTS, CORRECTED FOR
PERCENTAGE OF CAPACITY UTILIZED, 1920-35**

(1929=100)



ANALYSIS OF THE DIFFERENCES IN THE MAN-HOUR RATIO IN THE INDIVIDUAL PLANTS

In an attempt to answer the question as to what types of plants had the lowest labor requirements, the standard man-hour ratios for the plants in the sample were classified into groups according to various characteristics, such as size, age, and type of process. It was thought that in this way some approach might be found to the question: What are the forces which tend to bring about the increase or decrease in the average man-hour ratio? If more production is being carried on in large plants and if these plants have lower labor-requirement ratios than others, obviously there will be a tendency for the man-hour ratio to fall. If, however, large plants with low man-hour ratios cut down sharply in their production during periods of depression in the industry, there will be a marked tendency for the ratio to increase. Or the change from one type of process to another, such as the change from the soft-mud to the stiff-mud process which took place during the first decade of the twentieth century, may bring about a change in the man-hour ratio.

Productivity Related to Size and Process

In table 31 the plants are separated into stiff-mud, soft-mud, and other processes. These other processes include the sand-lime and dry-press processes, in which there is much less handling than is usual in the stiff-mud and soft-mud processes. A cross classification is made by size. Plants with a capacity of less than 15 million brick per year are classified as small, while those of 30 million brick or over are classified as large. For all processes combined the average standard man-hour ratios are highest for small plants, the average being 11.48, and lowest for large plants, the average being 6.87, which is about 60 percent as high as for small plants. In other words, 40 percent less labor is used to produce 1,000 brick in large plants than in small plants; the same relationship holds for each process; that is, the large plants have the smaller man-hour ratios, and the smaller plants have the larger man-hour ratios. There is one exception in soft-mud plants, when small- and medium-size plants are compared, but this is doubtless due to the fact that there are so few plants in these classes. The sand-lime and dry-press processes require the least amount of labor, while the soft-mud process requires the most. In the subclassifications this relationship is not so clear, probably again because of the smallness of the sample of soft-mud plants. The change from the soft-mud to the stiff-mud process after 1900 tended to bring about a reduction in the amount of labor utilized. Soft-mud required more handling labor until the installation of the autobrick machine

Table 31. - AVERAGE STANDARD MAN-HOUR RATIOS FOR SAMPLE BRICK AND TILE PLANTS, BY CAPACITY AND PROCESS^a

| Process | All plants | | Annual capacity (millions of common-brick equivalents) | | | | | |
|-------------------------|------------|------------------|---|------------------|----------|------------------|------------|------------------|
| | | | Less than 15 | | 15-29.99 | | 30 or over | |
| | Ratio | Number of plants | Ratio | Number of plants | Ratio | Number of plants | Ratio | Number of plants |
| All processes | 9.66 | 69 | 11.48 | 22 | 9.82 | 29 | 6.87 | 18 |
| Stiff-mud | 9.67 | 55 | 12.40 | 14 | 9.66 | 25 | 6.99 | 16 |
| Soft-mud | 10.33 | 9 | 10.74 | 4 | 12.73 | 3 | 5.91 | 2 |
| Sand-lime and dry-press | 8.27 | 5 | 9.03 | 4 | 5.23 | 1 | - | 0 |

^aIncludes all plants for which standard man-hour ratios could be calculated.

in the twenties, at which time a great reduction in the labor of handling took place in those plants which introduced this machine. It will be noticed that the two large soft-mud brick plants have a lower average standard man-hour ratio than the large stiff-mud plants. The average in this class might not be so low if the sample were larger. Nevertheless 5.91, the average for these soft-mud plants, is a low man-hour ratio for any plant.

From an examination of table 31 it is evident that any changes in the proportions of production between large plants and small plants would bring about a correspondingly large shift in the man-hour ratio because of the great difference in productivity between them.

Productivity Related to Age of Plant

In table 32 the standard man-hour ratios are classified by age and capacity. There seems to be no clear relationship of any sort between the man-hour ratio and the age of plants, some

Table 32.- AVERAGE STANDARD MAN-HOUR RATIOS FOR SAMPLE BRICK AND TILE PLANTS, BY CAPACITY AND AGE^a

| Age ^b | All plants | | Annual capacity (millions of common-brick equivalents) | | | | | |
|------------------|------------|------------------------|--|------------------------|----------|------------------------|------------|------------------------|
| | | | Less than 15 | | 15-29.99 | | 30 or over | |
| | Ratio | Number of plants | Ratio | Number of plants | Ratio | Number of plants | Ratio | Number of plants |
| All ages | 9.81 | 59 | 11.63 | 18 | 9.86 | 27 | 7.42 | 14 |
| Less than 10 | 9.81 | 11 | 9.82 | 4 | 10.06 | 6 | 8.30 | 1 |
| 10-14 | 9.86 | 5 | 15.51 | 1 | 8.90 | 2 | 7.98 | 2 |
| 15-19 | 10.62 | 7 | 10.46 | 3 | 10.73 | 4 | - | 0 |
| 20-24 | 8.10 | 13 | 10.54 | 3 | 7.33 | 5 | 7.42 | 5 |
| 25-29 | 11.02 | 12 | 11.92 | 3 | 10.76 | 8 | 10.45 | 1 |
| 30-39 | 7.61 | 3 | 12.84 | 1 | - | 0 | 5.00 | 2 |
| 40-49 | 10.17 | 4 | 9.60 | 1 | 14.56 | 1 | 8.27 | 2 |
| 50 or over | 11.71 | 4 | 16.66 | 2 | 8.00 | 1 | 5.50 | 1 |

^aIncludes all plants for which the ages were known and for which standard man-hour ratios could be calculated.

^bAge is measured in number of years intervening between year of construction and year or mean of years from which the standard man-hour ratio has been derived.

of the oldest plants having the lowest man-hour ratios. Since new machinery which may entirely revolutionize the efficiency of a plant is often installed without new plants being built, these figures fail to tell the full story. In fact, 23 of the plants in the sample underwent some reconstruction during the period 1919-35.

Productivity Related to Geographic Area

A classification of plants by geographic area and by standard man-hour ratio is shown in table 33. It will be noticed that in the Chicago area all the plants are in the group of lowest man-hour ratios, that is, from 4.00 to 6.99 man-hours per thousand brick. The New York area, including the Hudson River Valley and the New Jersey plants, is the only other region with more than one plant in this group of low man-hour ratios, except Wisconsin, where the plants are sand-lime plants. A combination of several characteristics brings about the very low man-hour ratios in the Chicago area, namely: Production of common brick only, sold as "run-of-kiln"; large size of the plants due to the market which they serve; clay adaptable to high-speed production by the stiff-mud process and to short burning time; and a high degree of mechanization. The sample in the New York area contains only one plant with a capacity of 30 million or more, but two of the six plants are in the group having man-hour ratios between 4 and 7. These are soft-mud plants in the Hudson River Valley. As has been seen, this area was more recently mechanized than the Chicago area, the period of mechanization coming after the World War when the pressure of labor costs was great. Here autobrick machines which eliminate the handling of the bricks as they come from the molder have been installed, as well as overhead cranes for setting the brick in the kilns and mechanical loading of the brick in crates for shipment. As seen from the comparison of stiff-mud and soft-mud plants, it is unusual to find soft-mud plants with man-hour ratios as low as stiff-mud plants, but these plants show that complete mechanization of a soft-mud plant may today bring about as great a productivity as complete mechanization of a stiff-mud plant.

In eastern Pennsylvania, also serving a large metropolitan market, only two out of six plants have a capacity of over 15 million, and only two plants have a man-hour ratio of less than 10. Here again the soft-mud plants predominate, while the stiff-mud

Table 33.- CHARACTERISTICS AND GEOGRAPHIC LOCATIONS OF SAMPLE BRICK AND TILE PLANTS

| Plant characteristic | All areas | Chicago | Hudson Valley, New Jersey | Eastern Pennsylvania | Western Pennsylvania, Western New York, Ohio | Indiana, Illinois ^a | Maryland, Tennessee | Virginia, North Carolina | Florida, Georgia | Iowa, Missouri, Kansas, Oklahoma | Wisconsin |
|---------------------------|-----------------|---------|---------------------------|----------------------|--|--------------------------------|---------------------|--------------------------|------------------|----------------------------------|-----------|
| All plants | 78 | 9 | 6 | 6 | 13 | 14 | 5 | 6 | 3 | 14 | 2 |
| Standard man-hour ratio | | | | | | | | | | | |
| 4- 6.99 | 15 | 9 | 2 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 2 |
| 7- 9.99 | 29 | 0 | 3 | 2 | 4 | 6 | 0 | 4 | 0 | 10 | 0 |
| 10-12.99 | 19 | 0 | 0 | 1 | 9 | 2 | 2 | 1 | 3 | 1 | 0 |
| 13 or over | 15 | 0 | 1 | 3 | 0 | 6 | 3 | 0 | 0 | 2 | 0 |
| Capacity ^b | | | | | | | | | | | |
| Less than 15 | 26 | 0 | 2 | 4 | 3 | 5 | 2 | 1 | 2 | 6 | 1 |
| 15-29.99 | 33 | 0 | 3 | 1 | 9 | 6 | 2 | 3 | 0 | 8 | 1 |
| 30 or over | 19 | 9 | 1 | 1 | 1 | 3 | 1 | 2 | 1 | 0 | 0 |
| Process | | | | | | | | | | | |
| Stiff-mud | 61 | 9 | 2 | 2 | 11 | 12 | 4 | 5 | 3 | 13 | 0 |
| Soft-mud | 12 ^c | 0 | 4 | 4 | 2 ^d | 0 | 1 | 1 ^d | 0 | 0 | 0 |
| Dry-process and sand-lime | 5 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 1 | 2 |

^aChicago excluded.

^bMeasured in millions of common-brick equivalents per year.

^cIncludes two plants using both stiff- and soft-mud processes.

^dIncludes one plant using both stiff- and soft-mud processes.

plants are unable to operate at the speed of those in the Chicago area and their burning time is much longer because of the type of clay used. The soft-mud plants tend to be on the eastern seaboard, while the stiff-mud plants predominate in other sections of the country. Moreover, in the eastern cities brick is sold by grade and therefore requires sorting, while in Chicago it is commonly sold as "run-of-kiln."

Another difference between areas is the difference in diversification of products. While the plants in close proximity to the metropolitan areas tend to produce common brick or common and face, the plants farther removed from these markets have a greater diversification of products. This is especially true of the plants west of the Mississippi, which produce a wide range of brick and tile products, and is also true of the plants in Indiana and Illinois, which are too distant from the Chicago market to compete in the market for common brick and which have specially good grades of clay for other products. This diversification tends to be associated with somewhat higher man-hour ratios than might be expected; nevertheless 11 of the 14 plants in the group west of the Mississippi have man-hour ratios of less than 10.

Investment per Unit of Capacity

The plants were classified according to the amount of investment per unit of capacity in order to determine, if possible, whether high investment per unit of capacity tended to be associated with low or high man-hour ratios. In order to do this it was necessary to classify the plants into two groups, those making common and face brick and those making paving brick and tile. Unfortunately the number of plants was small, and data on net investment are somewhat difficult to interpret. Considering these limitations, the evidence points to the conclusion that the greater the investment in machinery and equipment per unit of capacity in the common- and face-brick plants, the lower the man-hour ratio. Four of the six common- and face-brick plants for which data on investment were available are medium-size; one is large, and one is small. If the one large plant is excluded, the ranks are the same for net investment per unit of capacity and for man-hour ratios when the lowest man-hour ratio and the highest investment figure are given the rank of one. The net investment ranges from \$0.79 per thousand brick with a man-hour ratio of 9.60 to \$3.53 with a ratio of 5.95.

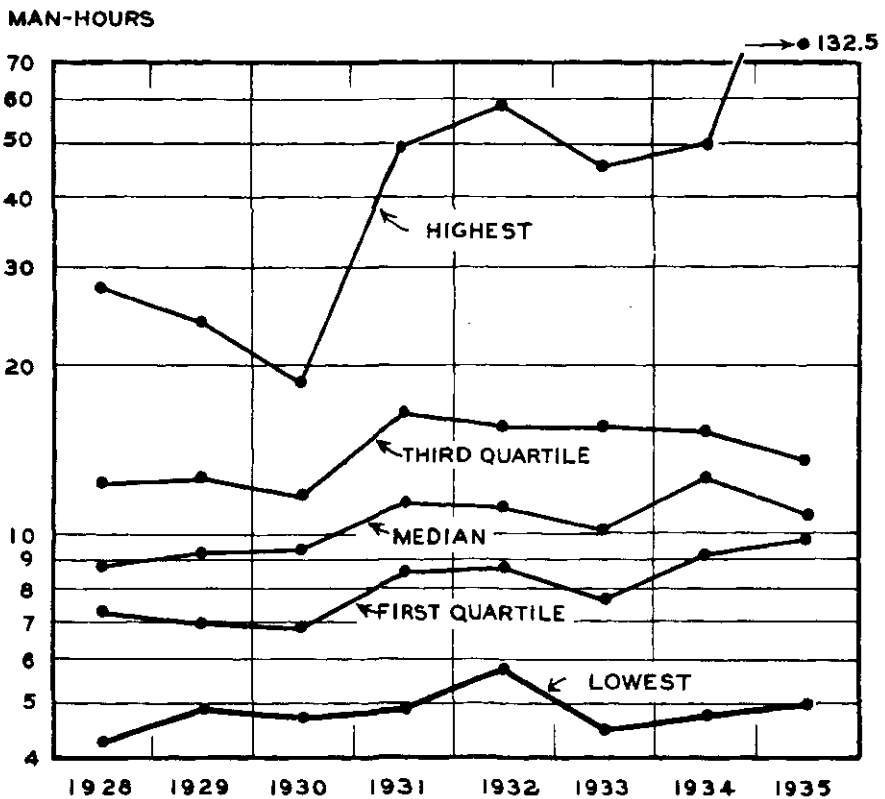
When tile and paving-brick plants are ranked in the same way, the lower man-hour ratios seem to be correlated with the low net-investment figures, though the relationship is far from clear. This may be due to the fact that the greater the diversification of the types of brick and tile, the larger the amount of investment required; and, at the same time, the greater the diversification, the greater the amount of individual handling that is necessary, and, therefore, the higher the man-hour ratio.³⁵

Changes in the Man-hour Ratio Over Time

In the previous discussion the question has arisen of the behavior of individual plants during periods of recession and

Figure 22.- DISPERSION OF MAN-HOUR RATIOS, 37 IDENTICAL BRICK AND TILE PLANTS, 1928-35

(Ratio scale)



Based on table A-25

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³⁵See table A-24 for the data on which these correlations are based.

activity in the industry. When several plants are owned by one company, there are various factors which enter into the decisions as to which plants will operate. If the demand is insufficient to keep all plants operating, the production is usually centered in a few of the plants only, in order that the plants that are operated can be operated at or near capacity. In the second place, the plants which are selected for operation may be selected because they are low-cost plants, in which case productivity of labor would be an important item in the selection, or they may be selected because they are nearer to the market, in which case plants with higher rather than those with lower ratios might be selected for operation. Many plants owned by multiple-plant corporations have been closed during the depression. Some have been permanently abandoned and others will probably be opened if the demand warrants it, but many small, individually owned plants have also been closed. There is no basis for determining whether any larger proportion of corporately owned plants is closed than of individually owned plants.

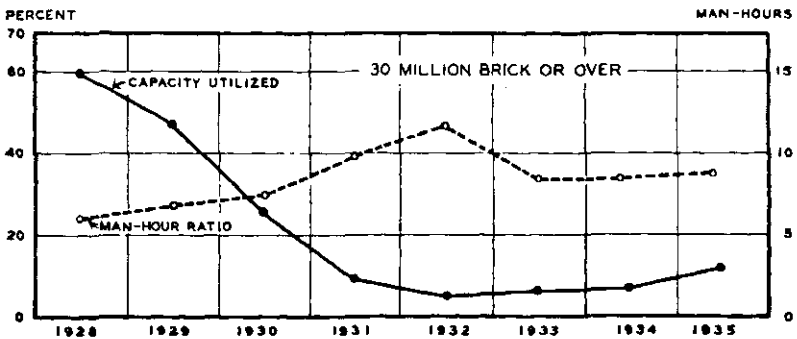
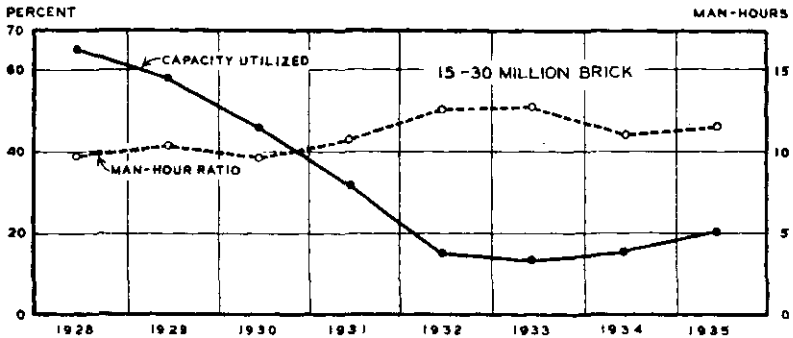
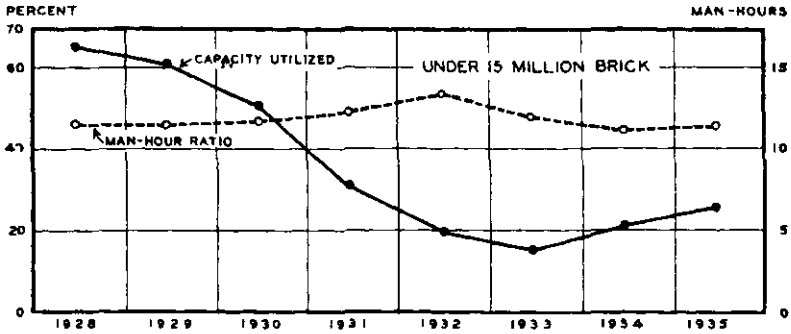
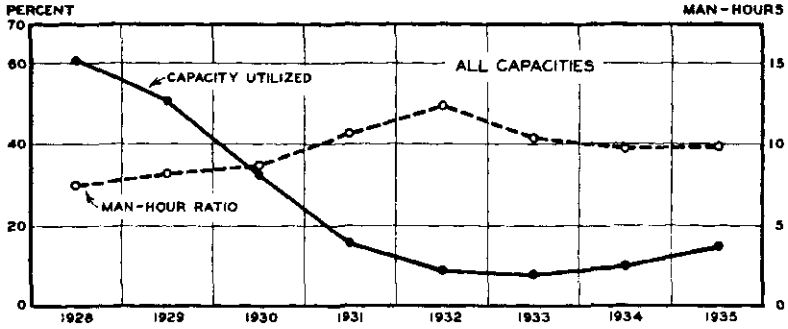
In order to understand the behavior of individual plants, a study was made of a group of 37 identical brick and tile plants for the period 1928-35. Table A-25 and figure 22 present the lowest and highest man-hour ratios for each year and the quartile man-hour ratios. The great range between the highest and lowest ratios is marked in all years and increases during the depression. The man-hour ratio in the plant with the lowest productivity

Table 34.- WEIGHTED MEAN OF MAN-HOUR RATIOS AND OF PERCENTAGE OF CAPACITY UTILIZED, 37 IDENTICAL BRICK AND TILE PLANTS, 1928-35

| Year | Man-hour ratio ^a | Percent of capacity utilized |
|------|-----------------------------|------------------------------|
| 1928 | 7.47 | 61 |
| 1929 | 8.18 | 51 |
| 1930 | 8.73 | 33 |
| 1931 | 10.68 | 18 |
| 1932 | 12.46 | 9 |
| 1933 | 10.44 | 8 |
| 1934 | 9.80 | 10 |
| 1935 | 9.89 | 15 |

^aTable A-25, col. (6).

Figure 23.- WEIGHTED MEAN OF MAN-HOUR RATIOS AND PERCENTAGE OF CAPACITY UTILIZED, 37 IDENTICAL BRICK AND TILE PLANTS, BY CAPACITY, 1928-35



Based on tables 34, A-26

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tends to be 5 to 10 times that in the plant with the highest productivity; the man-hour ratio for the third quartile, 50 to 100 percent greater than that of the first quartile. This great dispersion in the ratios is marked throughout the period and is typical of brick and tile plants. Except in 1930 and 1934 the array is positively skewed, showing a tendency for the man-hour ratios to be more widely dispersed above the median than below, which would be expected when there is such a wide dispersion.

The rather erratic nature of the fluctuations is due, in part, to very irregular production in many plants and also to the fact that only in the first 2 years are all the plants operating. A contingent labor-reduction ratio shows the reduction in labor requirements which would take place if the plants should increase their productivity to the point where the weighted mean would become equal to the first quartile of the given year. While in 1928 and 1935 there is little difference between the weighted mean and the first quartile, showing without doubt a preponderance of the large plants, in several years the reduction in labor which would have taken place was 20 percent or more.

Figure 23 and table 34 present the weighted mean of the man-hour ratios and the percentage of capacity utilized. Except for 2 years, an inverse relationship exists between the two curves. Why the improvement which started in 1934 did not continue until 1935 is difficult to determine. When the 37 plants are broken down into three size groups, a little more light is thrown on the nature of the fluctuations.

In figure 23 and table A-26 the plants in the group are classified by size. The small- and medium-size plants operated more continuously than the large plants in this group of 37 plants and at a higher percentage of capacity. A comparison of the indexes of the man-hour ratios of the three groups in table 35 shows that the smaller the size, the more stable the man-hour ratio. The man-hour ratio of the small-size group rose less than 20 percent from 1929 to 1932 and in 1935 had returned to its 1929 level, while the man-hour ratio for the large-size group rose 72 percent and in 1935 was 28 percent above its 1929 figure. The total capacity of the small- and medium-size plants together was less than half the capacity of the large plants. Hence the fluctuations in the large-size group tend to have a greater effect on the average man-hour ratios than the fluctuations in the other two groups.

In figure 24 and table A-27 the plants in the group are classified by process. The average man-hour ratio of the plants using the stiff-mud process increased steadily from 1928 to 1932 as capacity fell off, until in 1932 it was more than 100 percent higher than its 1928 figure. In the soft-mud process and in the sand-lime process the variations are less marked, amounting to not more than 20 percent in the soft-mud and to 30 percent in the other processes. In 1935 the soft-mud group had returned to its 1929 man-hour ratio, but the stiff-mud group was 27 percent above its 1929 figure.

**Table 35. - INDEXES OF WEIGHTED MEAN OF MAN-HOUR RATIOS,
37 IDENTICAL BRICK AND TILE PLANTS,
BY CAPACITY AND PROCESS, 1928-35**

(1929=100)

| Plant characteristic | 1928 | 1929 | 1930 | 1931 | 1932 | 1933 | 1934 | 1935 |
|---|-------|-------|-------|-------|-------|-------|-------|-------|
| All plants ^a | 91.3 | 100.0 | 106.7 | 130.6 | 152.3 | 127.6 | 119.8 | 120.9 |
| Annual capacity ^b (millions of common-brick equivalents) | | | | | | | | |
| Less than 15 | 99.8 | 100.0 | 100.9 | 106.9 | 116.2 | 105.7 | 98.3 | 99.6 |
| 15-29.99 | 93.6 | 100.0 | 92.8 | 103.0 | 122.3 | 123.1 | 107.2 | 111.2 |
| 30 or over | 90.4 | 100.0 | 109.2 | 145.3 | 172.4 | 123.9 | 124.0 | 128.3 |
| Process ^c | | | | | | | | |
| Stiff-mud | 91.2 | 100.0 | 111.1 | 163.0 | 188.2 | 146.4 | 126.3 | 127.4 |
| Soft-mud | 89.0 | 100.0 | 91.4 | 86.5 | 103.8 | 86.9 | 99.8 | 99.5 |
| Sand-lime and dry-press | 103.1 | 100.0 | 102.7 | 109.4 | 99.7 | 130.6 | 99.2 | 102.5 |

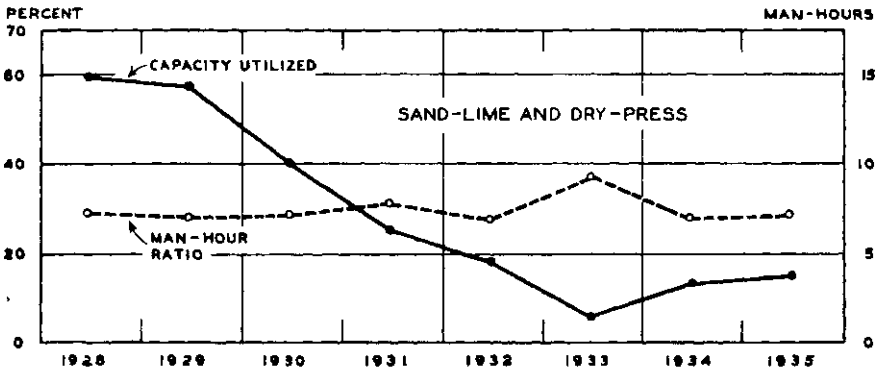
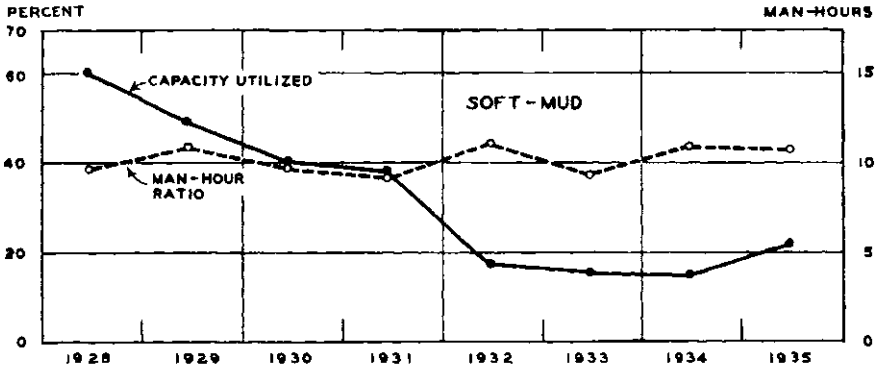
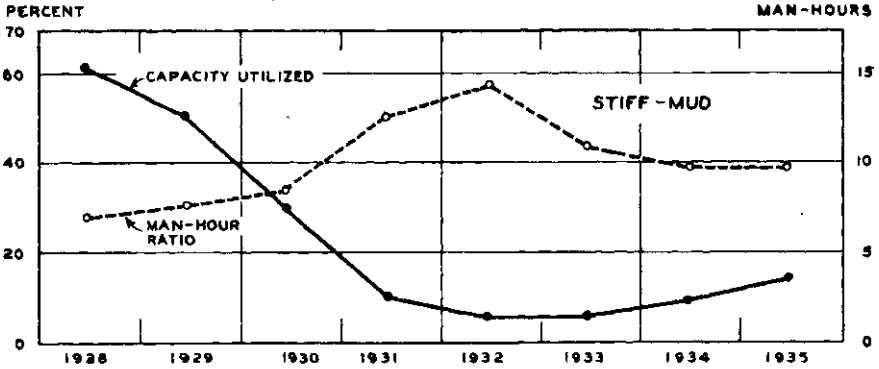
^aComputed from table A-25, col. (6).

^bComputed from table A-26.

^cComputed from table A-27.

From this sample of 37 plants it would appear that during the 1928-35 period the operation of large plants and stiff-mud plants was characterized by more severe fluctuation than that of other plants and the man-hour ratios in these plants rose more during the decline in capacity utilized from 1928-32 than the man-hour ratios in other plants. In other words, medium- and small-size plants and soft-mud plants tended to be more stable in operation and in their man-hour ratios than large stiff-mud plants. It is possible that this group of 37 plants is not typical of the brick and tile plants in general. That it is overweighted with large plants is evident, and it is possible that it is overweighted with large plants of more erratic production than others.

Figure 34. - WEIGHTED MEAN OF MAN-HOUR RATIOS AND PERCENTAGE OF CAPACITY UTILIZED, 37 IDENTICAL BRICK AND TILE PLANTS, BY PROCESS, 1928-35



Based on table A-27

**EVALUATION OF FACTORS AFFECTING THE
AVERAGE MAN-HOUR RATIO**

From the foregoing analysis it appears that small plants are less efficient than large plants; hence changes in the average man-hour ratio may come about by changes in the proportions of the production produced by large and small plants. Also, the soft-mud plants tend, in general, to be of somewhat lower productivity than stiff-mud plants, although at present large soft-mud plants are attaining a productivity comparable to that of large stiff-mud plants. Hence a change in proportions produced by these two branches of the industry would change the average man-hour ratio. Likewise, the more diversified plants tend to have higher man-hour ratios than the plants specializing in one product, but here another factor comes into operation. To the extent that greater diversification is accompanied by increasing size of plants and the closing up of small plants, this tendency toward decreased productivity may be more than offset. Although it is impossible because of lack of data to determine what change has taken place in the plants in the western plains, it seems likely that the movement toward diversification of products under multiple-plant management may have led to a decrease in the average man-hour ratio in that section of the country.

As has been pointed out, the predominating factor affecting the man-hour ratios in individual plants is the change in capacity utilized; this factor tends to obscure all others so that it is difficult to isolate the effects of other factors. When production in the industry rose in the twenties because of a greatly increased demand for building materials, several factors affecting the average man-hour ratio came into action: (1) The percentage of capacity utilized in individual plants rose, which brought about a decrease in the man-hour ratios in these plants; (2) plants which had been idle began operating, which would be a factor tending toward decrease in the man-hour ratios if the plants were large and had lower man-hour ratios than the average, and toward an increase if they were smaller and had higher man-hour ratios than the average; (3) new machinery and equipment were installed which would tend to decrease the man-hour ratio whether installed for the purpose of reducing fuel costs, making a more perfect product, reducing waste, reducing labor costs, or freeing the plants from their dependence on unsatisfactory or uncertain labor supply; and (4) some increase in size of plants took place

in order to fulfill a new demand, a factor which would also tend to reduce the average man-hour ratio. The resultant of all these factors is shown in the fall of the man-hour ratio from 1920-25.

Data on the total number of establishments in brick and tile are lacking prior to 1925, but from the data on the number of establishments producing each of the five products, it is probable that there was little if any increase in the total number. The number of establishments producing face brick and hollow building tile increased between 1921-25, but the number of establishments making the other products decreased. Since most of these establishments make more than one product, it is impossible to estimate from these data the increase in the total number of establishments.

Evidence seems to point to the conclusion that the increased use of capacity in large plants, the establishment of new large plants, and possibly the return to production of some large plants more than offset the tendency to an increase in the ratio which may have been introduced by the return to production of some small plants. The stabilizing effect of the small plants is lost in the chain index of man-hour ratios for the sample because of the overweighting of large plants. Hence the fall in the average man-hour ratio in the universe is probably less than that shown by the index.

An examination of table A-6 shows the great but decreasing overweighting given in the sample for common brick to Region IV (including the Chicago district) during all years up to and including 1929, and the marked but decreasing underweighting given in Region I (including New York) during this same period. The production of common brick in the Illinois region increased more than in any other region during the period 1919-25. This overweighting tends to exaggerate the decrease in the man-hour ratio due to the increase in production in this highly efficient area. On the other hand, the underweighting of the New York area tends to obscure the effects of certain improvements which took place in the man-hour ratio due to the installation of autobrick machines in the soft-mud plants in the Hudson River Valley and the mechanization of handling which occurred in 1919-29.

The effect of increased production in small plants, whether for plants coming back into operation or for plants increasing their production, is overshadowed by the importance of these two regions. The increase in production in other areas is much

less than in these two. In comparing the change in the chain aggregative index with the weighted mean based on census data shown in table 29, both were found to have decreased by 23 percent from 1921 to 1925. On the upswing of the cycle of production there are two main factors that make for a decrease in the average man-hour ratio: the increasing use of the facilities for production and the relative shift in production from small plants with high man-hour ratios to large plants with low ratios.

When production was falling off from 1925 to 1932, the large plants decreased their production more than the small plants. The Chicago area reduced its proportion of production more than the New York area; this means that soft-mud plants operated more continuously than stiff-mud plants. The result was an increase in the average man-hour ratio due to plant operation below capacity and to the large falling off in the proportion of the products produced by the large plants. There was a tendency, however, toward decrease in the man-hour ratio due to the closing down of many small plants. This latter tendency is obscured to some extent in the chain aggregative index for the sample. The closing of this large number of small plants tended to offset the other factors so that the man-hour ratio based on census data increased only about 3 percent from 1925 to 1932, while the chain aggregative index increased 21 percent. The increase in the index due to the falling off in capacity was greater than it should have been because of the overweighting by Illinois plants in the years 1925-29 and the underweighting by the New York plants. By 1931 the sample weighting for the two regions including these States was approximately the same as that in the universe.³⁶

The decrease in the man-hour ratio takes place during the cyclical upturn of activity in the industry, which brings into operation some factors of permanent significance such as improvements in machinery and equipment, building of a small number of new and more mechanized plants to supply new kinds of demand or demand in new areas, and enlargement of the capacity of plants already built. During the decline in production which follows the period of great productive activity, the competition resulting from the increased capacity tends to drive out of existence many of the smaller and less profitable plants, so that when the industry starts its revival many of them have disappeared. The man-hour

³⁶See table A-8.

ratio is consequently lower than at a corresponding point in the previous cycle. For example, if the chain aggregative index of the man-hour ratio, which was 109.9 for 1933 when the plants were operating at only 9 percent of capacity, be compared with the chain index of 116.7 for 1921 when the plants were operating at 24.5 percent of capacity, this improvement in productivity is evident. Though the absolute difference between these two index numbers, removed as they are by 12 years and based on a changing sample, is not reliable as a measure of the change, nevertheless the direction of the change agrees with that shown by the index based on census data. It therefore seems reasonable to conclude that an improvement has taken place in the productivity of the plants from 1921-33, but any reliable estimate as to the amount of this change is difficult to make.

MAN-HOUR RATIOS IN THE VERTICAL STRUCTURE OF THE INDUSTRY

In the foregoing sections an attempt has been made to describe and analyze the changes which have taken place in the man-hours of operating and indirect labor per thousand brick. Such changes have been associated not only with the technological changes which have taken place in the brick and tile plants but also with the changes in the amount of brick and tile produced. An attempt will now be made to answer certain questions in regard to the man-hour ratios in other segments of the industry. Is the downward trend of the man-hour ratio which is characteristic of operating and indirect labor in the plants also characteristic of other parts of the industry, such as labor used in manufacturing machinery, production of fuel, and transportation? What effect do the cycles which characterize the industry have upon the man-hour ratios in other segments? What is the approximate total man-hour requirement per thousand brick in the vertical structure of the industry? What proportion of these man-hours is utilized in each segment, and what is the trend of this man-hour ratio? None of these questions can be answered with any great degree of exactitude, and, in general, the picture of the vertical structure of the industry can be drawn only in its broadest outlines.

Plant-Office Man-hour Ratios

Plant-office man-hours include not only the hours of the hired clerical staff but also the time which is spent by the owners in

the administration of the business. Since office man-hours are the most rigid element in the total plant man-hours and respond least to fluctuations in output, it can be expected that the office man-hour ratio will show an inverse relationship to output and total man-hours. This is confirmed by an examination of table 36. During the period 1922-35 the plant-office man-hour ratio shows a range of 0.34 to 1.38 man-hours per thousand brick. The low point is reached in 1926 and the high in 1933. Since this does not include office man-hours in the plants which did not operate in any one year and as in many cases a skeleton force remains to take care of sales of brick, the ratio is probably underestimated in years of low production.

Table 36.- PLANT-OFFICE MAN-HOUR RATIOS IN SAMPLE BRICK AND TILE PLANTS, 1922-35

| Year | Number of plants reporting | Man-hours | | Man-hour ratio ^a |
|------|----------------------------|-----------|---|-----------------------------|
| | | Number | Percent of total man-hours including office | |
| 1922 | 15 | 88,204 | 4.7 | 0.51 |
| 1923 | 20 | 111,120 | 3.2 | 0.36 |
| 1924 | 18 | 102,923 | 3.2 | 0.36 |
| 1925 | 21 | 117,525 | 3.1 | 0.35 |
| 1926 | 20 | 102,831 | 3.1 | 0.34 |
| 1927 | 24 | 134,969 | 3.9 | 0.42 |
| 1928 | 30 | 170,919 | 4.5 | 0.46 |
| 1929 | 44 | 250,223 | 4.1 | 0.39 |
| 1930 | 46 | 263,547 | 5.6 | 0.61 |
| 1931 | 47 | 265,531 | 7.9 | 0.91 |
| 1932 | 47 | 232,903 | 11.0 | 1.34 |
| 1933 | 44 | 216,628 | 11.8 | 1.38 |
| 1934 | 49 | 230,555 | 10.7 | 1.22 |
| 1935 | 47 | 217,194 | 8.2 | 0.91 |

^aWeighted mean of man-hour ratios for all reporting plants.

This series of man-hours is based on a changing sample; hence too much importance must not be attached to year-to-year fluctuations, but in general the series may be said to reflect the tendencies characterizing plant-office man-hour ratios. The percentage which plant-office man-hours is of the total plant

man-hours varies from 3.1 percent in 1925 and 1926 to 11.8 percent in 1933. This rise during the period of low production reflects the difficulty of adjusting office man-hours to a rapidly changing volume of output. Thus office man-hours per thousand brick tend to become an increasing burden when production declines. When the plants are operating under multiple-plant ownership, the plant office may be closed and only the central office left open. This would tend, of course, to keep down the rise in the plant-office man-hours per thousand brick, but the comparatively few cases of this have not been sufficient to offset the tendency of the ratio to rise.

Except for the year 1929 no attempt has been made to estimate from census data the man-hours of work performed by salaried employees. The number of employees in this class as reported by the census is about 10 percent of the average number of wage earners.³⁷ This includes not only salaried employees but owners of the brick plants and corporation officials. The difficulty of estimating the number of hours spent per year by the members of this group in work pertaining to the brick and tile plants has prevented the making of any estimate of man-hours, except in 1929 when an estimate of 2,244 hours (51 weeks of 44 hours each) per individual per year was made in order to fit this group into the picture of the whole.³⁸ In 1929 the estimate based on census data was 0.85 man-hours per thousand brick, which is about twice that for the field study. It is likely that this is due to the very much larger proportion of small plants in the industry than are represented in the sample, though it is possible that it is an overestimate of the average number of hours per individual per year. If it is due to the large number of small plants reporting to the census, then the existing trend toward larger-size plants is likely to reduce the plant-office man-hours per thousand brick in the future. It seems reasonable to expect that a plant can increase its capacity without a proportional increase in its office force.

Man-hour Ratios for Fuel

Table 37 presents an estimate of the number of man-hours required to produce the fuel per thousand brick. Unfortunately, data are available for only certain census years, but the trend is evident

³⁷See table 10.

³⁸See table 40.

when 1914 and 1919 are compared with 1929. During the earlier 2 years, the man-hours utilized were over 0.9 per thousand brick, but by 1929 they had been reduced 45 percent to 0.5 man-hours. This reflects the trend which has been noticed toward greater economy in the use of fuel and also the trend toward greater productivity in the production of fuel.³⁹ There should be added to the latter figure the number of man-hours used in transporting the fuel, which was 0.8 man-hours per thousand brick in 1929.⁴⁰ The trend in both of these ratios is downward and will doubtless continue to be so in the near future.⁴¹

Table 37.- ESTIMATED MAN-HOUR RATIOS FOR FUEL FOR BRICK AND TILE PLANTS, 1914-29

| Year | Production ^a (millions of common-brick equivalents) | Plant fuel man-hours ^b (thousands) | Man-hour ratio (2)÷(1) |
|------|---|---|------------------------------|
| | (1) | (2) | (3) |
| 1914 | 13,099 | 12,502 | 0.95 |
| 1919 | 9,155 | 8,393 | .92 |
| 1929 | 12,581 | 6,578 | .52 |

^aTable A-13, col. (1).

^bFor methods used in obtaining these figures, see appendix B, section on *Estimated Employment and Man-hours in the Vertical Structure of the Industry.*

During periods of low production, the fuel per thousand brick tends to rise because of several factors. It may be necessary to burn less than a kiln of brick, in which case the unit fuel requirement is greater; or the smaller beehive kilns may be used in place of the tunnel kilns, and these are less economical when both are burned at capacity. Moreover, the tendency, already noted, for the large plants to cut down their production proportionately more than the small plants would tend to increase the fuel consumed per unit of output. Hence man-hours utilized for fuel will not fall off in depression to as great an extent as the decrease in the brick burned, unless the opposite tendency toward increased productivity in production of fuel offsets this tendency toward less economical use of fuel.

³⁹See pp. 10, 42-3.

⁴⁰See table 40.

⁴¹For methods used in estimating man-hours, see appendix B, section on *Estimated employment and man-hours in the Vertical structure of the industry.*

Man-hour Ratios for Machinery and Equipment

The problem of estimating the labor utilized in the manufacture of the machinery annually consumed in the production of brick and tile necessitates some method of allocating the machinery over the period of its use, as well as a method of measuring the amount of labor embodied in the machinery. Two methods of estimating the embodied man-hours may be used: (1) An estimate based on the gross investment for the given year; and (2) an estimate based on the depreciation in machinery and equipment for the given year. Gross investment for any given year was considered to be the total investment in machinery and equipment to date minus retirements and sales. In order to use the first of these two methods the dollars of gross investment were converted into man-hours by multiplying by a figure representing the man-hours per dollar of investment utilized in the manufacture of the machinery. (This method was followed in table A-28, on which table 38 is based.) A figure for man-hours per dollar of investment was computed for each year from 1920 to 1935, the years for which data were available. The figure used to convert gross investment for a given year into man-hours was the average of all the figures for the previous years including that for the given year, on the assumption that the buying of the machinery had been distributed more or less evenly over the previous years. In order to prorate the man-hours over the life of the machinery, the total of the man-hours was divided by the average length of life of the machinery, which was estimated at 13.9 years, a figure arrived at from an examination of the records of various plants.

The second method is based on the assumption that the yearly depreciation figure used by the company is a measure of the amount of machinery and equipment which is used up in production each year. The fact, however, that the figuring of depreciation tends often to be a mere accounting practice having more relation to taxes and financial condition of the company than to the actual wear and tear of the machinery makes data derived from the depreciation accounts unsatisfactory. It is not unusual to find that the machinery which has been entirely written off as far as depreciation is concerned is being used for production. Hence no attempt has been made to use the quite inadequate data available for this purpose.

Table 38 gives the man-hours embodied in machinery and equipment, when estimated on the basis of gross investment, for a group of

nine plants from 1926-35. It will be seen that the man-hour ratios vary from 0.28 in 1926 to 0.89 in 1933. The reason for this variation is evident when one looks at the decrease in production amounting to 60 percent between 1926 and 1935. This increase in the ratio reflects the increase in fixed costs per unit of production which takes place with the falling off in production.

Table 38.- ESTIMATED MAN-HOUR RATIOS FOR MACHINERY, NINE IDENTICAL BRICK AND TILE PLANTS, 1926-35^a

| Year | Production (millions of common-brick equivalents) | Plant machinery man-hours (thousands) | Man-hour ratio |
|-------------------|--|---|-------------------|
| | (1) | (2) | (3) |
| 1926 | 166 | 46 | 0.28 |
| 1927 | 148 | 50 | .34 |
| 1928 | 145 | 54 | .38 |
| 1929 | 130 | 57 | .44 |
| 1930 | 124 | 56 | .45 |
| 1931 | 98 | 57 | .58 |
| 1932 | 71 | 59 | .82 |
| 1933 ^b | 39 | 35 | .89 |
| 1934 | 69 | 55 | .80 |
| 1935 | 65 | 56 | .86 |

^aBased on table A-28.

^bFigures represent data for six plants, as three plants were not operating in 1933.

Man-hour Ratios for Transportation of Brick and Tile

Table 39 presents for the years 1929-35 the man-hours per thousand brick used in the transportation of brick and tile on Class I railroads.⁴² This falls from 1.25 man-hours in 1929 to 0.88 in 1935.⁴³ A similar decline doubtless took place in the man-hours used in the transportation of fuel during this period.

This is, of course, only part of the man-hours used in the transportation of brick and tile. Some of it is transported by waterways and some by truck. There is an increasing use of

⁴²For methods used in estimating man-hours, see appendix B, section on "Estimated Employment and Man-hours in the Vertical Structure of the Industry."

⁴³The denominator used is the total production of brick and tile and not that transported on the railroads, which was approximately 70 percent of the total in 1929.

Table 39. - ESTIMATED MAN-HOUR RATIOS FOR TRANSPORTATION OF BRICK AND TILE ON CLASS I RAILROADS, 1929-35

| Year | Production ^a (millions of common-brick equivalents) | Transportation man-hours ^b (thousands) | Man-hour ratio (2)÷(1) |
|------|---|---|------------------------------|
| | (1) | (2) | (3) |
| 1929 | 12,581 | 15,773 | 1.25 |
| 1931 | 5,429 | 6,726 | 1.24 |
| 1933 | 2,035 | 2,144 | 1.05 |
| 1935 | 3,426 | 3,016 | 0.88 |

^aTable A-13, col. (1).

^bFor methods used in obtaining these figures, see appendix B, section on "Estimated Employment and Man-hours in the Vertical Structure of the Industry."

trucks for delivery purposes, and it is conceivable that this would tend to decrease the man-hours needed to distribute the brick and tile to the consumers, as some of the handling would be eliminated. Moreover, automatic loading and unloading of trucks is also bringing about a reduction in man-hours.

Man-hour Ratios in the Vertical Structure of the Industry

Table 40 attempts to give a picture of the man-hours utilized in the various segments of the industry in 1929 so far as it has been possible to make an estimate.⁴⁴ While 9.6 man-hours per thousand common-brick equivalents were spent on the average in the plants, the estimate outside the plants totaled 3.4 man-hours. The figure fails to include trucking of the finished product, which would amount to at least 1.0 man-hour. There are, of course, other minor omissions, such as the salaried workers in the production of fuel and the man-hours embodied in the structures which house the machinery. Perhaps even more important are the man-hours spent in repairs and maintenance. It is likely that for 10 man-hours in the plant there are at least 5 man-hours outside.⁴⁵

While the trend of the man-hours per thousand brick is evidently downward, it is impossible to give any estimate of the rate of decrease. Moreover, during periods of declining production the

⁴⁴For methods used in estimating man-hours, see appendix B, section on "Estimated Employment and Man-hours in the Vertical Structure of the Industry."

⁴⁵Cf. Bernard H. Topkis, "Labor Requirements in the Production of Clay Products," *Monthly Labor Review*, 45, No. 6 (Dec. 1937), 1409 for similar estimates for 1935.

Table 40.- MAN-HOURS AND MAN-HOUR RATIOS IN SPECIFIED SEGMENTS OF THE BRICK AND TILE INDUSTRY, 1928^a

| Segment | man-hours | | Man-hour ratio |
|--------------------------------|-----------|------------------|----------------|
| | Thousands | Percent of total | |
| | (1) | (2) | (3) |
| All specified segments | 163,935 | 100.0 | 13.0 |
| Fuel production | 6,645 | 4.1 | 0.5 |
| Bituminous coal | 6,312 | 3.9 | - |
| Anthracite coal | 266 | 0.2 | - |
| Coke ^b | 67 | * | - |
| Fuel transportation | 10,535 | 6.4 | 0.8 |
| Bituminous coal | 9,961 | 6.1 | - |
| Anthracite coal | 119 | 0.1 | - |
| Coke | 33 | * | - |
| Refinery products ^c | 422 | 0.2 | - |
| Machinery ^d | 5,536 | 3.4 | 0.4 |
| Brick and tile manufacturing | 120,972 | 73.8 | 9.6 |
| Wage earners | 110,351 | 67.3 | - |
| Salaried employees | 10,621 | 6.5 | - |
| Brick and tile transportation | 15,773 | 9.6 | 1.3 |
| Brick and tile distribution | 4,474 | 2.7 | 0.4 |

^aFor methods and sources see appendix B, section on "Estimated Employment and Man-hours in the Vertical Structure of the Industry."

^bIncludes only man-hours for production of coal used in producing coke.

^cIncludes only the man-hours in refining fuel oils and gasoline and does not include production of the raw materials or the transportation of these raw materials.

^dEstimated man-hours embodied in machinery prorated annually over the lifetime of the machinery. See Table 4, col. (4) for the man-hour ratio used in col. (3). Man-hours in col. (1) are the product of this man-hour ratio and total production in the industry.

*Less than 0.05 percent.

trend of the man-hour ratio is upward, not only for the plants but also for machinery and possibly to some extent for fuel. Hence it is probable that man-hours per thousand brick in the whole vertical structure of the industry varies inversely with the percentage of capacity utilized in the brick and tile plants.

PRODUCTION COSTS

Production costs are the limiting factors in the supply of brick which will be offered on the market at a given price. If costs

are too high the manufacturer has the alternative of reducing costs or closing down operations. Reduction of costs tends to reduce the man-hours per thousand brick either in the plant itself or in other segments of the industry but may prevent the closing down of operations. An examination of costs, therefore, may throw some light on the forces which have been bringing about a reduction of the man-hour ratio.

Labor Costs

On the average, labor costs during the period 1909-25 amounted to 40 percent of the value of the brick produced.⁴⁶ In some of the plants surveyed, labor costs were as high as 60 percent of the total cost of producing the brick, while in other plants they were as low as 20 percent, but they are the largest item of cost and one which tends to receive much attention when wages are high.

Table 41 presents the median average hourly earnings in brick and tile plants in five different areas. As might be expected, the southern States, which include the States east of the Mississippi River and south of New Jersey, Pennsylvania, and the Ohio River, had the lowest average hourly earnings both in 1929 and 1935. In 1929 they had the highest man-hour ratio and yet the lowest labor cost. In the northern group east of the Mississippi, the Chicago district had the lowest labor cost. Its high average hourly earnings were offset by the low labor-requirement ratio. The area including the States of Ohio, New Jersey, New York, and Pennsylvania had the highest labor costs, while the States west of the Mississippi⁴⁷ had low average hourly earnings and low labor costs.

The high labor cost of producing brick for the eastern market was certainly one of the forces making for the installation of machinery which took place during the decade of the twenties. It might also have been a force which resulted in driving smaller plants, with their higher labor requirements, out of the market. It will be noticed that the median labor-requirement ratio in this area dropped from 11.0 in 1929 to 10.4 in 1935.

In 1935 average hourly earnings were lower than in 1929; the median man-hour ratios had declined in two areas, that is, in

⁴⁶Based on *Census of Manufactures* data.

⁴⁷The plants included were in Iowa, Kansas, Missouri, Oklahoma, and California.

**Table 41.- LABOR COSTS FOR SAMPLE BRICK AND TILE PLANTS,
BY AREA, 1929 AND 1935^a**

| Year and Area | Number of plants | Median | | |
|---------------|------------------|-------------------------|----------------|-------------------------------|
| | | Average hourly earnings | Man-hour ratio | Labor cost per thousand brick |
| | (1) | (2) | (3) | (4) |
| 1929 | | | | |
| I | 12 | \$0.391 | 9.4 | \$3.72 |
| II | 12 | .474 | 10.0 | 4.68 |
| III | 21 | .536 | 11.0 | 5.25 |
| IV | 10 | .328 | 12.2 | 3.70 |
| V | 8 | .884 | 5.2 | 4.56 |
| 1935 | | | | |
| I | 15 | .396 | 9.4 | 3.72 |
| II | 10 | .382 | 13.2 | 5.18 |
| III | 20 | .448 | 10.4 | 4.86 |
| IV | 13 | .306 | 9.9 | 2.95 |
| V | 3 | .818 | 10.4 | 8.37 |

^aPlants are grouped on the basis of their geographic area into five major divisions:

- Area I: States west of the Mississippi River (California, Iowa, Kansas, Missouri, and Oklahoma).
- Area II: Illinois, Indiana, and Wisconsin, excluding the Chicago district.
- Area III: New Jersey, New York, Ohio, and Pennsylvania.
- Area IV: Southern States east of the Mississippi River (Florida, Georgia, Maryland, North Carolina, Tennessee, and Virginia).
- Area V: Chicago district (Cook County, Ill.).

the southern States and in the States of New Jersey, New York, Ohio, and Pennsylvania; in two others they had risen, and in the western area the man-hour ratio had not changed. In the New York market area, the labor costs per thousand brick had declined to third highest, while in the Chicago area, in which the sample for 1935 is very small, they had risen to the highest. The States in Area II, the region in which Chicago is located, had the second highest labor costs. The increase in the man-hour ratios in these States was only partly compensated for by the decrease in hourly wages. In this area the reaction to higher costs seems to have been a decrease both in production and employment, while in the eastern States it was a decrease in the man-hour ratio accompanied by a relatively smaller decline in production and employment than in the Chicago area (Area V).

In the southern area, which includes some plants producing for the Washington market, a reduction in the man-hour ratio,

coupled with only a small reduction in average hourly earnings, has brought about a 20-percent reduction in labor costs. The peculiar conditions of demand in the Washington market may have been an important factor in this reduction. Plants in that market were busy when there was idleness in the rest of the country.

Direct comparison of costs between areas is somewhat fruitless, as they produce primarily for noncompeting markets with different conditions of price and demand and different customs in regard to kinds of brick and tile. Labor costs which may be relatively low when compared with other markets may be a high proportion of costs in the market in question and so exert a pressure toward change. Thus in the NRA hearings much was said in favor of allowing low wages in small communities and in the South, on the ground that the expenditure of labor per thousand brick was so much greater than in the larger plants in metropolitan areas and in the North. It was contended at that time that the payment of higher wages would compel many of these plants to shut down operation.

Analysis of Costs per Thousand Brick

Production costs per thousand common brick for six plants are broken down into component parts in table 42. It will be noticed that while labor costs were 40 percent of total costs in 1925, they were only 33 percent in 1935. When census data are used, labor costs are found to be 40 percent of total value in 1925 and 36 percent in 1935. The decrease in labor costs from \$4.34 to \$3.30 is due to the fall in average hourly earnings, since on the average these six plants showed no appreciable change in productivity.

Most plants exhibited an increase in man-hour ratios during this period and, in many instances, an actual increase in labor costs. This group of six plants can hardly be said to be typical of the industry in respect to labor costs except as they illustrate certain tendencies toward decrease in these costs both through increased productivity and decreased average hourly earnings, the latter being characteristic of all plants.

The second largest item of costs per unit is overhead, which increased, as might be expected, with the decline in production. On the other hand, fuel costs may reflect, as do labor costs, the tendency of the plants in the industry to economize in this

Table 42.- COST PER THOUSAND COMMON BRICK, SIX IDENTICAL BRICK AND TILE PLANTS,^a 1925 AND 1935

| Item | 1925 | 1935 |
|--|--|---------|
| Total production (thousands of common-brick equivalents) | 109,414 | 49,388 |
| Man-hours, operating and indirect | 1,092,983 | 489,916 |
| Man-hours per thousand common-brick equivalents | 9.99 | 9.92 |
| Percentage of capacity utilized | 77.4 | 34.9 |
| | Cost (dollars) per thousand common-brick equivalents | |
| Total | 10.73 | 9.89 |
| Total manufacturing | 7.36 | 6.25 |
| Labor, operating and indirect | 4.34 | 3.30 |
| Raw materials and supplies | 0.54 | 0.38 |
| Fuel for burning | 1.11 | 1.03 |
| Overhead | 1.15 | 1.37 |
| Other manufacturing expense | 0.22 | 0.17 |
| Power | 1.13 | 1.52 |
| Administrative ^b | 1.24 | 1.03 |
| Selling | 0.17 | 0.41 |
| Other ^b | 0.83 | 0.68 |

^aTwo large-, two small-, and two medium-size plants.

^bFor more detailed break-down, see table A-29.

large item of expense, though it is recognized, of course, that the reduction in fuel costs may be due in part to a lowered price for fuel. These factors have evidently offset the increased cost of fuel per unit of product which usually accompanies low-capacity production. To the extent that the reduction of costs represents more economical use of fuel, it is usually associated with a reduction in labor requirements, accompanied as it may be by shorter burning time, better regulation of heat, and, therefore, a smaller proportion of spoiled products and less handling of fuel. Increased use of power is probably indicative of some increase in expense when plants are not run at capacity, but it is also indicative of a greater use of power due to more mechanical handling and the like.

While this sample of six plants cannot be said to measure the average trends in costs in the plants in the industry as a whole,

it is indicative of changes taking place in plants which were able to produce at approximately the same rate of productivity in 1935 as in 1925, although producing at a much lower percentage of capacity. To some extent it may represent the trend in those plants which are likely to win out in the competition for markets by lowering the major items of cost.

The force of competition exerts a pressure toward reducing labor and fuel costs, both of which tend to reduce the man-hour ratio in the industry as a whole. To the extent, however, that this reduction of unit costs is followed by reduction in price of brick and tile, the effect upon the industry may be to increase production, and therewith employment.

SUMMARY

The trend in the industry toward larger and fewer plants has persisted since 1889 and seems likely to continue. Large plants are capable of a greater degree of mechanization than small ones, so that a downward trend in the labor-requirement ratio in the plants, averaging 1.3 percent per year since 1889, has been associated with increasing size.⁴⁸

During periods of short duration the change in the man-hour ratio is determined so largely by changes in the capacity utilized that the trend of improvement in productivity is obscured. In order to measure changes in productivity, it therefore became necessary to compare years that are separated by the length of a major cycle of activity in the industry.

When the brick and tile industry is increasing in activity, there is a marked decline in the man-hour ratio, but much of this is due to the increase in productivity which comes from a more economical use of the various factors of production arising from a higher percentage utilization of capacity. While production is declining the man-hour ratio tends to rise. Any failure to rise during such a period may be taken as evidence of a potential increase in productivity which will be evident when the plants are again operating at a relatively high percentage of capacity.

⁴⁸This is the annual average decrease between the terminal years 1889 and 1935. If the years 1889 and 1925 (both cyclical peak production years) had been used, the average decrease would have been 1.8 percent.

Outside of the plants, also, the industry is characterized by a steadily decreasing man-hour ratio with the possible exception of distribution, about which little is known.

The effect of high wages after the World War was to increase the mechanization of the industry, especially with respect to the handling and conveying operations which require much labor. Likewise, the high cost of fuel tended toward a more economical use of fuel, resulting not only in reduction in the cost of fuel but in a reduction in the labor costs associated with burning.

The relation of these changes in productivity to employment of labor will receive more consideration in chapter V.

CHAPTER V

ABSORPTION AND DISPLACEMENT OF LABOR IN THE BRICK AND TILE INDUSTRY

The outstanding conclusion from the analysis in the previous chapters is that the brick and tile industry has been, and continues to be, characterized by great instability of employment and that this instability has been increasing rather than decreasing. It is the result of fluctuations in the consumption of brick and tile rather than of technological changes in its manufacture. In fact, insofar as the competition from substitute materials for construction has been an increasing factor in retarding the demand for brick, the cheapening of the product due to technological change has probably been a factor favorable to greater consumption and therefore to greater production and employment.

ABSORPTION AND DISPLACEMENT OF LABOR

An analysis of the changes in employment associated with technological change may be broken down into three parts: the changes in employment which result from changes in (a) the volume of production, (b) productivity, and (c) employment in the machinery industries.

Table 43 presents an analysis of the changes which took place in eight identical plants from 1926 to 1935. It will be noticed that the largest year-to-year changes in man-hours are associated with changes in production. In 6 of the 9 years there were decreases in production which reduced the man-hours utilized in the plants. In the other 3 years there were increases. The average annual decrease due to the decline in production from 1928 to 1933 was 182,000 man-hours, or 16 percent of the 1928 man-hours total for the eight plants.

During the period 1926-35 the man-hour ratio remained relatively stable, fluctuating between a low of 8.51 in 1934 and a high of 10.07 in 1935. In 5 of the 6 years in which production declined the man-hour ratio rose, but the amount of its rise was relatively small so that the decline in man-hours due to the falling off in production was offset only to a small extent by the increase in the man-hour ratio due to decreased productivity.

Table 43:- YEAR-TO-YEAR NET CHANGES IN UTILIZATION OF LABOR, EIGHT IDENTICAL BRICK AND TILE PLANTS, 1926-35^a

| Year | Change since previous year in - | | | | | |
|------|--|-------------------|-----------------------|-------------------|----------------|------------------------------|
| | Production (millions of common-brick equivalents) | Man-hour ratio | Man-hours (thousands) | | | Total of three factors |
| | | | Due to changes in - | | | |
| | | | Produc- tion | Man-hour ratio | Machin- ery | |
| (1) | (2) | (3) | (4) | (5) | (6) | |
| 1927 | - 5 | +0.53 | - 42 | + 64 | -56 | - 34 |
| 1928 | + 4 | -0.20 | + 39 | - 25 | +48 | + 62 |
| 1929 | -20 | +0.28 | -186 | + 30 | -17 | -173 |
| 1930 | + 5 | -1.02 | + 52 | -113 | -36 | - 98 |
| 1931 | -26 | -0.10 | -226 | - 8 | +10 | -225 |
| 1932 | -26 | +0.16 | -218 | + 9 | * | -209 |
| 1933 | -38 | +0.37 | -332 | + 8 | -13 | -337 |
| 1934 | +39 | -0.50 | +350 | - 30 | + 3 | +323 |
| 1935 | -19 | +1.56 | -161 | + 63 | - 4 | -102 |

^aBased on table A-30.

*Less than 500.

In only one of the years of declining production, 1931, was there any increase over the preceding year in the man-hours used in making machinery, and the increase in this year was much less than the decline of the previous year.

The net result of these three factors was an average year-to-year decrease of 88.1 thousand man-hours per year during the period 1926-35. This is the equivalent of 40 or more men in these eight plants. If, however, only the 5 years of generally declining production from 1929 to 1933 inclusive are considered, the decrease averaged 208,000 man-hours per year, or more nearly 95 men per year.

These eight plants are far from being representative of the industry. While production in the industry was falling off between 1926 and 1928, these plants maintained their production; and while the production of brick and tile in 1935 was 23 percent of what it had been in 1927, for these plants it was 33 percent of 1927 production. If data had been available for the industry as a whole for the period 1926-35, the average year-to-year net displacement of labor would probably have been greater proportionately and there would have been no net absorption in

any year prior to 1934.¹ As in these eight plants, by far the larger part of this displacement would have been brought about by a falling off in production. To what extent this displacement in plant labor could have been avoided by decreasing the cost of production through technological improvements it is impossible to say.

If similar data had been available for 1921-25, they would have shown a net absorption of labor due to increasing production² and increasing man-hours of employment in the machine industries in the face, however, of decreasing man-hours due to a reduction in the man-hour ratio. It is, of course, the absorption of labor in this period of cyclical expansion which laid the basis for some of the displacement in the following period.

EFFECTS OF INSTALLATION OF MACHINERY UPON DISPLACEMENT OF LABOR

The effects of the installation of machinery upon the displacement of labor were studied in 55 plants over the period 1920-35. Of the 244 reported installations of equipment, 39 percent displaced labor, while 48 percent were said to have had no direct effect on brick-plant employment and 13 percent added labor. Although 48 percent appeared to have had no effect upon the number of persons on the pay roll, the result of some of these installations was no doubt to reduce waste, improve the quality of the bricks by better-regulated drying and burning, reduce the burning time, or to speed up production in some way. Thus a reduction in labor time per thousand brick might easily have been brought about without any reduction in the labor force. In other words, in place of reducing the labor force, the time of operation may have been reduced or more first-quality brick may have been produced in the same amount of labor time.

The laborers affected by these installations were in the main unskilled or hand laborers. Of the men who were displaced, 90 percent were in this class, and only 10 percent were machine operators. The effect of the high cost of unskilled labor on the mechanization of the industry is thus evident.³ Some of this mechanization took place in the mining of the clay; some of it is

¹This is postulated on the facts that production in the United States declined each year from 1928 to 1933 and increased in the 2 following years, while changes in the amount of machinery installed were relatively small.

²See tables 23 and A-19.

³See chapter III, pp. 66-7 and chapter IV, pp. 142-4 for a discussion of labor costs.

seen in the automatic features of the soft-mud brick machine, and some in the handling equipment.

Table A-31 presents the man-hours employed in producing the machinery which was installed in these 55 plants during the years 1920-35, together with the number of plant workers either displaced or added by this machinery. During the period 1920-35, 164 men were displaced and 51 men added as a result of the installation of this machinery. Sixty-five percent of this displacement occurred during 6 years, 1924-29, years of relatively high production.

These figures, however, tell us nothing about the increased capacity for production which may have resulted from the installation of these machines or the decreased costs which may have resulted in increased sales from these particular plants. To what extent these improvements made possible more stable operation it is impossible to say, and to what extent there was a transfer of production to these plants and away from other plants is also unknown. Some of the displacement of employment may have occurred in industries competing with brick and tile, or decreased costs may simply have prevented further displacement of brick and tile by other products.

EFFECTS OF COSTS UPON EMPLOYMENT

The nature of the industry is such that unit costs tend to rise with a fall in production. This characteristic, as has been pointed out, tends to cause the owners of brick and tile plants to shut down operation rather than to offer their products below cost of production. This keeps up the price in the face of a falling demand and further restricts production. Moreover, this characteristic of the industry causes the manufacturers of brick and tile to run their plants at capacity, if possible, in order to cut down costs. The surplus stocks are stored until sold, and in the meantime the plant is shut down except for the sale and delivery of bricks from storage, which requires only a few employees. This tends to accentuate the fluctuations in employment.

The capacity of the plants and the labor force necessary for their operation are much larger than needed to supply even peak production during peak years and many times larger than needed to supply production in other years. In depression years a force is maintained during periods of operation which is large enough to carry on the operation of the plant efficiently, but the number is far above that which would be required if the same production

could be efficiently spread throughout the year. A plant is organized to produce so many bricks a day, and to operate efficiently it must produce at that rate and also produce enough brick while in operation to fill at least one kiln. It seems likely that large plants, because of their very great capacity, find it even more difficult than smaller plants to operate continuously for any length of time. This is illustrated in figure 23, which shows the percentage of capacity utilized in the three size groups of plants during the years 1928-35.

Labor cost has been an important factor in the mechanization of the plants. Until the war period unskilled labor was plentiful and in 1914 received on the average only 20 cents an hour. With the decline in immigration during the war and the restriction imposed by law after the war, the price of unskilled labor rose to between 40 and 50 cents an hour. There were at this time in the Hudson River Valley large plants in which large portions of the handling and conveying were still done by hand. The invention of the autobrick machine, combined with an automatic conveyor for the pallets, made the soft-mud process capable of almost complete mechanization. The resulting reduction of costs in soft-mud brick was noticeable in the price of brick in the New York market, and it was accompanied by a much smaller decline in production for that market than the average decline for the United States.

No reduction in cost of brick, however, is likely to effect the most important cause of the decline in consumption, the falling off in building construction. The major cycles in employment in the industry correspond with cycles in building activity, and until some stability can be achieved in this industry, employment in brick and tile must necessarily suffer severe fluctuations. Moreover, the fact that each boom brings into being larger and more efficient plants may make for greater intermittency of operation following boom periods.

FUTURE EMPLOYMENT IN THE INDUSTRY

Trend in Employment

The employment trend in the industry will probably continue downward because of the use of a variety of newer materials better suited to modern building construction. It has been seen, however, that hollow building tile and face brick were increasing in use

during the period 1909-25. Should the increase in production in these two branches continue its upward trend so that a new peak above the 1925 level is reached with the next boom in building activity, increased employment in the areas of western Pennsylvania and Ohio, where superior clay and cheap fuel give a competitive advantage, may be anticipated. The markets supplied would be largely the city markets, and much would depend upon the ability of the plants to supply the products at a price low enough to prevent displacement by competing building materials and to adapt the products to changing architectural demands. The Face Brick Association has been outstanding in the promotion of the use of face brick, and this work is likely to continue. There may be more use of glazing and special finishes which may increase the use of the product both for exterior and interior finish.

The demand for common brick, as well as for paving brick and drain tile, will probably continue a downward course so that many of the plants now idle will never open, and others may turn to a more diversified line of products. It is likely that large, mechanized common-brick plants within easy shipping distance of the city markets, where the demand for common brick is bound to continue, will hold their own with competing materials; but in the remainder of the country, high transportation costs of brick are likely to keep closed many of the small and high-cost plants, and other building materials may take the place of brick in localities at a distance from large markets.

If the present movement in the direction of higher wages and greater security of income for wage earners persists, as it seems likely to do, the effect would be to raise costs proportionately more in the smaller, less mechanized plants and so change the competitive relations both with the products of other brick and tile plants and with other building materials. The result would be, as it has probably been in the past, the closing of the less mechanized plants.

If the cities attached to metropolitan centers continue to grow, as they now seem likely to do, the demand for brick and tile will certainly continue, but it will probably center on face brick and building tile.

Cyclical and Seasonal Fluctuations

The major cycles in the industry are also likely to continue unless a change is brought about in the cyclical activity of

building construction. Government construction may help to some extent to fill in the gaps left by depression in private construction, but it would be necessary that this take the form of public buildings in order to create much employment in the brick and tile industry. Public slum clearance and public-housing schemes might do much to create employment in the industry and to stabilize employment. The stabilization of employment must most certainly wait for the solution of the problem of stabilization of building construction. Until the building industry is so organized that year-to-year needs for new construction are supplied annually and not left to cumulate, the greatest employment problems in the brick and tile industry will also remain unsolved.

Seasonal employment is affected by the factor of the weather militating against continuous operation and also by seasonal demand in the building industry. Probably all the large plants today could be run 12 months of the year, though this might require storing the clay for a few weeks or blasting the clay in certain winter months. For the past 10 years the fluctuations in demand have certainly been an outstanding factor in the seasonal operation of the plants. In city construction there tend to be spring and fall seasons of building which lead to a certain amount of seasonality in production and employment in the plants. An examination of plant seasonals in recent years, however, shows great irregularity due doubtless to the existence of a capacity several times greater than the existing demand. When an order comes in that cannot be filled from stock, the plants operate to the capacity of the brick machine and kiln and then shut down until that stock is nearing exhaustion. Only as plant capacity becomes more adjusted to demand will the seasonal fluctuations cease to be so erratic and so great.

Since the industry seems always to be in a state of contraction or expansion, there can be little stability in any adjustment. There are still many small plants that operate only in summer and fill a local demand, but as far as the total production in the industry is concerned, these are of relatively minor significance.

Man-years of Work Supplied by the Brick and Tile Plants

An attempt has been made to estimate the average length of the full-time working year and by means of this and the annual production to make a rough estimate of the number of jobs that the

industry offers, assuming that an average man-year is equivalent to an average job. If 6 weeks are allowed for necessary shut-downs and holidays in 1925, then 46 weeks can be considered as the average length of the working year. The normal or full-time working week in 1925 was approximately 53 hours in length. Adjusting the normal week by a 10-percent reduction in order to approximate the actual hours worked gives a man-year of 2,200 hours. Looked at in terms of income, this average job furnished an income of approximately \$1,100 in 1925. In 1935, with the decrease in the number of hours worked per week, the average number of hours per job per year was approximately 1,700, which would afford an income of around \$700 when the fall in wages is also considered.⁴ The number of these jobs was approximately 63,000 in 1925 and 19,000 in 1935. To what extent the number of jobs so estimated was in fact divided among a greater number of men because of part-time work is unknown.

From similar data an estimate was made of the number of man-years required to produce a million brick in different years. While it took 14.7 man-years to produce a million brick in 1869, this had decreased to 5.7 in 1909 and further to 4.1 by 1925. In the depression this rose to 6.0 because of the increase in the man-hour ratio and the decrease in the number of hours in the working year.⁵

Looked at differently, 50 men, a rather typical plant force before the depression, would have produced on the average 3.4 million brick in 1869, 8.8 million in 1909, and 12.2 million in 1925, while in 1933 they would have produced only 8.3 million.

The question naturally arises as to how many man-years of employment we may expect the brick and tile plants to offer to workers when the industry will have resumed more normal production. Past experience shows that when that time arrives several factors will combine to bring about an increase in the productivity of the brick and tile plants: (1) The increase in the capacity utilized in the individual plants making for a better utilization of plant facilities and labor; (2) a more than proportional increase in production in some of the large plants with the lowest man-hour ratios, which have either been shut down or are running at lower production levels than other plants; (3) the large field

⁴Average hourly earnings on which these estimates are based were obtained from the plant reports of the NRP-NBER field survey.

⁵These estimates and those that follow include only the labor of wage earners in the plant and exclude that of office workers.

still available for installation of technological improvements; and (4) the characteristic of the industry of adding improved equipment during periods of high production. If it is assumed that with the resumption of activity the average length of the working year has increased to 47 weeks because of the closing down of most of the smaller summer plants and that a 40-hour week has become the normal full-time working week, then allowing 10 percent for interruptions, the actual hours worked per employee per year would average around 1,690. Then if the assumption is also made that productivity improves at the same rate as it did between 1919 and 1925, the average man-hour ratio might be 7.4 man-hours at the peak of production, and the man-years per million brick might be 4.4. The period 1919-25 was chosen as corresponding to this future period of revival and prosperity since they were years when the industry was expanding its production after a depressed period. If production at its height can be assumed to have returned to its 1929 level, the industry would be offering approximately 55,000 jobs for wage earners in the plants. These would be in larger plants than were operating in 1925, and they would be more concentrated in the neighborhood of metropolitan areas and in the localities having the better deposits of clay. The plants would probably produce a larger proportion of face brick and hollow building tile than in the twenties, and their products would be more diversified.

The present deficiency in housing, the Government housing program, the conservativeness of the consumers of building materials coupled with the present building codes favoring brick, and the trend of population toward communities located within commuting distances from metropolitan centers make it seem likely that the brick and tile industry is due to return to a certain degree of activity which will absorb workers into the industry but at a slower rate than the increase in production.

APPENDIXES

Except as credited to another source, all data presented in the appendixes are based on the first and second surveys mentioned in the Introduction. Where necessary in order to distinguish these surveys from other sources, they have been cited as the NRP-NBER field survey.

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APPENDIX A
STATISTICAL DATA

**Table A-1. - ANALYSIS OF SAMPLE OF BRICK AND TILE PLANTS:
COMMON-BRICK PRODUCTION, BY REGION, 1919-31^a**

(Thousands of brick)

| Region | 1919 | 1921 | 1923 | 1925 | 1927 | 1929 | 1931 |
|---|-----------|-----------|-----------|-----------|------------------------|-----------|----------------------|
| United States | | | | | | | |
| Sample | 277,899 | 239,316 | 847,421 | 991,366 | 855,626 ^b | 692,030 | 249,290 |
| Universe | 4,751,881 | 4,447,987 | 7,282,181 | 7,561,501 | 7,060,984 | 5,505,359 | 2,314,664 |
| Sample as percent of universe | 5.8 | 5.4 | 11.6 | 13.1 | 12.1 | 12.6 | 10.8 |
| Region I - New York and New Jersey | | | | | | | |
| Sample | 16,403 | 31,776 | 59,966 | 76,341 | 92,806 | 66,739 | 80,344 |
| Universe | 692,755 | 811,896 | 1,297,142 | 1,353,774 | 1,554,888 | 1,011,270 | 736,246 |
| Sample as percent of universe | 2.4 | 3.9 | 4.6 | 5.6 | 6.0 | 6.6 | 10.9 |
| Region II - Pennsylvania | | | | | | | |
| Sample | 0 | 0 | 29,629 | 42,785 | 75,760 | 79,384 | 26,404 |
| Universe | 450,144 | 362,138 | 639,573 | 592,542 | 508,630 | 418,458 | 162,178 |
| Sample as percent of universe | 0 | 0 | 4.6 | 7.2 | 14.9 | 19.0 | 17.3 |
| Region III - Ohio | | | | | | | |
| Sample | 6,754 | 6,698 | 8,727 | 8,749 | 24,529 | 20,297 | 3,171 |
| Universe | 293,757 | 287,877 | 384,278 | 369,311 | 300,095 | 280,411 | 86,630 |
| Sample as percent of universe | 2.3 | 2.6 | 2.5 | 2.4 | 8.2 | 7.8 | 3.7 |
| Region IV - Illinois, Indiana, and Wisconsin | | | | | | | |
| Sample | 240,469 | 164,662 | 817,949 | 732,645 | 515,696 | 333,659 | 19,698 |
| Universe | 742,435 | 673,602 | 1,492,461 | 1,709,252 | 1,494,800 ^c | 1,020,414 | 187,457 |
| Sample as percent of universe | 32.4 | 24.4 | 41.4 | 42.9 | 34.5 | 32.7 | 10.5 |
| Region V - Maryland, Virginia, North Carolina, and Tennessee | | | | | | | |
| Sample | 11,669 | 31,742 | 93,504 | 85,331 | 101,255 | 94,017 | 56,302 |
| Universe | 543,921 | 497,097 | 729,261 | 663,997 | 653,758 | 574,346 | 232,506 |
| Sample as percent of universe | 2.2 | 6.4 | 12.8 | 12.5 | 15.5 | 16.4 | 24.2 |
| Region VI - Florida, Georgia, and Alabama | | | | | | | |
| Sample | 0 | 0 | 30,181 | 29,977 | 28,482 | 27,017 | 11,763 |
| Universe | 269,104 | 283,347 | 369,122 | 430,856 | 327,372 ^d | 310,149 | 106,647 ^e |
| Sample as percent of universe | 0 | 0 | 8.2 | 7.0 | 8.7 | 8.7 | 11.0 |
| Region VII - Iowa, Nebraska, Kansas, Missouri, Oklahoma, and Texas | | | | | | | |
| Sample | 2,404 | 4,433 | 7,445 | 13,338 | 14,025 ^b | 70,917 | 38,996 |
| Universe | 527,746 | 423,784 | 597,627 | 678,886 | 337,456 ^f | 541,924 | 216,640 |
| Sample as percent of universe | 0.5 | 1.0 | 1.2 | 2.0 | 4.2 | 13.1 | 18.0 |
| Region VIII - California | | | | | | | |
| Sample | 0 | 0 | 0 | 0 | 0 | 0 | 8,619 |
| Universe | 126,892 | 192,214 | 426,340 | 429,032 | 324,207 | 287,971 | 94,709 |
| Sample as percent of universe | 0 | 0 | 0 | 0 | 0 | 0 | 9.3 |
| Region IX - All others | | | | | | | |
| Sample | 0 | 0 | 0 | 0 | 2,671 | 0 | 1,793 |
| Universe | 1,106,123 | 946,092 | 1,376,173 | 1,313,701 | 1,559,778 | 1,080,410 | 491,631 |
| Sample as percent of universe | 0 | 0 | 0 | 0 | 0.2 | 0 | 0.4 |

^aData for universe from Census of Manufactures.

^bIncludes 9,945,000 common-brick equivalents.

^cExcludes Wisconsin.

^dExcludes Florida.

^eCensus reports no producing establishments in Florida for this year.

^fIncludes Missouri and Texas only.

**Table A-2.- ANALYSIS OF SAMPLE OF BRICK AND TILE PLANTS:
FACE-BRICK PRODUCTION, BY REGION, 1919-31^a**

(Thousands of brick)

| Region | 1919 | 1921 | 1923 | 1925 | 1927 | 1929 | 1931 |
|----------------------------------|---------|---------|-----------|---------------------|----------------------|---------------------|----------------------|
| United States | | | | | | | |
| Sample | 15,461 | 15,561 | 75,329 | 164,562 | 122,222 | 170,092 | 62,333 |
| Universe | 791,068 | 673,346 | 1,931,175 | 2,474,690 | 2,412,903 | 2,139,406 | 903,226 |
| Sample as percent of universe | 2.0 | 1.6 | 3.9 | 6.6 | 5.1 | 6.0 | 6.9 |
| Region I | | | | | | | |
| Sample | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Universe | 27,320 | 30,366 | 37,752 | 26,537 ^b | 21,995 ^b | 21,937 ^b | 2,065 ^b |
| Sample as percent of universe | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Region II | | | | | | | |
| Sample | 0 | 0 | 0 | 0 | 26,206 | 27,106 | 14,136 |
| Universe | 190,309 | 223,706 | 466,910 | 567,655 | 593,117 | 466,222 | 210,725 |
| Sample as percent of universe | 0 | 0 | 0 | 0 | 4.8 | 5.8 | 6.7 |
| Region III ^c | | | | | | | |
| Sample | 0 | 0 | 0 | 0 | 24,399 | 34,677 | 7,477 |
| Universe | 148,747 | 181,559 | 496,534 | 579,198 | 567,662 | 500,662 | 218,162 |
| Sample as percent of universe | 0 | 0 | 0 | 0 | 4.3 | 6.9 | 3.4 |
| Region IV | | | | | | | |
| Sample | 8,233 | 15,489 | 56,012 | 58,940 | 60,375 | 72,534 | 26,610 |
| Universe | 176,354 | 168,637 | 395,030 | 500,684 | 414,033 ^d | 357,452 | 130,196 ^e |
| Sample as percent of universe | 4.6 | 9.2 | 14.2 | 11.8 | 14.6 | 20.3 | 20.4 |
| Region V | | | | | | | |
| Sample | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Universe ^d | 11,533 | 23,266 | 90,623 | 136,598 | 126,033 | 114,718 | 36,979 ^e |
| Sample as percent of universe | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Region VII ^f | | | | | | | |
| Sample | 7,226 | 92 | 7,433 | 2,605 | 0 | 22,627 | 6,705 |
| Universe | 117,191 | 102,667 | 193,941 | 258,556 | 146,142 | 252,678 | 99,907 |
| Sample as percent of universe | 6.2 | 0.1 | 3.8 | 1.0 | 0 | 9.0 | 6.7 |
| Region VIII | | | | | | | |
| Sample | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Universe | 7,668 | 14,167 | 26,664 | 34,163 | 22,266 | 17,479 | 3,274 |
| Sample as percent of universe | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Region IX ^g | | | | | | | |
| Sample | 0 | 0 | 11,984 | 103,017 | 9,192 | 12,948 | 5,405 |
| Universe | 109,926 | 126,756 | 221,721 | 350,979 | 519,433 | 466,340 | 201,918 |
| Sample as percent of universe | 0 | 0 | 5.4 | 29.4 | 1.8 | 3.2 | 2.7 |

^aData for universe from *Census of Manufactures*. See table A-1 for States included in each region.

^bNew Jersey only.

^cExcludes Wisconsin.

^dMaryland included in Region IX; census reports no producing establishments in Virginia and North Carolina for 1919 and 1921.

^eExcludes Tennessee.

^fNebraska included in Region IX; Kansas, Iowa, and Oklahoma excluded in 1927.

^gIncludes Region VI.

**Table A-3.- ANALYSIS OF SAMPLE OF BRICK AND TILE PLANTS:
VITRIFIED-BRICK PRODUCTION, BY REGION, 1919-29^a**

(Thousands of brick)

| Region | 1919 | 1921 | 1923 | 1925 | 1927 ^b | 1929 |
|----------------------------------|---------|---------|---------|---------------------|-------------------|---------|
| United States | | | | | | |
| Sample | 8,670 | 8,537 | 14,368 | 1,269 | 95,182 | 80,306 |
| Universe | 489,242 | 561,946 | 699,289 | 539,101 | 405,812 | 367,650 |
| Sample as percent of universe | 1.8 | 1.5 | 2.1 | 0.2 | 23.5 | 21.6 |
| Region II | | | | | | |
| Sample | 0 | 0 | 0 | 0 | 29,844 | 18,866 |
| Universe | 66,204 | 85,848 | 80,262 | 57,363 ^c | 46,643 | 44,080 |
| Sample as percent of universe | 0 | 0 | 0 | 0 | 61.4 | 42.8 |
| Region III | | | | | | |
| Sample | 0 | 0 | 0 | 0 | 60,456 | 49,285 |
| Universe | 125,491 | 191,185 | 185,215 | 158,068 | 109,807 | 136,194 |
| Sample as percent of universe | 0 | 0 | 0 | 0 | 55.1 | 36.2 |
| Region IV ^d | | | | | | |
| Sample | 0 | 0 | 0 | 0 | 0 | 3,977 |
| Universe | 68,244 | 97,446 | 126,494 | 77,907 | 46,841 | 31,664 |
| Sample as percent of universe | 0 | 0 | 0 | 0 | 0 | 12.6 |
| Region VII ^e | | | | | | |
| Sample | 0 | 0 | 0 | 0 | 0 | 0 |
| Universe | 32,961 | 47,574 | 64,132 | 47,908 | 36,966 | 14,412 |
| Sample as percent of universe | 0 | 0 | 0 | 0 | 0 | 0 |
| Region IX ^f | | | | | | |
| Sample | 8,670 | 8,537 | 14,368 | 1,269 | 4,882 | 8,178 |
| Universe | 176,342 | 139,893 | 243,166 | 197,855 | 163,555 | 141,300 |
| Sample as percent of universe | 4.9 | 6.1 | 5.9 | 0.6 | 3.0 | 5.8 |

^aData for universe from *Census of Manufactures*. See table A-1 for States included in each region.

^bData for universe are for "paving brick" only.

^cIncludes "vitrified paving brick" only. Data for "other paving brick" included in census classification "other States" to avoid disclosing data for individual establishments.

^dIndiana included in Region IX. No production reported for Wisconsin by census.

^eKansas only; all other States are included in Region IX.

^fIncludes Regions I, V, VI, and VIII.

**Table A-4.- ANALYSIS OF SAMPLE OF BRICK AND TILE PLANTS:
HOLLOW-BUILDING-TILE PRODUCTION, BY REGION, 1919-31^a**

(Tons)

| Region | 1919 ^b | 1921 ^b | 1923 | 1925 | 1927 | 1929 | 1931 |
|----------------------------------|----------------------|----------------------|-----------|-----------|-----------|-----------|----------------------|
| United States | | | | | | | |
| Sample | 1,739 | 1,063 | 2,034 | 2,896 | 4,073 | 218,296 | 140,311 |
| Universe | 2,329,217 | 2,017,543 | 3,326,348 | 3,818,966 | 3,605,519 | 3,317,829 | 1,646,254 |
| Sample as percent of universe | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 6.6 | 8.5 |
| Region I | | | | | | | |
| Sample | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Universe | 194,789 | 215,005 | 361,303 | 438,726 | 456,266 | 514,564 | 293,056 |
| Sample as percent of universe | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Region II | | | | | | | |
| Sample | 0 | 0 | 0 | 0 | 21 | 19 | 11 |
| Universe | 175,780 | 126,847 | 211,029 | 245,772 | 266,217 | 252,554 | 109,757 |
| Sample as percent of universe | 0 | 0 | 0 | 0 | * | * | * |
| Region III | | | | | | | |
| Sample | 0 | 0 | 0 | 0 | 233 | 3,182 | 1,417 |
| Universe | 664,744 | 650,637 | 1,064,662 | 1,180,131 | 1,133,961 | 745,052 | 399,216 |
| Sample as percent of universe | 0 | 0 | 0 | 0 | * | 0.4 | 0.4 |
| Region IV ^c | | | | | | | |
| Sample | 0 | 0 | 0 | 0 | 0 | 106,913 | 27,980 |
| Universe | 467,530 | 340,897 | 468,183 | 361,828 | 619,511 | 511,519 | 187,220 |
| Sample as percent of universe | 0 | 0 | 0 | 0 | 0 | 20.9 | 14.9 |
| Region VII | | | | | | | |
| Sample | 1,739 | 1,063 | 2,034 | 2,896 | 3,821 | 81,519 | 95,371 |
| Universe | 493,782 ^d | 314,366 ^d | 568,332 | 625,751 | 594,485 | 596,690 | 247,694 ^e |
| Sample as percent of universe | 0.4 | 0.3 | 0.3 | 0.5 | 0.7 | 13.7 | 38.5 |
| Region VIII | | | | | | | |
| Sample | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Universe | 54,186 | 73,828 | 105,547 | 85,309 | 99,006 | 81,475 | 51,972 |
| Sample as percent of universe | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Region IX ^f | | | | | | | |
| Sample | 0 | 0 | 0 | 0 | 0 | 26,663 | 15,552 |
| Universe | 288,426 | 296,965 | 506,392 | 661,466 | 496,093 | 616,675 | 357,337 |
| Sample as percent of universe | 0 | 0 | 0 | 0 | 0 | 4.3 | 4.4 |

^aData for universe from *Census of Manufactures*; universe includes "partition, load bearing, furring, and book tile" only. See table A-1 for States included in each region.

^bData for universe are for all "hollow building tile or block."

^cWisconsin included in Region IX.

^dcensus reports no producing establishments in Oklahoma.

^eExcludes Oklahoma.

^fIncludes Regions V and VI.

*Less than 0.05 percent.

**Table A-5.- ANALYSIS OF SAMPLE OF BRICK AND TILE PLANTS:
DRAIN-TILE PRODUCTION, BY REGION, 1919-29^a**

(Tons)

| Region | 1919 | 1921 | 1923 | 1925 | 1927 | 1929 |
|----------------------------------|-----------|---------|---------|---------|---------|---------|
| United States | | | | | | |
| Sample | 24,761 | 23,217 | 24,624 | 19,705 | 29,284 | 44,228 |
| Universe | 1,241,168 | 976,313 | 615,640 | 660,673 | 734,392 | 858,521 |
| Sample as percent of universe | 2.0 | 2.4 | 4.0 | 3.0 | 4.0 | 5.2 |
| Region III | | | | | | |
| Sample | 0 | 0 | 0 | 0 | 0 | 0 |
| Universe | 246,158 | 256,333 | 168,485 | 201,748 | 197,974 | 271,796 |
| Sample as percent of universe | 0 | 0 | 0 | 0 | 0 | 0 |
| Region IV ^b | | | | | | |
| Sample | 0 | 0 | 0 | 0 | 3,178 | 3,412 |
| Universe | 403,554 | 231,246 | 160,512 | 210,103 | 232,692 | 252,634 |
| Sample as percent of universe | 0 | 0 | 0 | 0 | 1.4 | 1.3 |
| Region VII ^c | | | | | | |
| Sample | 24,761 | 23,217 | 24,624 | 19,705 | 26,106 | 38,960 |
| Universe | 335,587 | 269,554 | 173,678 | 119,933 | 176,404 | 200,224 |
| Sample as percent of universe | 7.4 | 8.6 | 14.2 | 16.4 | 14.8 | 19.4 |
| Region IX ^d | | | | | | |
| Sample | 0 | 0 | 0 | 0 | 0 | 1,956 |
| Universe | 255,869 | 219,180 | 112,965 | 128,829 | 127,332 | 133,667 |
| Sample as percent of universe | 0 | 0 | 0 | 0 | 0 | 1.5 |

^aData for universe from *Census of Manufactures*. See table A-1 for States included in each region.

^bWisconsin included in Region IX.

^cIowa only; other States included in Region IX.

^dIncludes Regions I, II, V, VI, and VIII.

**Table A-6. - ANALYSIS OF SAMPLE OF BRICK AND TILE PLANTS:
PERCENTAGE DISTRIBUTION OF COMMON-BRICK PRODUCTION
BY REGION, 1919-31^a**

(United States = 100 percent)

| Year | Region | | | | | | | | |
|----------|--------|------|-----|-------------------|------|------------------|------------------|------|------|
| | I | II | III | IV | V | VI | VII | VIII | IX |
| 1919 | | | | | | | | | |
| Sample | 5.9 | 0 | 2.4 | 86.5 | 4.3 | 0 | 0.9 | 0 | 0 |
| Universe | 14.6 | 9.5 | 6.2 | 15.6 | 11.4 | 5.6 | 11.1 | 2.7 | 23.3 |
| 1921 | | | | | | | | | |
| Sample | 13.3 | 0 | 2.8 | 68.8 | 13.3 | 0 | 1.8 | 0 | 0 |
| Universe | 18.3 | 8.1 | 5.8 | 15.1 | 11.2 | 6.4 | 9.5 | 4.3 | 21.3 |
| 1923 | | | | | | | | | |
| Sample | 7.1 | 3.5 | 1.0 | 72.9 | 11.0 | 3.6 | 0.9 | 0 | 0 |
| Universe | 17.8 | 8.8 | 4.9 | 20.4 | 10.0 | 5.1 | 8.2 | 5.9 | 18.9 |
| 1925 | | | | | | | | | |
| Sample | 7.9 | 4.3 | 0.9 | 73.9 | 8.6 | 3.0 | 1.4 | 0 | 0 |
| Universe | 17.9 | 7.8 | 4.9 | 22.6 | 9.0 | 5.7 | 9.0 | 5.7 | 17.4 |
| 1927 | | | | | | | | | |
| Sample | 10.9 | 8.9 | 2.9 | 60.3 | 11.8 | 3.3 | 1.6 ^b | 0 | 0.3 |
| Universe | 22.0 | 7.2 | 4.3 | 21.1 ^c | 9.3 | 4.6 ^d | 4.8 ^e | 4.6 | 22.1 |
| 1929 | | | | | | | | | |
| Sample | 9.6 | 11.5 | 2.9 | 48.2 | 13.6 | 3.9 | 10.3 | 0 | 0 |
| Universe | 18.4 | 7.6 | 4.7 | 18.6 | 10.4 | 5.6 | 9.9 | 5.2 | 19.6 |
| 1931 | | | | | | | | | |
| Sample | 32.2 | 11.4 | 1.3 | 7.9 | 22.6 | 4.7 | 15.7 | 3.5 | 0.7 |
| Universe | 31.8 | 7.0 | 3.7 | 8.1 | 10.0 | 4.6 ^f | 9.4 | 4.1 | 21.3 |

^aComputed from table A-1. 1927 sample data for United States include 9,945,000 common-brick equivalents. See table A-1 for States included in each region.

^bIncludes 9,945,000 common-brick equivalents.

^cExcludes Wisconsin.

^dExcludes Florida.

^eIncludes Missouri and Texas only.

^fCensus reports no producing establishments in Florida for this year.

**Table A-7. - ANALYSIS OF SAMPLE OF BRICK AND TILE PLANTS:
PERCENTAGE DISTRIBUTION OF FACE-BRICK PRODUCTION
BY REGION, 1919-31^a**

(United States = 100 percent)

| Year | Region | | | | | | | |
|----------|------------------|------|------|-------------------|------------------|------------------|------|-----------------|
| | I | II | III | IV | V ^b | VII ^c | VIII | IX ^d |
| 1919 | | | | | | | | |
| Sample | 0 | 0 | 0 | 53.3 | 0 | 46.7 | 0 | 0 |
| Universe | 3.4 | 24.1 | 18.8 | 22.5 | 1.5 | 14.8 | 1.0 | 13.9 |
| 1921 | | | | | | | | |
| Sample | 0 | 0 | 0 | 99.4 | 0 | 0.6 | 0 | 0 |
| Universe | 3.5 | 25.6 | 20.8 | 19.3 | 2.7 | 11.8 | 1.6 | 14.7 |
| 1923 | | | | | | | | |
| Sample | 0 | 0 | 0 | 74.3 | 0 | 9.9 | 0 | 15.8 |
| Universe | 2.0 | 24.3 | 25.7 | 20.4 | 4.7 | 10.0 | 1.4 | 11.5 |
| 1925 | | | | | | | | |
| Sample | 0 | 0 | 0 | 35.8 | 0 | 1.6 | 0 | 62.6 |
| Universe | 1.1 ^e | 23.7 | 23.4 | 20.2 | 5.5 | 10.5 | 1.4 | 14.2 |
| 1927 | | | | | | | | |
| Sample | 0 | 23.1 | 20.0 | 49.4 ^f | 0 | 0 | 0 | 7.5 |
| Universe | 0.9 ^e | 24.6 | 23.5 | 17.2 ^f | 5.3 | 6.1 | 0.9 | 21.5 |
| 1929 | | | | | | | | |
| Sample | 0 | 15.9 | 20.4 | 42.7 | 0 | 13.4 | 0 | 7.6 |
| Universe | 1.0 ^e | 21.8 | 23.4 | 16.7 | 5.4 | 11.8 | 0.8 | 19.1 |
| 1931 | | | | | | | | |
| Sample | 0 | 22.7 | 12.0 | 42.7 | 0 | 13.9 | 0 | 8.7 |
| Universe | 0.2 ^e | 23.3 | 24.1 | 14.4 ^f | 4.1 ^g | 11.1 | 0.4 | 22.4 |

^a Computed from table A-2. See table A-1 for States included in each region.

^b Maryland included in Region IX; census reports no producing establishments in Virginia and North Carolina for 1919 and 1921.

^c Nebraska included in Region IX; Kansas, Iowa, and Oklahoma excluded in 1927.

^d Includes Region VI.

^e New Jersey only.

^f Excludes Wisconsin.

^g Excludes Tennessee.

**Table A-8.- ANALYSIS OF SAMPLE OF BRICK AND TILE PLANTS:
PERCENTAGE DISTRIBUTION OF VITRIFIED-BRICK PRODUCTION
BY REGION, 1919-29^a**

(United States = 100 percent)

| Year | Region | | | | |
|-----------------------|-------------------|------|-----------------|------------------|-----------------|
| | II | III | IV ^b | VII ^c | IX ^d |
| 1919 | | | | | |
| Sample | 0 | 0 | 0 | 0 | 100.0 |
| Universe | 13.5 | 25.7 | 18.0 | 6.7 | 36.1 |
| 1921 | | | | | |
| Sample | 0 | 0 | 0 | 0 | 100.0 |
| Universe | 15.3 | 34.0 | 17.3 | 8.5 | 24.9 |
| 1923 | | | | | |
| Sample | 0 | 0 | 0 | 0 | 100.0 |
| Universe | 11.5 | 26.5 | 18.1 | 9.1 | 34.8 |
| 1925 | | | | | |
| Sample | 0 | 0 | 0 | 0 | 100.0 |
| Universe | 10.6 ^e | 29.3 | 14.5 | 8.9 | 36.7 |
| 1927 | | | | | |
| Sample | 31.4 | 63.5 | 0 | 0 | 5.1 |
| Universe ^f | 12.0 | 27.1 | 11.5 | 9.1 | 40.3 |
| 1929 | | | | | |
| Sample | 23.5 | 61.4 | 4.9 | 0 | 10.2 |
| Universe | 12.0 | 37.1 | 8.6 | 3.9 | 36.4 |

^aComputed from table A-3. See table A-1 for States included in each region.

^bIndiana included in Region IX. No production reported for Wisconsin by census.

^cKansas only; all other States are included in Region IX.

^dIncludes Regions I, V, VI, and VIII.

^eIncludes "vitrified paving brick" only. Data for "other paving brick" included in census classification "other States" to avoid disclosing data for individual establishments.

^fData for universe are for "paving brick" only.

**Table A-8. - ANALYSIS OF SAMPLE OF BRICK AND TILE PLANTS:
PERCENTAGE DISTRIBUTION OF HOLLOW-BUILDING-TILE PRODUCTION
BY REGION, 1919-31^a**

(United States = 100 percent)

| Year | Region | | | | | | |
|-----------------------|--------|-----|------|-----------------|-------------------|------|-----------------|
| | I | II | III | IV ^b | VII | VIII | IX ^c |
| 1919 | | | | | | | |
| Sample | 0 | 0 | 0 | 0 | 100.0 | 0 | 0 |
| Universe ^d | 8.4 | 7.8 | 28.5 | 20.0 | 20.8 ^e | 2.3 | 12.4 |
| 1921 | | | | | | | |
| Sample | 0 | 0 | 0 | 0 | 100.0 | 0 | 0 |
| Universe ^d | 10.6 | 6.3 | 32.2 | 16.9 | 15.6 ^e | 3.7 | 14.7 |
| 1923 | | | | | | | |
| Sample | 0 | 0 | 0 | 0 | 100.0 | 0 | 0 |
| Universe | 10.8 | 6.4 | 32.6 | 14.1 | 17.7 | 3.2 | 15.2 |
| 1925 | | | | | | | |
| Sample | 0 | 0 | 0 | 0 | 100.0 | 0 | 0 |
| Universe | 11.5 | 6.4 | 30.9 | 14.7 | 16.4 | 2.2 | 17.9 |
| 1927 | | | | | | | |
| Sample | 0 | 0.5 | 5.7 | 0 | 93.8 | 0 | 0 |
| Universe | 12.7 | 7.4 | 31.4 | 17.2 | 14.8 | 2.7 | 13.8 |
| 1929 | | | | | | | |
| Sample | 0 | * | 1.5 | 49.0 | 37.3 | 0 | 12.2 |
| Universe | 15.5 | 7.6 | 22.4 | 15.4 | 18.0 | 2.5 | 18.6 |
| 1931 | | | | | | | |
| Sample | 0 | * | 1.0 | 19.9 | 68.0 | 0 | 11.1 |
| Universe | 17.8 | 6.7 | 24.2 | 11.4 | 15.0 ^f | 3.2 | 21.7 |

^aComputed from table A-4. Universe includes "partition, load bearing, furring, and book tile" only. See table A-1 for States included in each region.

^bWisconsin included in Region IX.

^cIncludes Regions V and VI.

^dData are for all "hollow building tile or block."

^eCensus reports no producing establishments in Oklahoma.

^fExcludes Oklahoma.

*Less than 0.05 percent.

**Table A-10. - ANALYSIS OF SAMPLE OF BRICK AND TILE PLANTS:
PERCENTAGE DISTRIBUTION OF DRAIN-TILE PRODUCTION
BY REGION, 1919-29^a**

(United States = 100 percent)

| Year | Region | | | |
|----------|--------|-----------------|------------------|-----------------|
| | III | IV ^b | VII ^c | IX ^d |
| 1919 | | | | |
| Sample | 0 | 0 | 100.0 | 0 |
| Universe | 19.8 | 32.5 | 27.1 | 20.6 |
| 1921 | | | | |
| Sample | 0 | 0 | 100.0 | 0 |
| Universe | 26.3 | 23.7 | 27.6 | 22.4 |
| 1923 | | | | |
| Sample | 0 | 0 | 100.0 | 0 |
| Universe | 27.4 | 26.1 | 28.2 | 18.3 |
| 1925 | | | | |
| Sample | 0 | 0 | 100.0 | 0 |
| Universe | 30.5 | 31.8 | 18.2 | 19.5 |
| 1927 | | | | |
| Sample | 0 | 10.9 | 89.1 | 0 |
| Universe | 27.0 | 31.7 | 24.0 | 17.3 |
| 1929 | | | | |
| Sample | 0 | 7.7 | 87.9 | 4.4 |
| Universe | 31.7 | 29.4 | 23.3 | 15.6 |

^aComputed from table A-5. See table A-1 for States included in each region.

^bWisconsin included in Region IX.

^cIowa only; other States included in Region IX.

^dIncludes Regions I, II, V, VI, and VIII.

**Table A-11.- ANALYSIS OF SAMPLE OF BRICK AND TILE PLANTS:
NUMBER OF ESTABLISHMENTS, MAN-HOURS, AND PRODUCTION
1925-35^a**

| Year | Number of establishments | Man-hours ^b (thousands) | Production (millions of common-brick equivalents) ^c |
|----------|--------------------------|---------------------------------------|--|
| | (1) | (2) | (3) |
| 1925 | | | |
| Sample | 36 | 7,730 | 1,263 |
| Universe | 1,528 | 137,327 | 13,293 |
| 1927 | | | |
| Sample | 52 | 9,759 | 1,251 |
| Universe | 1,395 | 129,077 | 14,802 |
| 1929 | | | |
| Sample | 68 | 10,450 | 1,270 |
| Universe | 1,307 | 111,056 | 12,677 |
| 1935 | | | |
| Sample | 64 | 3,858 | 454 |
| Universe | 708 | 32,545 | 3,352 |

^aData for universe from *Census of Manufactures*. Figures refer to establishments whose major product is one of the five specified products of the brick and tile industry.

^bFigures for universe represent total estimated man-hours utilized in the production of all products in the plants whose major product is brick and tile and hence differ from the man-hours utilized in the production of all brick and tile wherever produced for these same years. For method used in estimating man-hours, see appendix B, section on "Estimated Employment and Man-hours in Brick and Tile Manufacturing."

^cFigures for universe represent production in those plants only whose major product is one of the five specified and hence differ from figures for total production of all brick and tile for these years. They were converted into common-brick equivalents by means of the conversion factors in table A-12. The value of that part of the production in each group of plants which was concerned with minor products (not the major product) was converted into equivalent units of the major product on the basis of value.

**Table A-12.- FACTORS FOR CONVERSION INTO
COMMON-BRICK EQUIVALENTS^a**

| Product | Year | Conversion factor | Product | Year | Conversion factor |
|-----------------------------------|-----------|-------------------|---|-----------|-------------------|
| Common brick | - | 1.000 | Hollow building tile ^c -Con. | 1904 | 0.899 |
| Face brick ^b | 1889-1911 | 1.958 | | 1905 | 0.878 |
| | 1912 | 1.901 | | 1906 | 0.858 |
| | 1913 | 1.845 | | 1907 | 0.837 |
| | 1914 | 1.791 | | 1908 | 0.817 |
| | 1915 | 1.739 | | 1909 | 0.797 |
| | 1916 | 1.688 | | 1910 | 0.776 |
| | 1917 | 1.639 | | 1911 | 0.756 |
| | 1918 | 1.591 | | 1912 | 0.735 |
| | 1919-35 | 1.545 | | 1913 | 0.715 |
| Vitrified brick | 1889-1918 | 1.809 | | 1914 | 0.695 |
| | 1919-35 | 1.936 | | 1915 | 0.674 |
| | | | | 1916 | 0.654 |
| | | | | 1917 | 0.633 |
| Hollow building tile ^c | 1889-99 | 1.000 | | 1918 | 0.613 |
| | 1900 | 0.980 | | 1919-35 | 0.593 |
| | 1901 | 0.960 | | | |
| | 1902 | 0.939 | Drain tile | 1859-1918 | 0.655 |
| | 1903 | 0.919 | | 1919-35 | 0.687 |

^aFor method of computation and sources see appendix B, section on "Conversion of Census Production Data into Common-Brick Equivalents."

^bBecause of a rapid shift in average value relative to common brick from 1911 to 1919, annual conversion factors have been geometrically interpolated between the conversion factors for the periods 1889-1911 and 1919-35 in order to reflect the transition to a lower relative value.

^cBecause of a gradual change in average value relative to common brick from 1889 to 1919, annual conversion factors have been interpolated on a straight-line basis between 1889 and 1919 in order to reflect the transition to a lower relative value.

**Table A-13. - INDEXES OF PRODUCTION OF BRICK AND TILE PRODUCTS
1894-1935^a**

(1922-23=100)

| Year | Total production (common-brick equivalents) ^b | | Common brick | | Face brick | | Vitrified brick | | Hollow building tile ^c | | Drain tile ^d | |
|------|--|-------|--------------|-------|------------|-------|-----------------|-------|-----------------------------------|-------|---------------------------|-------|
| | Millions | Index | Millions | Index | Millions | Index | Millions | Index | Thou- sands of tons | Index | Thou- sands of tons | Index |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) |
| 1894 | 7,997 | 57.6 | 6,152 | 60.5 | n.a. | - | 457 | 90.8 | n.a. | - | 1,554 | 235.9 |
| 1895 | 8,029 | 58.0 | 6,018 | 58.5 | 339 | 15.7 | 392 | 75.8 | n.a. | - | 1,004 | 152.4 |
| 1896 | 7,772 | 56.2 | 5,701 | 55.8 | 271 | 12.6 | 347 | 68.0 | 328 | 6.5 | 392 | 135.4 |
| 1897 | 7,612 | 55.0 | 5,293 | 52.6 | 311 | 14.4 | 436 | 86.6 | 397 | 10.3 | 803 | 121.9 |
| 1898 | 8,254 | 59.6 | 5,867 | 58.3 | 296 | 13.7 | 474 | 94.2 | 350 | 9.4 | 901 | 136.8 |
| 1899 | 10,642 | 76.9 | 7,695 | 75.2 | 439 | 20.3 | 581 | 115.4 | 326 | 6.5 | 1,066 | 164.8 |
| 1900 | 9,705 | 70.2 | 7,141 | 70.0 | 345 | 16.0 | 547 | 106.6 | 361 | 9.4 | 841 | 127.7 |
| 1901 | 10,859 | 78.5 | 8,039 | 78.2 | 415 | 19.3 | 605 | 120.2 | 374 | 9.7 | 847 | 128.8 |
| 1902 | 11,702 | 84.6 | 8,475 | 84.6 | 458 | 21.3 | 617 | 122.6 | 645 | 16.8 | 928 | 140.9 |
| 1903 | 12,000 | 86.7 | 8,454 | 84.5 | 433 | 20.1 | 654 | 130.0 | 793 | 20.6 | 1,196 | 180.0 |
| 1904 | 12,549 | 90.7 | 8,665 | 86.7 | 434 | 20.1 | 735 | 146.1 | 898 | 23.4 | 1,368 | 207.7 |
| 1905 | 13,745 | 99.3 | 9,817 | 97.4 | 542 | 25.1 | 666 | 132.3 | 828 | 21.5 | 1,430 | 217.1 |
| 1906 | 14,494 | 104.7 | 10,027 | 102.7 | 617 | 28.6 | 752 | 149.4 | 964 | 25.1 | 1,636 | 248.3 |
| 1907 | 14,447 | 104.4 | 9,796 | 95.6 | 565 | 27.2 | 676 | 134.1 | 926 | 24.1 | 1,747 | 265.2 |
| 1908 | 12,839 | 92.8 | 9,811 | 95.6 | 584 | 27.1 | 978 | 194.3 | 737 | 19.2 | 2,310 | 350.6 |
| 1909 | 15,743 | 113.8 | 9,792 | 95.6 | 616 | 30.8 | 1,024 | 203.3 | 1,036 | 27.0 | 2,559 | 388.4 |
| 1910 | 14,990 | 106.3 | 9,222 | 90.6 | 698 | 32.4 | 968 | 192.3 | 1,180 | 30.7 | 2,850 | 402.2 |
| 1911 | 14,132 | 102.1 | 8,475 | 82.6 | 725 | 33.6 | 949 | 188.5 | 1,354 | 35.2 | 2,287 | 347.1 |
| 1912 | 14,329 | 103.5 | 8,555 | 83.6 | 814 | 37.7 | 912 | 181.1 | 1,704 | 44.3 | 2,023 | 307.1 |
| 1913 | 14,197 | 102.5 | 8,089 | 78.2 | 828 | 36.4 | 959 | 190.4 | 2,038 | 53.0 | 2,104 | 320.0 |
| 1914 | 13,099 | 94.7 | 7,147 | 70.0 | 810 | 37.6 | 931 | 185.0 | 2,050 | 53.3 | 2,125 | 322.6 |
| 1915 | 12,810 | 92.6 | 6,851 | 67.0 | 856 | 39.7 | 953 | 189.4 | 1,936 | 50.4 | 2,203 | 334.4 |
| 1916 | 13,316 | 99.5 | 7,394 | 72.6 | 1,003 | 42.5 | 942 | 187.0 | 2,323 | 60.4 | 2,302 | 349.4 |
| 1917 | 11,372 | 82.2 | 5,865 | 58.3 | 758 | 35.1 | 707 | 140.4 | 2,590 | 67.4 | 2,058 | 312.4 |
| 1918 | 6,601 | 49.1 | 3,557 | 35.3 | 356 | 16.5 | 403 | 80.0 | 1,953 | 50.8 | 1,148 | 174.3 |
| 1919 | 9,155 | 66.2 | 4,752 | 46.9 | 791 | 36.7 | 469 | 97.2 | 2,328 | 60.6 | 1,241 | 188.4 |
| 1920 | 6,322 | 47.4 | 4,452 | 43.8 | 787 | 38.5 | 466 | 93.1 | 2,579 | 67.1 | 1,191 | 180.8 |
| 1921 | 6,752 | 53.2 | 4,446 | 43.8 | 873 | 40.5 | 582 | 111.6 | 2,018 | 52.5 | 976 | 148.2 |
| 1922 | 8,200 | 60.9 | 5,899 | 58.6 | 1,417 | 65.7 | 517 | 102.5 | 2,970 | 74.7 | 595 | 90.3 |
| 1923 | 14,275 | 103.2 | 7,282 | 71.6 | 1,931 | 69.5 | 699 | 138.9 | 3,765 | 98.0 | 616 | 93.4 |
| 1924 | 13,872 | 100.2 | 7,159 | 70.6 | 2,030 | 74.1 | 554 | 110.1 | 3,535 | 92.0 | 593 | 90.0 |
| 1925 | 15,368 | 111.2 | 7,562 | 74.6 | 2,475 | 114.7 | 539 | 107.1 | 4,225 | 108.9 | 661 | 100.3 |
| 1926 | 14,978 | 108.2 | 7,517 | 73.8 | 2,440 | 113.1 | 463 | 92.9 | 4,096 | 106.6 | 519 | 78.9 |
| 1927 | 14,768 | 106.3 | 7,061 | 69.6 | 2,413 | 111.9 | 503 | 100.0 | 4,114 | 107.1 | 734 | 111.5 |
| 1928 | 13,706 | 99.0 | 6,413 | 63.1 | 2,412 | 111.8 | 378 | 75.2 | 3,976 | 103.5 | 694 | 103.4 |
| 1929 | 12,581 | 90.9 | 5,505 | 54.0 | 2,139 | 98.2 | 368 | 73.0 | 4,164 | 108.3 | 659 | 100.3 |
| 1930 | 6,632 | 49.8 | 3,631 | 35.4 | 1,482 | 66.7 | 300 | 59.6 | 3,148 | 81.9 | 675 | 102.5 |
| 1931 | 5,429 | 39.2 | 2,315 | 22.8 | 903 | 41.9 | 207 | 41.2 | 1,928 | 50.2 | 253 | 38.4 |
| 1932 | 2,458 | 17.8 | 1,013 | 10.0 | 384 | 17.8 | 133 | 26.4 | 829 | 21.6 | 149 | 22.6 |
| 1933 | 2,035 | 14.7 | 1,020 | 10.0 | 270 | 12.5 | 63 | 12.5 | 608 | 15.8 | 168 | 25.5 |
| 1934 | 2,313 | 16.7 | 1,069 | 10.4 | 305 | 14.1 | 114 | 22.6 | 686 | 17.8 | 168 | 25.5 |
| 1935 | 3,426 | 24.8 | 1,811 | 17.8 | 473 | 21.9 | 83 | 16.5 | 913 | 23.8 | 264 | 40.1 |

^aData from *Mineral Resources of the United States* (U. S. Dept. Int., Bur. Mines) and *Census of Manufactures*. Figures prior to 1919 refer to quantities sold during the year, not quantities produced. Relatives were computed before figures were rounded off.

^bFor method of computation of total production in common-brick equivalents, see Appendix B, section on "Conversion of Census Production Data into Common-Brick Equivalents."

^cFigures for 1918 and prior years are estimated on basis of value. For method used see Appendix B, section on "Production and Average Value per Unit of Product."

^dFigures for 1918 and prior years are estimated on basis of value. For method used see Appendix B, section on "Production and Average Value per Unit of Product."

n.a. Data not available.

**Table A-14.- INDEXES OF BRICK AND TILE PRODUCTION
AND BUILDING ACTIVITY, 1894-1935**

(1914=100)

| Year | Production of brick and tile ^a | | Building activity ^b | 7-year moving average | |
|------|---|------------|--------------------------------|---|--------------------------------|
| | All products | Structural | | Production of structural brick and tile | Building activity ^b |
| | (1) | (2) | (3) | (4) | (5) |
| 1894 | 61.1 | 61.4 | 60.0 | 67.3 | 73.3 |
| 1895 | 61.3 | 66.7 | 79.7 | 66.0 | 70.5 |
| 1896 | 59.3 | 65.4 | 65.5 | 68.4 | 68.3 |
| 1897 | 58.1 | 62.8 | 73.1 | 70.6 | 66.9 |
| 1898 | 63.0 | 67.9 | 63.3 | 75.0 | 68.6 |
| 1899 | 61.2 | 68.6 | 76.4 | 79.7 | 68.0 |
| 1900 | 74.1 | 61.5 | 50.2 | 84.6 | 69.7 |
| 1901 | 82.9 | 91.9 | 72.1 | 90.4 | 71.8 |
| 1902 | 89.3 | 99.6 | 75.3 | 97.2 | 79.2 |
| 1903 | 91.6 | 100.2 | 77.7 | 101.8 | 85.2 |
| 1904 | 95.8 | 103.0 | 87.4 | 106.8 | 93.4 |
| 1905 | 104.9 | 115.8 | 115.3 | 107.3 | 97.0 |
| 1906 | 110.7 | 120.4 | 118.6 | 110.5 | 105.6 |
| 1907 | 110.3 | 118.9 | 107.2 | 112.6 | 111.5 |
| 1908 | 98.0 | 95.4 | 97.2 | 113.4 | 115.2 |
| 1909 | 120.2 | 121.9 | 136.1 | 113.1 | 115.5 |
| 1910 | 114.4 | 114.8 | 118.8 | 111.7 | 114.2 |
| 1911 | 107.9 | 108.9 | 113.2 | 109.3 | 113.2 |
| 1912 | 109.4 | 113.3 | 117.7 | 109.4 | 113.9 |
| 1913 | 108.3 | 110.5 | 109.3 | 107.1 | 110.1 |
| 1914 | 100.0 | 100.0 | 100.0 | 103.1 | 102.3 |
| 1915 | 97.8 | 96.2 | 102.5 | 95.2 | 90.3 |
| 1916 | 105.5 | 105.8 | 109.2 | 89.5 | 84.3 |
| 1917 | 66.8 | 67.3 | 64.0 | 84.5 | 77.8 |
| 1918 | 51.9 | 53.1 | 29.3 | 60.2 | 77.5 |
| 1919 | 69.5 | 73.4 | 75.9 | 80.4 | 86.5 |
| 1920 | 70.8 | 75.8 | 63.6 | 83.1 | 96.9 |
| 1921 | 86.5 | 69.8 | 98.3 | 88.3 | 114.7 |
| 1922 | 85.1 | 97.7 | 165.0 | 100.5 | 142.4 |
| 1923 | 108.4 | 124.7 | 182.1 | 109.6 | 161.8 |
| 1924 | 105.4 | 123.6 | 186.4 | 117.6 | 180.1 |
| 1925 | 116.9 | 138.6 | 223.3 | 125.4 | 192.5 |
| 1926 | 113.6 | 136.8 | 211.6 | 127.6 | 192.1 |
| 1927 | 110.3 | 132.0 | 191.9 | 120.8 | 179.6 |
| 1928 | 104.1 | 124.7 | 185.4 | 110.1 | 163.8 |
| 1929 | 95.6 | 112.5 | 162.1 | 93.3 | 136.2 |
| 1930 | 67.1 | 77.7 | 94.4 | 76.3 | 109.4 |
| 1931 | 41.2 | 48.4 | 77.6 | 60.3 | - |
| 1932 | 18.7 | 20.9 | 30.3 | 46.8 | - |
| 1933 | 15.5 | 17.9 | 24.4 | - | - |
| 1934 | 17.6 | 19.7 | n. a. | - | - |
| 1935 | 26.0 | 30.7 | n. a. | - | - |

^aBased on table A-13. "All products" includes common brick, face brick, vitrified brick, hollow building tile, and drain tile; "Structural" includes common brick, face brick, and hollow building tile.

^bAdapted from an index constructed by William H. Newman, "The Building Industry and Business Cycles," *The Journal of Business of the University of Chicago*, VIII, No. 3 (July 1935), Part 2, 63-71. It includes only private building, "those buildings erected by private enterprises and individuals each seeking to maximize his profit or satisfaction" (ibid., p. 2).

n. a. Data not available.

**Table A-15. - INDEXES OF WHOLESALE PRICES OF BUILDING MATERIALS
AND COMMON BRICK, ADJUSTED FOR WHOLESALE-PRICE LEVEL,
1890-1935^a**

(1926=100)

| Year | Building materials | Common brick | |
|------|--------------------|---------------|--|
| | | New York City | United States average unit value ^b |
| | (1) | (2) | (3) |
| 1890 | 82.7 | 71.0 | n. a. |
| 1891 | 79.2 | 62.2 | n. a. |
| 1892 | 79.9 | 67.2 | n. a. |
| 1893 | 77.9 | 66.3 | n. a. |
| 1894 | 83.1 | 63.5 | n. a. |
| 1895 | 79.5 | 66.2 | 91.6 |
| 1896 | 83.7 | 66.2 | 95.3 |
| 1897 | 80.3 | 64.4 | 91.2 |
| 1898 | 81.6 | 72.0 | 92.8 |
| 1899 | 83.5 | 66.3 | 84.5 |
| 1900 | 82.4 | 58.9 | 82.2 |
| 1901 | 80.1 | 63.3 | 87.2 |
| 1902 | 76.9 | 55.5 | 83.4 |
| 1903 | 78.4 | 60.2 | 85.4 |
| 1904 | 75.4 | 76.2 | 85.3 |
| 1905 | 80.0 | 81.9 | 88.5 |
| 1906 | 87.4 | 84.0 | 84.1 |
| 1907 | 87.1 | 57.4 | 78.4 |
| 1908 | 82.7 | 49.3 | 77.6 |
| 1909 | 79.4 | 57.4 | 73.7 |
| 1910 | 78.6 | 49.3 | 72.4 |
| 1911 | 85.2 | 55.2 | 77.3 |
| 1912 | 80.9 | 59.5 | 74.5 |
| 1913 | 81.2 | 57.2 | 75.6 |
| 1914 | 77.4 | 49.3 | 76.5 |
| 1915 | 77.0 | 52.9 | 75.4 |
| 1916 | 79.1 | 57.1 | 66.5 |
| 1917 | 75.1 | 46.0 | 59.2 |
| 1918 | 75.1 | 55.2 | 70.7 |
| 1919 | 63.4 | 70.0 | 82.3 |
| 1920 | 97.2 | 86.0 | 93.5 |
| 1921 | 99.8 | 94.7 | 112.1 |
| 1922 | 100.6 | 109.0 | 108.5 |
| 1923 | 108.1 | 119.6 | 109.8 |
| 1924 | 104.3 | 105.5 | 105.2 |
| 1925 | 98.3 | 66.3 | 96.3 |
| 1926 | 100.0 | 100.0 | 100.0 |
| 1927 | 99.3 | 88.4 | 99.1 |
| 1928 | 97.3 | 81.7 | 95.2 |
| 1929 | 100.1 | 68.4 | 95.4 |
| 1930 | 104.1 | 71.1 | 101.6 |
| 1931 | 108.5 | 63.4 | 109.0 |
| 1932 | 110.2 | 69.5 | 113.0 |
| 1933 | 116.8 | 84.8 | 111.7 |
| 1934 | 115.1 | 83.8 | 118.2 |
| 1935 | 106.6 | 74.0 | 106.6 |

^aBased on data in *Wholesale Prices*, bulletins of U. S. Dept. Labor, Bur. Labor Statistics. Indexes for building materials and common brick were deflated by the index for all commodities.

^bFigures for 1895-1912 are based on *Mineral Resources of the United States* (U. S. Dept. Int., Bur. Mines).
n. a. Data not available.

**Table A-16. - INDEXES OF PRODUCTION AND AVERAGE UNIT VALUE
OF STRUCTURAL BRICK AND TILE, 1913-35^a**

(1925=100)

| Year | Common brick | | Face brick | | Hollow building tile | | Average unit value divided by wholesale-price index ^b | | |
|------|--------------|--------------------|-------------|--------------------|----------------------|--------------------|--|------------|----------------------|
| | Pro-duction | Average unit value | Pro-duction | Average unit value | Pro-duction | Average unit value | Common brick | Face brick | Hollow building tile |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| 1913 | 107.6 | 52.8 | 33.9 | 63.7 | n.s. | - | 75.6 | 91.3 | - |
| 1914 | 95.1 | 52.1 | 33.2 | 62.8 | n.s. | - | 76.5 | 92.2 | - |
| 1915 | 91.2 | 52.4 | 35.1 | 61.1 | n.s. | - | 75.4 | 87.9 | - |
| 1916 | 98.4 | 56.9 | 41.1 | 62.7 | n.s. | - | 66.5 | 73.3 | - |
| 1917 | 78.0 | 69.6 | 31.1 | 75.2 | n.s. | - | 59.2 | 64.0 | - |
| 1918 | 47.3 | 92.8 | 14.6 | 93.7 | n.s. | - | 70.7 | 71.4 | - |
| 1919 | 63.2 | 114.0 | 32.4 | 111.1 | 56.9 | 113.5 | 82.3 | 80.2 | 81.9 |
| 1920 | 64.5 | 144.3 | 32.2 | 135.4 | 62.9 | 154.8 | 93.5 | 87.7 | 100.3 |
| 1921 | 59.1 | 109.4 | 35.8 | 113.9 | 49.2 | 108.2 | 112.1 | 110.7 | 110.9 |
| 1922 | 78.4 | 104.9 | 58.1 | 109.3 | 70.0 | 101.0 | 108.5 | 113.0 | 104.4 |
| 1923 | 96.9 | 110.5 | 79.2 | 110.4 | 91.9 | 110.6 | 109.8 | 109.7 | 109.9 |
| 1924 | 95.2 | 103.2 | 83.2 | 107.8 | 86.3 | 104.1 | 105.2 | 109.9 | 106.1 |
| 1925 | 100.6 | 99.7 | 101.4 | 100.6 | 103.1 | 102.0 | 98.3 | 97.2 | 98.6 |
| 1926 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| 1927 | 93.9 | 94.5 | 98.9 | 94.4 | 100.4 | 94.8 | 99.1 | 99.0 | 99.4 |
| 1928 | 85.3 | 92.1 | 98.8 | 91.0 | 97.0 | 95.6 | 95.2 | 94.1 | 98.9 |
| 1929 | 73.2 | 90.9 | 87.7 | 92.6 | 101.6 | 106.6 | 95.4 | 97.2 | 111.9 |
| 1930 | 48.3 | 87.8 | 60.7 | 91.1 | 76.9 | 104.0 | 101.6 | 105.4 | 120.4 |
| 1931 | 30.8 | 79.6 | 37.0 | 80.6 | 47.1 | 85.4 | 109.0 | 110.4 | 117.0 |
| 1932 | 13.5 | 73.2 | 15.7 | 75.3 | 20.3 | 75.6 | 113.0 | 116.2 | 117.0 |
| 1933 | 13.6 | 73.6 | 11.1 | 77.3 | 14.8 | 68.6 | 111.7 | 117.3 | 104.1 |
| 1934 | 14.6 | 88.5 | 12.5 | 85.3 | 16.7 | 83.5 | 118.2 | 113.9 | 111.5 |
| 1935 | 24.1 | 85.3 | 19.4 | 89.9 | 22.2 | 88.4 | 106.6 | 112.4 | 110.5 |

^aBased on Census of Manufactures data.^bWholesale-price index for all commodities from Wholesale Prices, bulletins of U. S. Dept. Labor, Bur. Labor Statistics.

n.s. Data not available.

Table A-17.- COMMON-BRICK PRICES IN SELECTED MARKETS, 1913-35

(Per thousand brick)

| Year | New York ^a (red domestic) | Chicago ^a (run- of-kiln) | Cincinnati ^a (red common) | United States | |
|------|--|---|--|--|-------------------------------|
| | | | | Average price, 82 yards ^a | Average value ^b |
| 1913 | \$ 6.56 | \$ 4.94 | \$ 7.00 | \$ 6.79 ^c | \$ 6.20 |
| 1914 | 5.53 | 4.87 | 6.75 | 6.71 ^c | 6.12 |
| 1915 | 6.05 | 4.78 | 6.25 | 6.74 ^c | 6.15 |
| 1916 | 6.03 | 4.78 | 6.75 | 7.32 ^c | 6.68 |
| 1917 | 8.88 | 4.95 | 8.44 | 8.95 ^c | 8.17 |
| 1918 | 11.93 | 7.45 | 12.94 | 11.94 ^c | 10.90 |
| 1919 | 15.96 | 8.95 | 13.58 | 14.01 | 13.36 |
| 1920 | 21.85 | 11.44 | 17.47 | 18.95 | 16.94 |
| 1921 | 15.21 | 9.33 | 16.94 | 15.76 | 12.84 |
| 1922 | 17.34 | 8.70 | 13.16 | 13.70 | 12.31 |
| 1923 | 19.81 | 8.76 | 14.05 | 14.51 | 12.97 |
| 1924 | 17.04 | 8.78 | 13.95 | 14.46 | 12.11 |
| 1925 | 14.70 | 8.61 | 12.62 | 14.00 | 11.71 |
| 1926 | 16.46 | 8.72 | 12.48 | 13.91 | 11.74 |
| 1927 | 13.87 | 8.91 | 12.02 | 14.02 | 11.10 |
| 1928 | 13.00 | 8.85 | 11.00 | 13.72 | 10.81 |
| 1929 | 10.73 | 8.87 | n.a. | 13.62 | 10.67 |
| 1930 | 10.10 | 9.02 | n.a. | 13.05 | 10.31 |
| 1931 | 10.02 | 8.68 | n.a. | 12.40 | 9.35 |
| 1932 | 9.54 | n.a. | n.a. | 10.69 | 8.59 |
| 1933 | 9.19 | n.a. | n.a. | 10.53 | 8.64 |
| 1934 | 10.33 | n.a. | n.a. | 12.00 | 10.39 |
| 1935 | 9.74 | n.a. | n.a. | 11.77 | 10.01 |

^aWholesale Prices, bulletins of U. S. Dept. Labor, Bur. Labor Statistics.^bCensus of Manufactures.^cFigures for "Average price, U. S." adjusted to level indicated by overlapping figures for 1919.

n.a. Data not available.

BRICK AND TILE

**Table A-18.- INDEXES OF PRODUCTION OF COMMON BRICK AND OF
AVERAGE UNIT VALUE ADJUSTED FOR WHOLESALE-PRICE LEVEL,
NEW YORK AND ILLINOIS, 1921-34^a**

(1926=100)

| Year | New York State | | Illinois | |
|------|----------------|---------------------------------|------------|---------------------------------|
| | Production | Average unit value ^b | Production | Average unit value ^b |
| | (1) | (2) | (3) | (4) |
| 1921 | 47.7 | 91.4 | 36.8 | 124.5 |
| 1922 | 62.5 | 110.5 | 73.0 | 104.8 |
| 1923 | 74.8 | 112.9 | 87.7 | 98.5 |
| 1924 | 79.1 | 101.9 | 94.1 | 98.4 |
| 1925 | 80.2 | 88.5 | 98.9 | 95.5 |
| 1926 | 100.0 | 100.0 | 100.0 | 100.0 |
| 1927 | 92.0 | 92.5 | 92.9 | 104.6 |
| 1928 | n.a. | - | n.a. | - |
| 1929 | 58.8 | 77.8 | 57.6 | 102.6 |
| 1930 | 49.2 | 76.7 | 27.2 | 114.1 |
| 1931 | 46.2 | 85.2 | 9.9 | 130.3 |
| 1932 | 14.6 | 93.6 | 2.9 | 134.0 |
| 1933 | n.a. | - | n.a. | - |
| 1934 | 12.0 | 97.6 | 5.2 | 130.7 |

^aBased on Census of Manufactures data.^bIndex of average value per thousand common brick divided by wholesale-price index for all commodities from Wholesale Prices, bulletins of U. S. Dept. Labor, Bur. Labor Statistics.

n.a. Data not available.

**Table A-19.- CHAIN INDEXES OF PRODUCTION AND MAN-HOURS
IN SAMPLE BRICK AND TILE PLANTS, 1916-35^a**

(1929=100)

| Year | Number of plants ^b | Production (common-brick equivalents) | Man-hours |
|------|-------------------------------|---------------------------------------|-----------|
| | (1) | (2) | (3) |
| 1916 | - | 94.7 | 90.4 |
| 1917 | 5 | 69.1 | 75.5 |
| 1918 | 5 | 41.9 | 53.5 |
| 1919 | 8 | 68.1 | 69.4 |
| 1920 | 22 | 65.1 | 85.7 |
| 1921 | 25 | 47.7 | 55.5 |
| 1922 | 27 | 109.2 | 99.5 |
| 1923 | 31 | 131.7 | 123.3 |
| 1924 | 35 | 146.2 | 131.3 |
| 1925 | 35 | 151.3 | 136.2 |
| 1926 | 35 | 143.3 | 132.2 |
| 1927 | 42 | 132.0 | 120.7 |
| 1928 | 50 | 120.9 | 112.7 |
| 1929 | 57 | 100.0 | 100.0 |
| 1930 | 72 | 69.7 | 72.1 |
| 1931 | 73 | 39.3 | 44.6 |
| 1932 | 78 | 22.5 | 26.1 |
| 1933 | 78 | 17.6 | 19.3 |
| 1934 | 79 | 21.9 | 24.3 |
| 1935 | 79 | 27.5 | 31.2 |

^aBased on year-to-year changes for identical plants.^bNumber of identical plants in given and preceding year.

**Table A-20. - PRODUCTION, MAN-HOURS, AND CAPACITY
FOR ALL SAMPLE BRICK AND TILE PLANTS, 1916-35**

| Year | Number of plants | Production (millions of common-brick equivalents) | Man-hours | | Capacity | |
|------|------------------|---|-------------------|---|---|-------------------------------|
| | | | Total (thousands) | Per thousand common-brick equivalents (3)+(2) | Millions of common-brick equivalents ^a | Percent utilized ^b |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| 1916 | 6 | 78 | 735 | 9.4 | 136 | 27.4 |
| 1917 | 6 | 56 | 603 | 10.9 | 136 | 22.3 |
| 1918 | 8 | 45 | 575 | 12.7 | 160 | 18.9 |
| 1919 | 23 | 336 | 2,453 | 7.3 | 943 | 32.4 |
| 1920 | 27 | 473 | 3,172 | 6.7 | 997 | 43.2 |
| 1921 | 28 | 296 | 2,414 | 8.2 | 1,042 | 24.5 |
| 1922 | 31 | 717 | 4,826 | 6.4 | 1,128 | 59.3 |
| 1923 | 38 | 993 | 7,140 | 7.2 | 1,328 | 70.3 |
| 1924 | 38 | 1,054 | 7,101 | 6.7 | 1,312 | 77.1 |
| 1925 | 38 | 1,127 | 7,874 | 7.0 | 1,397 | 80.1 |
| 1926 | 42 | 1,119 | 8,139 | 7.3 | 1,450 | 74.8 |
| 1927 | 55 | 1,284 | 9,890 | 7.7 | 1,693 | 73.1 |
| 1928 | 57 | 1,156 | 9,404 | 8.1 | 1,742 | 58.0 |
| 1929 | 72 | 1,178 | 10,577 | 9.0 | 2,120 | 47.2 |
| 1930 | 74 | 852 | 7,941 | 9.3 | 2,154 | 31.5 |
| 1931 | 78 | 508 | 5,291 | 10.4 | 2,179 | 18.0 |
| 1932 | 80 | 291 | 3,104 | 10.7 | 2,188 | 10.6 |
| 1933 | 79 | 230 | 2,327 | 10.1 | 2,173 | 8.9 |
| 1934 | 80 | 291 | 2,987 | 10.3 | 2,176 | 11.1 |
| 1935 | 80 | 368 | 3,670 | 10.5 | 2,106 | 15.5 |

^aCapacity estimated; excludes output of plants for which no capacity estimate is available, totaling approximately 3 percent of aggregate output after 1919 and up to 50 percent for the first 3 years.

^bobtained by dividing col. (5) into col. (2) adjusted for output of plants for which no capacity estimate was made.

**Table A-21. - CHAIN AGGREGATIVE INDEX OF MAN-HOUR RATIOS
FOR SAMPLE BRICK AND TILE PLANTS, 1916-35**

| Year | Number of plants | Man-hour ratio | | Link relative (2)+(3) | Chain index of link relatives (1929=100) |
|------|------------------|----------------|----------------|-----------------------|--|
| | | Given year | Preceding year | | |
| | (1) | (2) | (3) | (4) | (5) |
| 1916 | - | - | - | - | 95.6 |
| 1917 | 5 | 9.81 | 8.58 | 1.143 | 109.3 |
| 1918 | 3 | 11.47 | 9.81 | 1.169 | 127.7 |
| 1919 | 8 | 10.13 | 12.71 | 0.797 | 101.8 |
| 1920 | 22 | 7.03 | 7.11 | 0.989 | 100.7 |
| 1921 | 25 | 7.80 | 6.74 | 1.157 | 116.5 |
| 1922 | 27 | 6.24 | 7.97 | 0.783 | 91.2 |
| 1923 | 31 | 6.63 | 6.45 | 1.026 | 93.8 |
| 1924 | 35 | 6.73 | 7.02 | 0.958 | 89.9 |
| 1925 | 35 | 6.75 | 6.73 | 1.003 | 90.2 |
| 1926 | 35 | 6.96 | 6.79 | 1.025 | 92.5 |
| 1927 | 42 | 7.22 | 7.26 | 0.992 | 91.7 |
| 1928 | 50 | 8.07 | 7.92 | 1.018 | 93.4 |
| 1929 | 57 | 8.72 | 8.14 | 1.071 | 100.0 |
| 1930 | 72 | 9.29 | 8.98 | 1.034 | 103.4 |
| 1931 | 73 | 10.60 | 9.66 | 1.095 | 113.2 |
| 1932 | 78 | 10.65 | 10.41 | 1.023 | 115.9 |
| 1933 | 78 | 10.11 | 10.65 | 0.946 | 109.9 |
| 1934 | 79 | 10.22 | 10.11 | 1.011 | 111.1 |
| 1935 | 79 | 10.51 | 10.28 | 1.022 | 113.6 |

Table A-22.- CHAIN INDEX OF MEDIAN LINK RELATIVES OF
MAN-HOUR RATIOS FOR SAMPLE BRICK AND TILE PLANTS
1917-35

| Year | Link relatives | | | | Median | Coefficient of dispersion ^b | Chain index of median link relatives (1929=100) |
|------|----------------|----------------------------------|-----------|-----------|--------|--|---|
| | Number | Percentage distribution by class | | | | | |
| | | Neu-tral ^a | De-crease | In-crease | | | |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) | |
| 1917 | 4 | 25 | 50 | 25 | 0.934 | 0.128 | 112.7 |
| 1918 | 4 | 0 | 25 | 75 | 1.114 | .117 | 125.4 |
| 1919 | 12 | 8 | 84 | 8 | 0.905 | .102 | 113.6 |
| 1920 | 19 | 10 | 53 | 37 | 0.978 | .141 | 108.6 |
| 1921 | 21 | 5 | 48 | 47 | 1.001 | .179 | 108.7 |
| 1922 | 23 | 13 | 65 | 22 | 0.949 | .097 | 103.1 |
| 1923 | 29 | 14 | 48 | 38 | 0.988 | .111 | 101.9 |
| 1924 | 33 | 9 | 45 | 46 | 0.992 | .098 | 101.1 |
| 1925 | 34 | 21 | 47 | 32 | 0.987 | .094 | 99.8 |
| 1926 | 35 | 23 | 34 | 43 | 1.016 | .073 | 101.3 |
| 1927 | 42 | 12 | 50 | 38 | 0.982 | .081 | 99.5 |
| 1928 | 51 | 14 | 43 | 43 | 0.995 | .106 | 99.0 |
| 1929 | 56 | 14 | 41 | 45 | 1.010 | .110 | 100.0 |
| 1930 | 69 | 13 | 45 | 42 | 0.997 | .154 | 99.8 |
| 1931 | 65 | 9 | 28 | 63 | 1.084 | .276 | 108.1 |
| 1932 | 65 | 5 | 40 | 55 | 1.081 | .340 | 116.9 |
| 1933 | 57 | 5 | 53 | 42 | 0.957 | .462 | 111.8 |
| 1934 | 59 | 8 | 39 | 53 | 1.035 | .407 | 115.7 |
| 1935 | 66 | 12 | 44 | 44 | 0.998 | .303 | 115.4 |

^aFrom 0.981 to 1.019.

^bAverage deviation from median divided by median link relative.

Table A-23.- REGRESSION OF CHAIN AGGREGATIVE INDEX OF MAN-HOUR RATIOS ON PERCENTAGE OF CAPACITY UTILIZED, FOR ALL SAMPLE BRICK AND TILE PLANTS, 1916-35^a

| Year | Percentage of capacity utilized | Chain aggregative index of man-hour ratios ^b (1929=100) | Ordinates of regression ^c | Deviation of index from line of regression (2)-(3) | Index corrected for percentage of capacity utilized | |
|------|---------------------------------|---|--------------------------------------|---|---|----------|
| | | | | | 89.5 + (4) | 1929=100 |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| 1916 | 27.4 | 95.6 | 105.0 | - 9.2 | 80.3 | 86.8 |
| 1917 | 22.3 | 109.3 | 107.0 | + 2.5 | 92.0 | 99.5 |
| 1918 | 18.9 | 127.7 | 109.0 | +19.0 | 108.5 | 117.3 |
| 1919 | 32.4 | 101.8 | 102.9 | - 0.9 | 88.6 | 95.8 |
| 1920 | 43.2 | 100.7 | 98.9 | + 2.0 | 91.5 | 98.9 |
| 1921 | 24.5 | 116.5 | 106.0 | +10.7 | 100.2 | 108.3 |
| 1922 | 59.3 | 91.2 | 93.8 | - 2.4 | 87.1 | 94.2 |
| 1923 | 70.3 | 93.8 | 91.0 | + 2.8 | 92.3 | 99.8 |
| 1924 | 77.2 | 89.9 | 90.0 | - 0.1 | 89.4 | 96.6 |
| 1925 | 80.1 | 90.2 | 89.5 | + 0.7 | 90.2 | 97.5 |
| 1926 | 74.8 | 92.5 | 90.2 | + 2.3 | 91.8 | 99.2 |
| 1927 | 73.1 | 91.7 | 90.5 | + 1.2 | 90.7 | 98.1 |
| 1928 | 57.7 | 93.4 | 94.2 | - 0.8 | 88.7 | 95.9 |
| 1929 | 47.2 | 100.0 | 97.0 | + 3.0 | 92.5 | 100.0 |
| 1930 | 31.5 | 103.4 | 103.1 | + 0.3 | 89.8 | 97.1 |
| 1931 | 18.0 | 113.2 | 110.0 | + 3.2 | 92.7 | 100.2 |
| 1932 | 10.6 | 115.8 | 115.8 | 0 | 89.5 | 96.8 |
| 1933 | 9.0 | 109.9 | 117.0 | - 7.1 | 82.4 | 89.1 |
| 1934 | 11.1 | 111.1 | 115.0 | - 3.9 | 85.6 | 92.5 |
| 1935 | 15.5 | 113.6 | 112.0 | + 1.6 | 91.1 | 98.5 |

^aFor methods used see appendix B, section on "Corrections in the Man-hour Ratio for Percentage of Capacity Utilized."

^bTable A-21.

^cBased on freehand curves in figure 20.

Table A-24.- AVERAGE INVESTMENT AND MAN-HOURS PER THOUSAND COMMON-BRICK EQUIVALENTS IN INDIVIDUAL BRICK AND TILE PLANTS

| Plant | Investment per thousand common-brick equivalents ^a | | Standard man-hour ratio |
|---------------------------------------|---|--------|-------------------------|
| | Net | Gross | |
| Common and face brick | | | |
| Plant A | \$0.79 | \$2.16 | 9.60 |
| Plant B | 0.83 | 1.94 | 9.07 |
| Plant C | 1.21 | 2.90 | 5.50 |
| Plant D | 2.28 | 3.67 | 6.53 |
| Plant E | 3.49 | 4.22 | 7.53 |
| Plant F | 3.53 | 4.69 | 5.95 |
| Paving brick and hollow building tile | | | |
| Plant G | 1.79 | 9.39 | 10.14 |
| Plant H | 2.28 | 8.02 | 8.38 |
| Plant I | 2.34 | 2.93 | 17.79 |
| Plant J | 2.54 | 5.49 | 13.61 |
| Plant K | 2.74 | 3.76 | 21.67 |
| Plant L | 5.81 | 9.04 | 20.92 |

^a Average for 1925-32. Net investments represent gross investments in machinery and equipment less depreciation; gross investments represent total investments in machinery and equipment less retirements.

Table A-25.- ARRAY ANALYSIS OF MAN-HOUR RATIOS, 37 IDENTICAL BRICK AND TILE PLANTS, 1928-35

| Year | Range | | Quartile | | | Weighted mean ^a | Coef- ficient of disper- sion ^b | Measure of skewness ^c | Contingent labor- reduction ratio ^d |
|------|-------|--------|----------|--------|-------|----------------------------|---|--|---|
| | Low | High | First | Second | Third | | | | |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| 1928 | 4.31 | 27.60 | 7.29 | 8.79 | 12.61 | 7.47 | 0.379 | 0.436 | 0.024 |
| 1929 | 4.92 | 24.17 | 7.01 | 9.26 | 12.86 | 8.18 | .363 | .231 | .143 |
| 1930 | 4.71 | 18.83 | 6.86 | 9.41 | 11.93 | 6.73 | .306 | -.006 | .214 |
| 1931 | 4.83 | 49.48 | 8.57 | 11.22 | 16.45 | 10.68 | .519 | .327 | .198 |
| 1932 | 5.70 | 57.98 | 8.67 | 11.17 | 15.80 | 12.46 | .600 | .299 | .304 |
| 1933 | 4.42 | 44.35 | 7.65 | 10.06 | 15.85 | 10.44 | .642 | .398 | .267 |
| 1934 | 4.70 | 49.03 | 9.14 | 12.49 | 15.17 | 9.80 | .432 | -.111 | .067 |
| 1935 | 4.91 | 132.51 | 9.71 | 10.91 | 13.52 | 9.69 | .607 | .370 | .018 |

^a Obtained by dividing aggregate output into aggregate number of man-hours.

^b Average deviation from median divided by median.

^c Computed from formula: $(Q_3 + Q_1 - 2Q_2) \div (Q_3 - Q_1)$.

^d By the "first quartile to weighted mean" method; that is, the contingent labor-reduction ratio equals $1 - (Q_1 + \text{weighted mean})$.

Table A-26.- WEIGHTED MEAN OF MAN-HOUR RATIOS AND PERCENTAGE OF CAPACITY UTILIZED, 37 IDENTICAL BRICK AND TILE PLANTS, BY CAPACITY, 1928-35

| Annual capacity (millions of common- brick equivalents) | 1928 | 1929 | 1930 | 1931 | 1932 | 1933 | 1934 | 1935 |
|---|-------|-------|-------|-------|-------|-------|-------|-------|
| Less than 15 | | | | | | | | |
| Number of plants operating | 13 | 13 | 12 | 12 | 11 | 10 | 12 | 12 |
| Man-hour ratio | 11.41 | 11.43 | 11.53 | 12.22 | 13.51 | 12.08 | 11.23 | 11.38 |
| Percent of capacity utilized ^a | 65 | 61 | 51 | 31 | 19 | 15 | 21 | 26 |
| 15-29.99 | | | | | | | | |
| Number of plants operating | 11 | 11 | 11 | 11 | 11 | 10 | 10 | 10 |
| Man-hour ratio | 9.68 | 10.34 | 9.60 | 10.65 | 12.65 | 12.73 | 11.08 | 11.50 |
| Percent of capacity utilized ^a | 65 | 58 | 46 | 32 | 15 | 13 | 15 | 20 |
| 30 or over | | | | | | | | |
| Number of plants operating | 13 | 13 | 13 | 7 | 7 | 6 | 7 | 7 |
| Man-hour ratio | 6.09 | 6.74 | 7.36 | 9.79 | 11.62 | 8.35 | 8.36 | 8.65 |
| Percent of capacity utilized ^a | 59 | 47 | 26 | 9 | 5 | 6 | 7 | 12 |

^aFor all plants, not only for those operating.

Table A-27.- WEIGHTED MEAN OF MAN-HOUR RATIOS AND PERCENTAGE OF CAPACITY UTILIZED, 37 IDENTICAL BRICK AND TILE PLANTS, BY PROCESS, 1928-35

| Process | 1928 | 1929 | 1930 | 1931 | 1932 | 1933 | 1934 | 1935 |
|--|------|-------|------|-------|-------|-------|-------|-------|
| Stiff-mud | | | | | | | | |
| Number of plants operating | 22 | 22 | 22 | 16 | 16 | 16 | 17 | 17 |
| Man-hour ratio | 6.96 | 7.63 | 8.48 | 12.44 | 14.36 | 11.17 | 9.64 | 9.72 |
| Percent of capacity utilized ^a | 62 | 51 | 30 | 10 | 6 | 6 | 9 | 14 |
| Soft-mud | | | | | | | | |
| Number of plants operating | 10 | 10 | 10 | 10 | 9 | 8 | 9 | 9 |
| Man-hour ratio | 9.58 | 10.76 | 9.84 | 9.31 | 11.17 | 9.35 | 10.74 | 10.71 |
| Percent of capacity utilized ^a | 60 | 49 | 40 | 38 | 17 | 15 | 15 | 22 |
| Sand-lime and dry-press | | | | | | | | |
| Number of plants operating | 5 | 5 | 4 | 4 | 4 | 2 | 3 | 3 |
| Man-hour ratio | 7.32 | 7.10 | 7.29 | 7.77 | 7.08 | 9.27 | 7.04 | 7.28 |
| Percent of capacity utilized ^a | 59 | 57 | 40 | 25 | 18 | 6 | 13 | 15 |

^aFor all plants, not only for those operating.

Table A-28.- MAN-HOURS PER THOUSAND COMMON-BRICK EQUIVALENTS EMBODIED IN ANNUAL MACHINERY REQUIREMENTS, NINE IDENTICAL BRICK AND TILE PLANTS, 1926-35

| Year | Number of plants operating | Gross investment ^a (thousands) | Annual cumulative average of man-hours per dollar of value ^b | Total man-hours (thousands) (2)x(3) | Annual man-hours ^c (thousands) | Production (millions of common-brick equivalents) | Man-hours per thousand common-brick equivalents (5)÷(6) |
|------|----------------------------|---|---|-------------------------------------|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| 1926 | 9 | \$ 788 | 0.82 | 644 | 46 | 166 ^d | 0.28 |
| 1927 | 9 | 865 | .81 | 698 | 50 | 148 | .34 |
| 1928 | 9 | 948 | .80 | 756 | 54 | 145 | .38 |
| 1929 | 9 | 1,012 | .79 | 798 | 57 | 130 | .44 |
| 1930 | 9 | 999 | .77 | 774 | 56 | 124 | .45 |
| 1931 | 9 | 1,013 | .78 | 787 | 57 | 98 | .58 |
| 1932 | 9 | 1,033 | .79 | 814 | 59 | 71 | .82 |
| 1933 | 6 | 604 ^e | .80 | 484 | 35 | 39 | .89 |
| 1934 | 9 | 949 | .81 | 770 | 55 | 69 | .80 |
| 1935 | 9 | 952 | .82 | 778 | 56 | 65 | .86 |

^aTotal installed book values of investments in machinery and equipment, less retirements. Data exclude purchases or retirements for three plants not operating in 1933.

^bBased on number of man-hours per dollar of value shown below. The ratio for any one year is the average of the ratios for all the preceding years and the given year.

| | | | | | | | | | | | |
|------|------|------|------|------|------|------|------|------|------|------|------|
| 1920 | .... | 0.72 | 1924 | .... | 0.79 | 1928 | .... | 0.72 | 1932 | .... | 0.92 |
| 1921 | .... | .92 | 1925 | .... | .78 | 1929 | .... | .68 | 1933 | .... | .98 |
| 1922 | .... | .95 | 1926 | .... | .77 | 1930 | .... | .67 | 1934 | .... | .95 |
| 1923 | .... | .81 | 1927 | .... | .73 | 1931 | .... | .60 | 1935 | .... | .90 |

The ratios were estimated by the "Studies in Equipment Changes and Industrial Techniques" section of the WPA National Research Project.

^cCol. (4) divided by 13.9, which is the estimated average length of life, in years, of machinery and equipment in brick and tile plants.

^dPartly estimated.

^eThree plants, having a gross investment of \$408,000, were not operating in 1933.

Table A-28.- COST PER THOUSAND COMMON BRICK, 1925 AND 1935^a

| Item | 1925 | 1935 |
|--|--|---------|
| Number of plants | 10 | 8 |
| Production (thousands of common-brick equivalents) | 185,285 | 64,702 |
| Man-hours, operating and indirect | 1,609,508 | 654,130 |
| Man-hours per thousand common-brick equivalents | 8.69 | 10.11 |
| Percentage of capacity utilized | 75.8 | 38.3 |
| | Cost (dollars) per thousand common-brick equivalents | |
| Total | 10.36 | 10.59 |
| Manufacturing | 7.27 | 6.58 |
| Labor, operating and indirect | 4.11 | 3.33 |
| Raw materials and supplies | 0.59 | 0.67 |
| Fuel for burning | 1.30 | 1.05 |
| Overhead ^b | 1.09 | 1.32 |
| Other | 0.18 | 0.21 |
| Power | 0.99 | 1.27 |
| Administrative ^c | 1.02 | 1.10 |
| Selling | 0.11 | 0.59 |
| Other ^d | 0.97 | 1.05 |

^aEach of the plants included produces chiefly common brick. Six of the plants are included in both years. Capacity of the included plants ranges from 10,000 to 39,800 thousand common-brick equivalents in 1925 and from 10,000 to 37,500 in 1935. Total costs per thousand common-brick equivalents range from \$7.94 to \$19.15 in 1925 and from \$7.07 to \$18.04 in 1935.

^bIncludes depreciation, property taxes, insurance, maintenance and repairs, and other overhead expenses.

^cIncludes executive and clerical salaries and other administrative expenses.

^dComposed chiefly of interest payments and sales discounts.

Table A-30.- YEAR-TO-YEAR CHANGES IN UTILIZATION OF LABOR, EIGHT IDENTICAL BRICK AND TILE PLANTS, 1926-35^a

| Year | Production (millions of common-brick equivalents) | | Man-hours per thousand common-brick equivalents | | Man-hours utilized in production of machinery | | Changes in man-hours (thousands) since preceding year due to changes in - | | | |
|-------------------|---|-----------------------------|---|-----------------------------|---|------------------------------------|---|---|---|------------------------|
| | Given year | Change since preceding year | Given year | Change since preceding year | Gross additions (thousands of dollars) | Man-hours ^b (thousands) | Production | Man-hours per thousand common-brick equivalents | Man-hours utilized in production of machinery | Total of three factors |
| 1926 | 126 ^c | - | 8.99 ^c | - | 87 | 66 | - | - | - | - |
| 1927 | 121 | -5 | 9.52 ^c | +0.53 | 14 | 10 | -42 | +64 | -56 | -34 |
| 1928 | 126 | +4 | 9.32 | -0.20 | 61 | 56 | +39 | -25 | +46 | +62 |
| 1929 | 106 | -20 | 9.60 | +0.28 | 61 | 42 | +166 | +30 | -17 | -173 |
| 1930 | 111 | +5 | 8.58 | -1.02 | 6 | 5 | +52 | -113 | -36 | -98 |
| 1931 | 85 | -26 | 8.48 | -0.10 | 19 | 15 | -226 | -8 | +10 | -225 |
| 1932 | 59 | -26 | 8.64 | +0.16 | 17 | 15 | -216 | +9 | " | -209 |
| 1933 ^d | 20 | -36 | 9.01 | +0.37 | 3 | 3 | -332 | +8 | -13 | -337 |
| 1934 | 59 | +39 | 8.51 | -0.50 | 6 | 6 | +350 | -30 | +3 | +323 |
| 1935 | 40 | -19 | 10.07 | +1.56 | 2 | 2 | -161 | +63 | -4 | -102 |

^aIn the measurement of the net yearly change in the number of man-hours expended (M), changes in three factors were taken into consideration: the production of common-brick equivalents (P), the number of man-hours required per thousand common-brick equivalents (R), and the number of man-hours utilized in production of machinery (H). To determine man-hour changes attributable to changes in production, the differences between production in the given and preceding years ($P_1 - P_0$) was multiplied by the man-hour ratio for the preceding year (R_0). Since this does not take into account changes in the man-hour ratio, the man-hour changes attributable to changes in the ratio were determined by multiplying the difference between the ratios in the given and preceding years ($R_1 - R_0$) by the production of common-brick equivalents in the given year (P_1). Changes in man-hours utilized in production of machinery were measured by year-to-year differences ($H_1 - H_0$). Thus $M_1 = [(P_1 - P_0)R_0] + [(R_1 - R_0)P_1] + [H_1 - H_0]$.

The assumption implicit in this procedure is that year-to-year changes in output are largely independent of changes in unit labor requirements.

^bPreceding column multiplied by man-hours per dollar of value, shown in table A-28, sta. b.

^cPartly estimated.

^dFigures are based on data for five plants, since three of the plants were not operating in 1933.

^eLess than 500 man-hours.

Table A-31.- CHANGES IN EMPLOYMENT OF LABOR ACCOMPANYING THE INSTALLATION OF MACHINERY IN 55 BRICK AND TILE PLANTS 1920-35^a

| Year | Machines installed | | | Plant labor (number of men) ^b - | |
|-------|--------------------|-----------------|---|--|-------|
| | Number of units | Value (dollars) | Embodied labor ^c (man-hours) | Displaced | Added |
| | (1) | (2) | (3) | (4) | (5) |
| Total | 244 | 663,221 | 675,444 | 164 | 51 |
| 1920 | 7 | 33,350 | 24,156 | 20 | 1 |
| 1921 | 4 | 20,900 | 19,228 | 3 | 4 |
| 1922 | 14 | 25,950 | 24,653 | 4 | 1 |
| 1923 | 15 | 80,757 | 49,213 | 5 | 10 |
| 1924 | 25 | 102,400 | 60,896 | 25 | 0 |
| 1925 | 17 | 47,485 | 37,036 | 10 | 1 |
| 1926 | 23 | 54,660 | 49,769 | 21 | 0 |
| 1927 | 4 | 36,300 | 27,659 | 7 | 3 |
| 1928 | 44 | 169,230 | 121,125 | 16 | 4 |
| 1929 | 21 | 85,313 | 66,014 | 29 | 10 |
| 1930 | 11 | 45,907 | 30,357 | 12 | 2 |
| 1931 | 36 | 54,082 | 43,265 | 6 | 2 |
| 1932 | 2 | 11,200 | 10,304 | 2 | 0 |
| 1933 | 9 | 25,125 | 24,683 | 2 | 7 |
| 1934 | 5 | 57,153 | 54,295 | 0 | 3 |
| 1935 | 7 | 22,808 | 20,528 | 2 | 3 |

^aData are not comparable from year to year, since only the installations for which the employment effects were reported are included in this table.

^bBased on net effect of each installation.

^cValue multiplied by man-hours per dollar of value shown in table A-28.

**Table A-32.- OPERATING AND INDIRECT MAN-HOURS PER THOUSAND COMMON-BRICK EQUIVALENTS PRODUCED
BY PLANT, 1915-36^a**

| Year | Region, plant, and plant size | | | | | | | | | | | |
|------|-------------------------------|----------------------|---------|---------------------|--------|-------|------|---------------------|-----------------------|---------|-----------------------|--------|
| | IV-1-M | VII-2-M ^b | III-3-S | IV-4-M ^c | IV-5-S | VII-6 | IV-7 | IV-8-M ^d | V-9-S ^{defg} | IV-10-S | VII-11-S ^d | I-12-S |
| 1915 | 7.5 | | | | | | | | | | | |
| 1916 | 7.5 | 7.7 | 10.3 | 13.6 | 19.2 | 19.3 | 4.2 | | | | | |
| 1917 | 8.7 | 17.1 | 10.9 | n.a. | 16.7 | 13.6 | 4.5 | | | | | |
| 1918 | 10.2 | n.a. | 13.2 | n.a. | 17.8 | 10.7 | n.a. | 13.6 | 15.6 | 16.8 | | |
| 1919 | 7.7 | 4.6 | 11.1 | 13.2 | 17.6 | 10.2 | 4.8 | 13.3 | 13.9 | 16.2 | 16.2 | 8.2 |
| 1920 | 7.0 | 4.5 | 10.8 | 18.6 | 17.3 | 13.1 | 4.5 | 13.5 | 14.7 | 17.6 | 14.0 | 8.7 |
| 1921 | 6.2 | n.a. | 11.4 | 13.5 | 22.1 | 12.7 | 4.3 | 12.0 | 14.1 | 16.5 | 17.6 | 9.1 |
| 1922 | 5.9 | 12.8 | 9.7 | 13.3 | 18.0 | 12.3 | 4.3 | 11.5 | 14.0 | 17.3 | 18.4 | 9.3 |
| 1923 | 5.8 | 14.0 | 10.5 | 13.2 | 16.4 | 12.3 | 4.2 | 12.8 | 13.5 | 16.5 | 14.4 | 8.8 |
| 1924 | 5.4 | 13.8 | 11.4 | n.a. | 15.9 | n.a. | 4.2 | 11.5 | 14.4 | 19.2 | 15.5 | 8.7 |
| 1925 | 5.0 | 24.5 | 11.3 | 13.1 | 17.4 | n.a. | 4.2 | 10.6 | 13.1 | 18.0 | 15.7 | 8.3 |
| 1926 | 5.4 | 14.7 | 11.2 | n.a. | 21.6 | n.a. | 4.4 | 10.0 | 12.6 | 17.7 | 16.0 | 9.1 |
| 1927 | 4.9 | 12.8 | 12.2 | 14.1 | 16.6 | 12.2 | 4.4 | 9.6 | 11.9 | 16.9 | 16.5 | 8.8 |
| 1928 | 5.5 | n.a. | 11.4 | 13.4 | 27.6 | n.a. | n.a. | 9.3 | 11.4 | 17.0 | 13.9 | 9.7 |
| 1929 | 5.1 | 15.3 | 13.4 | 14.3 | 19.3 | n.a. | n.a. | 11.2 | 10.5 | 19.6 | 13.7 | 9.3 |
| 1930 | 5.6 | 13.7 | 11.7 | 13.2 | n.a. | n.a. | n.a. | 8.7 | 14.2 | 18.5 | 11.8 | 9.2 |
| 1931 | 4.8 | 13.8 | 31.8 | 14.8 | n.a. | n.a. | n.a. | 9.7 | 12.1 | 19.0 | 13.4 | 6.9 |
| 1932 | 6.2 | 11.3 | n.a. | 29.1 | n.a. | n.a. | n.a. | 15.6 | 13.4 | 23.6 | 103.0 | 8.8 |
| 1933 | n.a. | 32.9 | n.a. | 13.6 | n.a. | n.a. | n.a. | 9.6 | 12.8 | n.a. | 15.5 | 7.5 |
| 1934 | n.a. | 11.7 | 15.4 | 14.6 | n.a. | n.a. | n.a. | 9.7 | 13.4 | n.a. | 13.8 | 8.7 |
| 1935 | n.a. | 15.4 | 16.2 | 14.8 | n.a. | n.a. | n.a. | 9.4 | 16.0 | n.a. | 15.8 | 10.0 |
| 1936 | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. |

See footnotes at end of table.

**Table A-32.- OPERATING AND INDIRECT MAN-HOURS PER THOUSAND COMMON-BRICK EQUIVALENTS PRODUCED
BY PLANT, 1915-36^a - Continued**

| Year | Region, plant, and plant size | | | | | | | | | | | | |
|------|-------------------------------|----------------------|--------|----------------------|----------------------|----------------------|----------------------|----------------------|--------------------|----------------------|----------|---------|----------------------|
| | IV-13-L ^h | IV-14-L ^h | I-15-L | IV-16-L ^h | IV-17-L ^h | IV-18-L ^h | IV-19-L ^h | IV-20-L ^h | IV-21 ^h | IV-22-S ^l | VII-23-S | II-24-M | IV-25-S ^d |
| 1915 | | | | | | | | | | | | | |
| 1916 | | | | | | | | | | | | | |
| 1917 | | | | | | | | | | | | | |
| 1918 | | | | | | | | | | | | | |
| 1919 | 4.9 | 5.5 | 14.6 | 5.6 | 5.2 | 7.6 | 5.4 | 6.3 | 6.4 | | | | |
| 1920 | 5.4 | 5.6 | 10.3 | 5.1 | 5.2 | 6.7 | 5.9 | 6.0 | 5.0 | 11.4 | 11.2 | 10.0 | 9.0 |
| 1921 | 4.8 | 4.9 | 7.9 | 5.8 | 6.0 | n.a. | n.a. | 5.6 | n.a. | 13.2 | 18.5 | 10.0 | 11.4 |
| 1922 | 4.6 | 4.4 | 8.1 | 4.8 | 4.6 | 4.9 | 4.4 | 4.8 | 5.2 | 12.0 | 12.7 | 9.7 | 7.0 |
| 1923 | 4.7 | 4.4 | 7.4 | 4.9 | 4.9 | 5.0 | 4.5 | 5.7 | 4.6 | 9.4 | 9.9 | 9.1 | 8.7 |
| 1924 | 4.8 | 4.8 | 7.1 | 4.6 | 4.5 | 4.8 | 4.4 | 5.2 | 4.1 | 8.4 | 11.4 | 8.7 | 9.7 |
| 1925 | 4.6 | 4.4 | 6.5 | 4.6 | 5.1 | 5.2 | 4.6 | 4.8 | 4.4 | 8.8 | 10.9 | 7.9 | 9.8 |
| 1926 | 4.6 | 4.3 | 5.9 | 5.0 | 5.0 | 5.4 | 4.8 | 5.7 | 4.4 | 10.4 | 10.2 | 8.2 | 10.2 |
| 1927 | 4.9 | 4.1 | 6.4 | 5.1 | 5.3 | 5.2 | 5.4 | 5.1 | 4.2 | 9.8 | 11.9 | 7.5 | 9.6 |
| 1928 | 4.5 | 4.3 | 6.0 | 5.7 | 5.4 | 4.8 | 5.4 | 6.6 | n.a. | 8.6 | 8.4 | 7.8 | 8.8 |
| 1929 | 5.2 | 5.8 | 6.1 | 4.9 | 5.2 | 5.5 | 5.2 | n.a. | n.a. | 8.2 | 7.5 | 8.5 | 9.1 |
| 1930 | 7.8 | 4.7 | 6.0 | 7.2 | 8.4 | 8.9 | 5.7 | n.a. | n.a. | 9.2 | 7.2 | 7.9 | 10.3 |
| 1931 | n.a. | n.a. | 5.1 | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | 9.3 | 8.0 | 8.6 | 14.7 |
| 1932 | n.a. | n.a. | 5.7 | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | 8.8 | 7.5 | 8.4 | 10.5 |
| 1933 | 5.9 | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | 9.1 | 9.3 | 8.7 | 10.0 |
| 1934 | 32.3 | 4.4 | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | 9.3 | 5.9 | 9.5 | 13.3 |
| 1935 | 10.4 | 4.7 | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | 9.2 | 5.6 | 9.6 | 12.8 |
| 1936 | 15.2 | 4.9 | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | 12.6 | n.a. | n.a. | n.a. |

See footnotes at end of table.

**Table A-32.- OPERATING AND INDIRECT MAN-HOURS PER THOUSAND COMMON-BRICK EQUIVALENTS PRODUCED
BY PLANT, 1915-36^a - Continued**

| Year | Region, plant, and plant size | | | | | | | | | | | | | |
|------|-------------------------------|----------------------|--------|-----------------------|--------|---------|-----------------------|---------------------|----------------------|---------|---------------------|--------|-------|--|
| | IV-26-S | IV-27-L ^j | V-28-L | IV-29-M ^{de} | I-30-M | VI-31-L | IV-32-L ^{kl} | V-33-M ^j | V-34-L ^{de} | II-35-L | V-36-M ^j | I-37-S | IV-38 | |
| 1915 | | | | | | | | | | | | | | |
| 1916 | | | | | | | | | | | | | | |
| 1917 | | | | | | | | | | | | | | |
| 1918 | | | | | | | | | | | | | | |
| 1919 | | | | | | | | | | | | | | |
| 1920 | 8.5 | 6.4 | | | | | | | | | | | | |
| 1921 | n.a. | n.a. | 8.5 | 11.8 | 14.1 | | | | | | | | | |
| 1922 | 7.1 | 5.4 | 9.3 | 10.5 | n.a. | 6.4 | 10.7 | | | | | | | |
| 1923 | 9.8 | 5.0 | 9.8 | 9.7 | 15.9 | 10.7 | 10.4 | 14.8 | 10.5 | 9.6 | 11.1 | 15.4 | 7.3 | |
| 1924 | 7.2 | 5.2 | 10.3 | 8.4 | 12.8 | 12.3 | 10.8 | 16.9 | 12.1 | 8.4 | 13.9 | n.a. | 6.1 | |
| 1925 | 6.9 | 5.2 | 8.2 | 8.9 | 9.8 | 12.6 | 10.9 | 15.1 | 9.2 | 8.7 | 24.1 | 15.0 | 6.6 | |
| 1926 | 7.0 | 5.2 | 7.2 | 8.7 | 9.3 | 12.2 | 11.3 | 15.5 | 11.7 | n.a. | 16.9 | n.a. | 6.2 | |
| 1927 | 4.6 | 5.1 | 8.0 | 9.6 | 8.4 | 12.9 | 11.3 | 17.0 | 11.8 | 8.3 | 14.8 | 14.8 | 6.4 | |
| 1928 | 8.8 | 5.0 | 8.7 | 9.5 | 8.3 | 11.0 | 11.2 | 19.9 | 12.3 | 9.2 | 18.8 | 15.2 | n.a. | |
| 1929 | 10.0 | 5.8 | 10.2 | 9.2 | 7.4 | 12.3 | 10.9 | 21.0 | 12.8 | 9.3 | 24.2 | 16.8 | n.a. | |
| 1930 | 11.8 | 5.2 | 8.2 | 9.7 | 6.6 | 16.9 | 15.5 | 18.8 | 12.1 | 9.7 | 15.4 | 16.3 | n.a. | |
| 1931 | 15.4 | n.a. | 8.9 | 10.4 | 7.3 | 16.7 | 13.2 | 27.9 | 19.9 | 8.6 | 49.5 | 16.5 | n.a. | |
| 1932 | 7.2 | n.a. | 10.3 | 15.9 | 6.3 | 14.2 | 10.5 | 48.0 | 30.2 | 10.8 | 47.9 | 18.2 | n.a. | |
| 1933 | n.a. | n.a. | 5.9 | 14.1 | 6.9 | 7.1 | n.a. | 34.4 | 18.4 | 8.2 | 44.4 | 40.5 | n.a. | |
| 1934 | 12.5 | n.a. | 7.0 | 21.0 | 6.3 | 13.7 | n.a. | 35.1 | 49.0 | 10.7 | 23.8 | 17.8 | n.a. | |
| 1935 | 11.7 | n.a. | 8.3 | 13.5 | 8.0 | 9.9 | n.a. | 13.5 | 12.6 | 10.7 | 20.4 | 16.0 | n.a. | |
| 1936 | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | |

See footnotes at end of table.

**Table A-32. - OPERATING AND INDIRECT MAN-HOURS PER THOUSAND COMMON-BRICK EQUIVALENTS PRODUCED
BY PLANT, 1915-36^a - Continued**

| Year | Region, plant, and plant size | | | | | | | | | | | |
|------|-------------------------------|-----------------------|---------|----------------------|-----------------------|-----------------------|------------------------|------------------------|----------------------|----------------------|---------|----------------------|
| | II-39-M | II-40-M ^{de} | IX-41-L | II-42-S ^c | IV-43-S ^{de} | IV-44-M ^{de} | III-45-M ^{de} | III-46-M ^{de} | II-47-L ^d | IV-48-M ^d | II-49-S | II-50-M ^d |
| 1915 | | | | | | | | | | | | |
| 1916 | | | | | | | | | | | | |
| 1917 | | | | | | | | | | | | |
| 1918 | | | | | | | | | | | | |
| 1919 | | | | | | | | | | | | |
| 1920 | | | | | | | | | | | | |
| 1921 | | | | | | | | | | | | |
| 1922 | | | | | | | | | | | | |
| 1923 | | | | | | | | | | | | |
| 1924 | | | | | | | | | | | | |
| 1925 | 15.4 | | | | | | | | | | | |
| 1926 | 14.3 | 14.8 | 8.8 | 10.1 | 19.1 | 13.6 | 10.5 | 11.5 | | | | |
| 1927 | 15.2 | 12.1 | 8.0 | 9.3 | 18.6 | 12.2 | 11.0 | 11.5 | 9.9 | 7.8 | 13.5 | 10.2 |
| 1928 | 13.8 | 14.2 | 8.3 | 9.1 | 17.8 | 11.8 | 6.9 | 10.6 | 11.0 | 7.6 | 13.7 | 9.6 |
| 1929 | 14.1 | 12.7 | 8.1 | 9.7 | 17.0 | 11.9 | 11.1 | 12.8 | 11.8 | 7.3 | 11.0 | 9.7 |
| 1930 | 14.7 | 10.6 | 9.6 | 9.9 | 16.9 | 11.3 | 11.1 | 9.8 | 9.7 | 7.9 | 11.1 | 11.2 |
| 1931 | 15.1 | 11.4 | 10.7 | 18.4 | 29.6 | 12.9 | 18.5 | 16.9 | 10.8 | 9.4 | 11.8 | 12.4 |
| 1932 | 16.2 | 10.6 | 10.3 | 12.7 | 3.2 | 10.5 | n.a. | n.a. | 11.6 | 15.8 | 15.2 | 14.0 |
| 1933 | 16.2 | 13.3 | 7.2 | 23.4 | n.a. | 13.0 | n.a. | n.a. | 34.9 | 13.6 | 20.2 | 13.9 |
| 1934 | 15.1 | 20.1 | 10.8 | 12.4 | 24.9 | 13.6 | 16.4 | n.a. | 11.5 | 12.3 | 8.5 | 10.4 |
| 1935 | 132.5 | 27.2 | 9.8 | 10.0 | 70.8 | n.a. | 10.1 | n.a. | 9.4 | 11.5 | 9.6 | 10.2 |
| 1936 | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. |

See footnotes at end of table.

**Table A-32.- OPERATING AND INDIRECT MAN-HOURS PER THOUSAND COMMON-BRICK EQUIVALENTS PRODUCED
BY PLANT, 1915-36^a - Continued**

| Year | Region, plant, and plant size | | | | | | | | | | | |
|------|-------------------------------|------------------------|-----------------------|-----------------------|-----------------------|---------|-----------------------|--------------------|-----------------------|----------------------|----------------------|-----------------------|
| | III-51-M ^d | III-52-M ^{dm} | III-53-M ^d | III-54-S ^d | VI-55-S ^{de} | IV-56-L | IV-57-M ^{dg} | IV-58 ^g | I-59-M ^{ino} | II-60-S ^p | IX-61-M ^d | IV-62-L ^{dq} |
| 1915 | | | | | | | | | | | | |
| 1916 | | | | | | | | | | | | |
| 1917 | | | | | | | | | | | | |
| 1918 | | | | | | | | | | | | |
| 1919 | | | | | | | | | | | | |
| 1920 | | | | | | | | | | | | |
| 1921 | | | | | | | | | | | | |
| 1922 | | | | | | | | | | | | |
| 1923 | | | | | | | | | | | | |
| 1924 | | | | | | | | | | | | |
| 1925 | | | | | | | | | | | | |
| 1926 | | | | | | | | | | | | |
| 1927 | 8.6 | 11.2 | 7.8 | 9.7 | | | | | | | | |
| 1928 | 8.2 | 13.3 | 8.1 | 10.1 | 15.1 | 6.2 | 8.3 | 14.2 | 7.6 | 15.1 | 7.9 | |
| 1929 | 8.4 | 13.2 | 8.4 | n.a. | 12.9 | 5.1 | 7.8 | 12.8 | 10.6 | 13.7 | 8.1 | 7.3 |
| 1930 | 8.2 | 11.6 | 8.2 | n.a. | 11.0 | 5.2 | 9.2 | 13.9 | 5.4 | 14.2 | 8.1 | 7.3 |
| 1931 | 8.4 | 10.7 | 9.1 | n.a. | 14.1 | 8.8 | 8.4 | 10.3 | 5.7 | 19.1 | 10.5 | 7.7 |
| 1932 | 8.1 | 9.0 | n.a. | n.a. | 15.3 | 11.4 | 9.2 | 10.4 | 6.9 | 11.2 | 8.7 | 6.4 |
| 1933 | n.a. | n.a. | n.a. | n.a. | 10.9 | 6.4 | 11.2 | 13.6 | 8.6 | 10.1 | 10.4 | 6.6 |
| 1934 | 7.3 | 9.1 | n.a. | n.a. | 13.4 | 18.9 | 10.4 | 10.0 | 5.4 | 14.3 | 16.2 | 8.3 |
| 1935 | 9.3 | 11.2 | n.a. | n.a. | 11.6 | 10.9 | 10.3 | 14.3 | 7.4 | 11.4 | 25.1 | 9.8 |
| 1936 | n.a. | n.a. | n.a. | n.a. | 11.4 | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | 9.2 |

See footnotes at end of table.

Table A-32.- OPERATING AND INDIRECT MAN-HOURS PER THOUSAND COMMON-BRICK EQUIVALENTS PRODUCED,
BY PLANT, 1915-36^a - Continued

| Year | Region, plant, and plant size | | | | | | | | | | | |
|------|-------------------------------|----------|-----------------------|----------|-----------------------|-----------------------|------------------------|---------------------|----------|----------------------|-----------------------|-----------------------|
| | II-63-S ^c | VII-64-S | VII-65-M ^d | VII-66-M | VII-67-M ^d | VII-68-S ^d | VII-69-M ^{de} | I-70-S ^d | VII-71-S | V-72-S ^{dp} | VII-73-M ^d | III-74-M ^e |
| 1915 | | | | | | | | | | | | |
| 1916 | | | | | | | | | | | | |
| 1917 | | | | | | | | | | | | |
| 1918 | | | | | | | | | | | | |
| 1919 | | | | | | | | | | | | |
| 1920 | | | | | | | | | | | | |
| 1921 | | | | | | | | | | | | |
| 1922 | | | | | | | | | | | | |
| 1923 | | | | | | | | | | | | |
| 1924 | | | | | | | | | | | | |
| 1925 | | | | | | | | | | | | |
| 1926 | | | | | | | | | | | | |
| 1927 | | | | | | | | | | | | |
| 1928 | | | | | | | | | | | | |
| 1929 | 12.0 | 9.7 | 9.1 | 8.1 | 7.1 | 14.1 | 7.9 | 12.5 | 8.5 | 12.0 | 7.1 | 11.2 |
| 1930 | 12.9 | 8.4 | 10.7 | 10.0 | 7.1 | 10.7 | 8.9 | 11.7 | 11.4 | 18.9 | 8.9 | 10.2 |
| 1931 | 11.0 | 8.2 | 49.8 | 8.6 | 9.8 | 9.1 | 8.5 | 14.9 | 10.8 | 11.6 | 8.8 | 14.4 |
| 1932 | 11.8 | 8.4 | 10.5 | 6.2 | 7.0 | 7.1 | 11.8 | 17.3 | 10.9 | 16.4 | 14.2 | 17.8 |
| 1933 | 13.2 | 8.2 | 76.0 | 11.9 | 11.9 | 8.5 | 8.6 | 12.5 | 9.1 | 12.2 | 9.0 | 17.9 |
| 1934 | 13.9 | 12.0 | 9.8 | 21.9 | 13.3 | 8.3 | 7.8 | 15.6 | 9.1 | 9.8 | 9.2 | 25.4 |
| 1935 | 12.8 | 9.4 | 10.0 | 11.6 | 10.1 | 9.2 | 7.4 | 21.0 | 12.1 | 9.9 | 9.2 | 17.3 |
| 1936 | 11.9 | 13.5 | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. |

See footnotes at end of table.

**Table A-32. - OPERATING AND INDIRECT MAN-HOURS PER THOUSAND COMMON-BRICK EQUIVALENTS PRODUCED
BY PLANT, 1915-36^a - Continued**

| Year | Region, plant, and plant size | | | | | | | | | | | |
|------|-------------------------------|-----------------------|-----------------------|---------------------|---------|------------------------|-----------------------|---------|----------------------|----------------------|---------------------|----------------------|
| | VII-75-S ^d | IV-76-L ^{de} | III-77-M ^d | V-78-M ^r | VIII-79 | VII-80-M ^{de} | VI-81-S ^{de} | IV-82-M | VII-83 ^{de} | IV-84-S ^d | V-85-M ^d | VII-86 ^{de} |
| 1915 | | | | | | | | | | | | |
| 1916 | | | | | | | | | | | | |
| 1917 | | | | | | | | | | | | |
| 1918 | | | | | | | | | | | | |
| 1919 | | | | | | | | | | | | |
| 1920 | | | | | | | | | | | | |
| 1921 | | | | | | | | | | | | |
| 1922 | | | | | | | | | | | | |
| 1923 | | | | | | | | | | | | |
| 1924 | | | | | | | | | | | | |
| 1925 | | | | | | | | | | | | |
| 1926 | | | | | | | | | | | | |
| 1927 | | | | | | | | | | | | |
| 1928 | | | | | | | | | | | | |
| 1929 | 10.8 | 15.5 | | | | | | | | | | |
| 1930 | 11.8 | 14.5 | 10.0 | 9.6 | | | | | | | | |
| 1931 | 11.6 | n.a. | 11.0 | 8.9 | 9.0 | 7.6 | 10.4 | 18.0 | 8.8 | | | |
| 1932 | 14.8 | n.a. | 9.8 | 7.6 | 7.2 | 8.6 | 15.0 | 7.1 | 11.0 | 25.7 | | |
| 1933 | 11.9 | n.a. | 10.8 | 8.7 | 8.8 | 5.5 | 9.5 | n.a. | n.a. | 23.7 | 10.2 | n.a. |
| 1934 | 11.1 | n.a. | 8.5 | 8.3 | 8.8 | 6.8 | 10.1 | 14.7 | n.a. | 25.7 | 10.5 | n.a. |
| 1935 | 12.6 | n.a. | 10.9 | 8.7 | 7.8 | 7.2 | 8.9 | n.a. | 6.2 | 23.3 | 9.4 | 8.3 |
| 1936 | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | 11.0 | n.a. | 20.5 | n.a. | n.a. |

See footnotes at end of table.

Table A-32. - OPERATING AND INDIRECT MAN-HOURS PER THOUSAND COMMON-BRICK EQUIVALENTS PRODUCED BY PLANT, 1915-36^a - Continued

^aTotal operating and indirect man-hours include the following departments: Clay, machine house (including drying), setting and tossing, burning, handling and loading, and indirect labor, such as maintenance and repair, power, trucking (within the plant), superintendent and other (watchman, etc.). All office and clerical functions are excluded.

The region is shown by the roman numeral preceding the factory code number. (See table A-1 for States included in each region.) The size-division of plants is based upon estimated annual capacity measured in common-brick equivalents: Small (S), less than 15 million brick; medium (M), 15-29.9 million brick; and large (L), 30 million brick or over.

^bFigures for 1927 and prior years exclude man-hours of superintendent..

^cDiverse products are combined into simple aggregate.

^dDiverse products are combined on the basis of relative labor-time requirements.

^eDiverse products are combined on the basis of relative labor-time requirements found in similar plants.

^fMan-hours for the second half of 1929 were estimated on the assumption that the man-hour ratio for the first half is valid for the second half.

^gMan-hours are unreliable for 1929-30 for plant 9, 1930 for plant 58, and for unspecified years for plant 57.

^hMan-hours for loading and tossing for the years 1922-27 are derived

from all other operating and indirect man-hours by calculating the average percentage for the period 1926-35.

ⁱNo handlers and loaders are shown, nor any indication as to whether they are included in another department.

^jDiverse products are combined on a simple physical-weight basis.

^kPart of output is glazed.

^lJanuary 1933 to November 1935.

^mPlant has machine shop supplying other plants of the same corporation with spare parts, etc. No prorating has been attempted.

ⁿClay mining is done by contract labor not shown in aggregate man-hours.

^oSome labor spent in new construction is likely to be included in total operating and indirect labor.

^pDelivery trucking is included.

^qData are for two units, 1929 and 1930; and for one unit only from 1931 on.

^rOutput is measured in terms of brick sold, unadjusted for annual inventory.

n.a. Data not available because plant is idle or dismantled, or for some other reason.

APPENDIX B

TECHNICAL NOTES

ANALYSIS OF THE SAMPLE

Production

The production data for the universe, taken from the *Census of Manufactures*, include production from allestablishments producing clay products without regard to size of the output, with the exception of establishments which were idle throughout the year or which in the years 1921 and 1923 reported products valued at less than \$5,000.

Production data (in physical units) for the sample were included:

- (a) Only for those plants and years for which corresponding man-hour data were available.
 - (b) Only where the total production of the plant for the given year was reported. No incomplete annual production data were included.
 - (c) Only for the five products, common brick, face brick, vitrified brick, hollow building tile, and drain tile.
- For both sample and universe production data are for burned brick and tile. These data were then converted into common-brick equivalents by use of the conversion factors given in table A-12.

Man-hours

The man-hours for the universe are estimates based on census data. These estimates include only that portion of the time of wage earners reported by the census as working in brick and tile establishments which could be properly allocated to the production of the five specified products. For methods used in obtaining the estimates, see pages 196-8.

The man-hours for the plants in the sample include all labor time of wage earners in plant and yard utilized directly or indirectly in the production processes (operating and indirect labor). Any man-hours used in transportation of products from the plant and also any used in construction or major repairs of structures and equipment are excluded. For a list of the

principal occupations included see appendix C. The man-hours for the plants in the sample were included only when corresponding production data were available for the given years.

Establishments

For the universe the number of establishments is the number, as reported in the census, whose major product is any one of the five specified products. This would be somewhat less than the number producing these products, but the census does not give the data necessary for determining this number. Establishments not operating in any one year are omitted for that year. Establishments which sell from stock but do no manufacturing are not considered as operating. While some establishments may include two or more plants operating under common ownership, the term "establishment" usually signifies a single plant.

For the sample each establishment signifies one plant. Plants not operating in any one year are omitted from the sample for that year, as are all plants for which either man-hour or production data are lacking or are incomplete for the year.

Measurement of Size of Establishments

The establishments in the universe selected for comparison with the sample in respect to size were necessarily those whose major product was one of the specified products. The total production of these establishments was converted into common-brick equivalents by means of the conversion factors shown in table A-12 when the quantities of specified products were given, or by means of average value at comparable establishments when the quantities were not given. The man-hours for the universe were the total man-hours utilized in this production. Hence neither man-hours nor production in table A-11 agrees with that in table 23 since some of the products of these establishments are not brick and tile as defined by this study and some brick and tile are made in other establishments.

Regions

The States in the universe were grouped together in regions on the basis of geographic location and markets, with the exception of Area IX which included all States not included in the

other regions, either because data were lacking or because the production was relatively unimportant over the period of years surveyed. The production of common brick was made the basis for classification into the nine regions. For the other four products the same numbering and general geographic location of regions were followed, but the boundaries were sometimes changed by excluding from a given region the States that were relatively unimportant in the production of the given product. Also in some cases an entire region was omitted because of its relative unimportance in respect to a given product. These differences are indicated in the various tables.

PRODUCTION AND AVERAGE VALUE PER UNIT OF PRODUCT

Common Brick

Quantities and values of common brick produced or sold were obtained from the *Census of Manufactures* for census years 1869-1935 and from *Mineral Resources of the United States*¹ annually for 1894-1918. It was necessary to estimate the number of common brick produced in 1849 and 1859 from figures of total value of brick produced as given in the census. This was done by dividing the total value by the average wholesale price of common brick as reported in the Aldrich Report,² adjusted by an estimated ratio between unit value and price based on data for 1869 and 1879 when both were available.

Average values per thousand common brick were obtained for the years 1869, 1879, and 1889 from total value and quantity figures in the census. Average values per thousand for years 1899-1918 are those obtained from *Mineral Resources of the United States*. Average values for 1919 and subsequent years are from the census.

Face Brick

This product is not reported separately prior to 1869. Quantity and average values per thousand brick for 1869-1935 are from the same sources as those for common brick.

¹Quantity figures from this source refer to amounts sold and value of sales.

²U. S. Congress, Senate, *Wholesale Prices, Wages and Transportation*, S. Doc. No. 3074, 52d Cong., 2d sess., 1893, III, part IV, 222.

Vitrified Brick

This product is not reported prior to 1889. Quantity and average values per thousand brick for 1889-1935 are from the same sources as those for common brick.

Hollow Building Tile

This product is not reported separately prior to 1896. Quantities prior to 1917 were estimated from total value by dividing by the estimated value per ton. In the period 1896-1917 average values per ton are available for 1899, 1904, and 1917. Average values were estimated for 1900-3 inclusive by a straight-line interpolation between 1899 and 1904; and quantities, by dividing interpolated average value per ton for each year into total value reported. For the years intervening between 1904 and 1917, the ratio of average value per ton of hollow building tile to the average value per thousand common brick was interpolated on a straight-line basis. The average value per thousand common brick in each year multiplied by the respective interpolated ratio gave an estimated value per ton of hollow building tile. The same sources were used as for common brick.

Drain Tile

Drain tile is not reported in 1849. Quantities prior to 1919 were estimated from total value by dividing by value per ton.

Average values per ton were estimated for census years 1859, 1869, 1879, 1889, and annually for 1896-1918 on the basis of the observed relationship between average value per thousand common brick and the average value per ton of drain tile from 1919 to 1925, which was very steady. The same sources were used as for common brick.

**CONVERSION OF CENSUS PRODUCTION DATA
INTO COMMON-BRICK EQUIVALENTS**

A geometric average of the ratios of the value per unit (per thousand for brick and per ton for tile) of each product to the value per unit of common brick for each year from 1919 to the present was computed. This was 1.545 for face brick, 1.936 for vitrified brick, 0.593 for hollow building tile, and 0.687 for

drain tile. These ratios were used as conversion factors to convert the quantities of face brick, vitrified brick, hollow building tile, and drain tile into equivalent common-brick units for the years 1919-35. It was noticed that the value per unit of face brick maintained a fairly stable ratio to the value of common brick prior to 1912, which was around 1.9. From 1869 to 1911 the conversion factor of 1.958 was used, which is the geometric average of the ratios of the value per unit of face brick to the value per unit of common brick from 1899 to 1911. From 1911 to 1919 there was a downward trend in this ratio; hence for the years 1912-18 inclusive a geometric interpolation between the ratios 1.958 and 1.545 was used.

For vitrified brick prior to 1919 the geometric average of the ratios from 1899 to 1918 was used as a conversion factor. This was 1.808.

For hollow building tile prior to 1917 values per ton for only 2 years were given. In 1899 this value per ton was approximately the same as the value of common brick per thousand. By 1904 the ratio of the value of a ton of hollow building tile to the value of a thousand common brick had gone down 10 percent and by 1919 approximately 40 percent. The downward trend in this ratio seems reasonable considering the increasing development of the production of hollow tile. Having no other given data with which to work, a straight-line trend for the conversion factor for hollow building tile was assumed between 1.00 in 1899 and 0.593 in 1919.

The plotted ratio for the relation of value per unit of drain tile to the value per unit of common brick showed some upward trend from 1919-35. Hence the conversion factor chosen for the period 1899-1918 inclusive was the average for the years 1919-25, or 0.655, a lower one than for the later period. As computed, the common-brick equivalent of drain tile for the years previous to 1919 is essentially the value of the drain tile for the year divided by the price of common brick for that year.

The sum of the equivalent common-brick production for all of the products for each year gives the production for each year in terms of common-brick equivalents.

See pages 193-4 for the sources of the data used for computation of conversion factors and page 24 for discussion of the limitations of the methods used.

**ESTIMATED EMPLOYMENT AND MAN-HOURS
IN BRICK AND TILE MANUFACTURING****Wage Earners**

Average Number.— For the years 1925, 1927, 1929, and 1935 the census reports the number of wage earners in establishments classified by major product, together with the quantity and value of the major product and the total value of all products produced in these plants. These data, together with the total quantities of each of the products produced in the United States, make possible an estimate of the number of wage earners to be allocated to the production of the five products of the industry. The formula used for the number of wage earners allocated to each specified product was to multiply the total number of wage earners by the ratio that the value of the specified product was of the total value of all products produced in the given class of establishments and then to raise this number by multiplying it by the ratio that the total quantity of the specified product produced is of the quantity produced in these establishments. Since most of the five products were produced in these establishments either as a major product or as a secondary product, the error in this method is not great.

For the years 1879-1909 the census gives similar data for what it designates as the "Brick and Tile" sector of the clay-products industries. This corresponds fairly closely but not exactly to the definition used in this study. The number of wage earners as given in the census for this sector was multiplied by the ratio that the total value of the five specified products, wherever produced, was of the value of all products in this sector.

From 1849-69 the number of wage earners for brick and tile was either reported separately for building brick and drain tile or reported together for these two so that no estimate was necessary. Hollow building tile and paving brick do not appear in census reports before 1879.

For the remaining years, it was necessary to make estimates on the basis of the ratio of the value of the five products to the value of the products in the census classification of "Clay Products (Other Than Pottery) and Nonclay Refractories." A correction based on data for the years 1925, 1927, 1929, and 1935 was made for the fact that the value of the products per wage earner

in the brick and tile sector is less than in the remainder of the industry.

For the years 1849-89 the census schedules asked for the average number employed during the months of continuous operation. In order to enable comparison with subsequent years, it was necessary to convert this average number to an average for the 12 months. This was done by multiplying the average number employed as given in the census by the ratio of the estimated number of weeks of operation in these years to 51, that is, the working weeks in a full year, allowing 6 days for holidays.

Man-hours.- In general, the total number of man-hours for each of the census years 1869-1935 was computed by multiplying actual hours worked per week by 51, the number of working weeks per year, and this in turn by the average number of wage earners.

In 1869 and in 1879 the number of hours per week was estimated at 60, after examination of data on hours per week for those years for various industries and occupations in the United States Bureau of Labor Statistics Bulletin No. 499, *History of Wages in the United States from Colonial Times to 1928*.

The number of hours per week for 1889 was based on information in the *Eleventh Census of the United States: 1890* on the length of the working day. For the census years 1869, 1879, and 1889 the number of actual full-time weeks worked per year was assumed to be 31.2, which was the average term of operation of establishments in 1889 as determined from average-weekly-earnings data in the census. The product of the number of weeks and the number of hours per week gives the total hours per year per wage earner.

For census years 1899-1929 the number of hours worked per week was estimated from full-time or prevailing hours of work per week corrected to represent the number of actual hours worked, and this was multiplied by 51 weeks, the estimated number of working weeks in a year.

The average number of prevailing hours of labor was computed from frequency distributions given by the *Census of Manufactures* for 1909, 1914, 1919, 1921, 1923, and 1929. The figures for 1899 and 1904 were interpolated on a straight-line basis between 1889 (based on the stated prevailing length of the working day) and 1909. The figures for 1925 and 1927 were similarly interpolated.

Computations based on a comparison of customary or full-time hours per week with the number of hours actually worked in the

common-brick industry for pay-roll periods in 1922, as given in the Bureau of Labor Statistics Bulletin No. 359, *Productivity Costs in the Common-Brick Industry*, indicate that, on the average, wage earners in the common-brick industry in 1922 worked 88.8 percent of the full-time hours. This percentage was applied to the series of full-time hours per week for census years 1899-1929 to obtain actual hours worked per week for these years. The figure for the hours per year per wage earner is the product of actual hours worked per week and 51, the number of working weeks.

The average number of hours worked per week for 1933 was based on Bureau of Labor Statistics data and was obtained from National Recovery Administration, Division of Review, Evidence Study No. 38, *Structural Clay Products Industry* (mimeo., Sept. 1935). For 1935 the average number of hours worked per week was obtained from the *Monthly Labor Review* giving the data for the "Brick, Tile and Terra Cotta" industry. This number was multiplied by the ratio that the 1933 BLS figure for this industry bore to the NRA (BLS) figure for the "Structural Clay Products" industry for the same year.

Salaried Employees

Number.- In general, the number of salaried employees for the brick and tile sector of the industry was obtained by multiplying the average number of wage earners estimated for this branch of the industry by the percentage that the number of salaried employees was of the number of wage earners for the census industry.

In 1925 and subsequent years the number of central administrative officers was not included in the census figures, but in 1925 the census stated separately the number of such employees. For subsequent years the number of salaried employees was increased on the basis of the 1925 data to correct for this omission.

The number of salaried employees was not given by the census in 1931 nor in 1935. The number for 1931 was estimated by interpolation between 1929 and 1933. The number of salaried employees in 1935 was obtained by assuming the same percentage relationship between salaried employees and wage earners in 1935 as in 1933.

Man-hours.- The number of man-hours for the salaried workers was computed only for 1929 for the purpose of inclusion in the

vertical structure of the industry. The number of hours worked per year was assumed to be the product of five and one-half 8-hour days per week and 51 working weeks per year.

ESTIMATED EMPLOYMENT AND MAN-HOURS IN THE VERTICAL STRUCTURE OF THE INDUSTRY

Production of Fuel

Bituminous Coal.- The number of man-hours for the quantity of this fuel used in the industry was obtained for 1914, 1919, and 1929 by dividing the tons used in the "Clay Products (Other Than Pottery) and Nonclay Refractories" industry by the net tons produced per man-hour (obtained from material on labor productivity in coal mining prepared for the WPA National Research Project by Nicholas Yaworski from published data of the Federal Bureau of Mines). These figures were adjusted by the percentage that the value of the five specified products was of the value of all products of the clay-products industries.

Average employment was obtained by apportioning total average employment in bituminous coal, as given by Mr. Yaworski, on the basis of tons used in the clay-products industries. This was further adjusted by the percentage that the value of the five specified products was of the total value of products in the clay-products industries.

Anthracite Coal.- Man-hours and average employment were obtained in the same manner as for bituminous coal, and data used were from the same sources.

Coal Used in Coke.- The quantity of coal necessary for the production of coke consumed in the census industry was obtained from the number of tons of coal necessary to produce a ton of coke as stated by Mr. Yaworski. Man-hours and average employment were then estimated on the same basis as for coal.

Production of Coke.- The estimates possible from the data obtainable are extremely unsatisfactory because coke is a joint product. Estimates are based on census data for the coke industry on value of coke and other products produced, the quantities of coke produced, and on the data on the coke consumed by the brick and tile industry. The resulting figures are a small part of total fuel employment.

Production of Fuel Oils and Gasoline.- The estimates for these fuels are highly unsatisfactory because both are joint products. Estimates were based on census data for the number of wage earners and on the value and quantity of these products consumed in the brick and tile industry. The resulting figures are small.

Transportation of Fuel

The man-hours and employment occasioned by the transportation of each of the fuels used by the industry were estimated by identical methods.

The basic estimate for all transportation figures (brick and tile products as well as fuels) was that of all employment and man-hours attributable to freight transportation on Class I railroads. First a tabulation was made of all classes of employees given in Interstate Commerce Commission's *Wage Statistics of Class I Carriers, 1932 and 1935*, classifying separately specified freight occupations and joint occupations concerned with or related to office work, movement of trains, and movement of cars. The average numbers of employees in joint occupations were allocated on the basis of revenues, train-miles, or car-miles respectively, according to which seemed more appropriate in the particular case in question, using data from the ICC's *Freight Commodity Statistics, 1928-1935*. The resulting freight employment and man-hours were found to be approximately 70 percent of the total employment in 1932 and in 1935. The total man-hours on Class I railroads in 1928-35 (from *Statistical Abstract of the United States*) were multiplied by 70 percent to obtain estimated freight man-hours, except in 1932 which was the basis for all estimates. Average employment was obtained by dividing total freight man-hours by hours actually worked per year per employee. (Hours per year per employee paid for were given in *Statistical Abstract* and were converted to hours actually worked by using the percentage that the number of hours actually worked in 1932, as found from the ICC's *Wage Statistics of Class I Carriers, 1932 and 1935*, was of hours paid for.)

Computation of man-hours and average employment attributable to transportation on Class I railroads of all the specified fuels was next undertaken. This was done on the basis of ton-miles. Ton-miles for the specified fuels and all freight were available only for 1932 from the Federal Coordinator of Transportation, *Freight Traffic Report*. Freight revenues for the specified fuels

and total for all freight for 1928-35 were available from ICC's *Freight Commodity Statistics, 1928-1935*. The percentage that the number of ton-miles for each of the specified fuels in 1932 was of the total ton-miles in that year was found. The percentage that freight revenues for each of the specified fuels were of the total freight revenues was found for each year of the period, and this series was multiplied by the ratio that the percentage of ton-miles attributable to the specified fuel was to the percentage of freight revenues attributable to that fuel in 1932. This gave a series of estimated percentages of total freight ton-miles by means of which total freight man-hours and employees were allocated to the transportation of the specified fuels.

The methods used for further allocation to the brick and tile sector of the clay-products industries were the same as those described for other vertical segments of the industry.

Production of Clay-working Machinery

From the *Census of Manufactures* was obtained the total value of the products and the average number of wage earners for the whole machinery industry, from which was calculated a series of relatives of average value produced per wage earner for the years 1914-29 inclusive, using 1929 as a base. Also from the census was found the total value of clay-working machinery produced during 1914-28. Special tabulations were obtained from the Bureau of the Census for 1929, 1933, and 1935, giving for establishments which produced any clay-working machinery the total value of products, the average number of wage earners, and the value of clay-working machinery. Wage earners attributable to clay-working machinery were allocated on the basis of value for these 3 census years. Also the average value per wage earner was found for 1929, and this was multiplied by the relatives of value per wage earner for the whole machinery industry to obtain an estimated series for 1914-28 of value per wage earner for clay-working machinery. The items of this series were then divided into the value of clay-working machinery for each year to obtain an estimate of the average number of wage earners attributable to production of clay-working machinery in these years.

The items of this series of wage earners for census years 1914-35 were multiplied by the percentage that the value of the five brick and tile products was of the total value of products in the clay-products industries (including pottery) to obtain

the number of wage earners engaged in the manufacture of clay-working machinery attributable to brick and tile.

Transportation of Brick and Tile on Class I Railroads

The method employed is identical with that used in making the estimate of man-hours and employment in transportation of fuel.

Distribution

Average employment in wholesale establishments dealing in building materials whose major sales were brick and tile was obtained from the census for 1929 and 1933. Man-hours per week were obtained by multiplying the average number of employees (as reported by the census in 1929 and in 1933) by the number of hours worked per week (given by NRA, Division of Review, Evidence Study No. 4, *Builder's Supplies Industry* [mimeo., Sept. 1935]). This figure was multiplied by 50 to obtain the man-hours per year, allowing 2 weeks for holidays. These figures for employment and man-hours were multiplied by the percentage that the value of brick and tile was of the value of the products of the census industry to obtain estimated employment and man-hours in distribution attributable to brick and tile.

COMPARABILITY OR CONVERSION OF FIELD-STUDY PRODUCTION DATA INTO COMMON-BRICK EQUIVALENTS

Internal Comparability

The standard procedure of putting diverse products on a comparable basis can be divided into four steps:

- (1) Selection of the standard or base product.
- (2) Computation of labor-time requirements for a unit of each product in each department. In each case they are expressed relative to labor-time requirements of the base product.
- (3) Computation of the weights to be given to each departmental ratio when combining the departmental ratios into the final comparability ratios.
- (4) Multiplication of each output figure by the appropriate comparability ratio and aggregating all the products thus computed.

If the final product is measured in terms of tons, a fifth step is required: conversion of the tonnage figure into pieces of the base product selected.

Selection of the Base Product.- The product usually selected as a base product was the one produced in greatest number and over the longest period, common brick always being selected if it was produced in the given plant. If the weight or any other major characteristic of the base product changed at all significantly during the period covered by the field reports, comparability ratios were recomputed.

Relative Labor-Time Requirements by Department.- Because of the fact that in the brick industry all products require the same type of processing but require varying amounts of labor time in the different departments, individual comparability ratios had to be computed for each department.

Clay department: Relative labor-time requirements were assumed to be directly proportional to physical weight, a brick weighing 10 pounds needing twice as much clay and, therefore, twice as much digging, etc., as a brick weighing 5 pounds. The ratios were then obtained by dividing weight of specified product by weight of base product.

Machine house: It was found empirically that 35 percent of machine-house man-hours, namely, those spent up to the point where the brick is cut, are proportional to the physical weight of the product and can be allocated in this proportion. For the remaining 65 percent, two methods were used, according to the availability of data.

- (1) Whenever task allotments were known for each product for a day on which the product in question was the only one processed, differences in these allotments were taken to indicate differences in relative labor-time requirements.
- (2) Sometimes the capacity of the brick machine was known for each product, and differences in labor-time requirements could be derived from these data.

Setting and tossing: Two methods were used. When data permitted, the labor time necessary to set one kiln was calculated for each product, and the ratio was obtained by relating the time for each product to the time for the base product. The

weakness in this approach is that in actual fact kilns are very rarely loaded with one type of product only. A second guide was the difference in piece rates. Whenever a full day's work amounted to approximately the same daily wage for setting of different types of products, the differences in piece rates could be assumed to reflect differences in labor-time requirements.

Burning: This step of the process is the product of two factors: the number of pieces per kiln and burning time per kiln. Since each factor may vary with the type of product burned, the final ratio is a combination of both kiln capacity and burning time.

Wheeling: Piece rates for different products were assumed to reflect differences in labor time.

Drawing: Ratios were based on time studies and estimates giving the time required to strip a kiln for each product.

In a few cases detailed departmentalized labor costs were available and could be taken to indicate labor time, if it was assumed that the proportion of skilled and unskilled (or low- and high-paid) workers was the same for each department. Otherwise, high cost in one department might reflect greater skill rather than a greater amount of man-hours. In other words, man-hours were assumed to be comparable.

Indirect and office labor were allocated to the different products in the same proportion as were total operating man-hours, thus not influencing the final ratio. In plants where only common and face brick were produced and the face brick required no additional labor but handling, indirect and office labor were allocated equally between the two products.

Combination of Departmental Ratios.- Since the proportion of man-hours contributed by each department to the aggregate is not the same, the departmental ratios could not be combined into a simple average but had to be weighted. The weight used for each department was the percentage that the man-hours for this department aggregated over the years of the survey bore to total man-hours similarly aggregated. Thus a constant weighting system was used for each plant throughout the survey period.

Conversion of Unadjusted to Adjusted Output.- This is self-explanatory and involves merely one step, that is, the multiplication of the quantity of each product by the appropriate ratio.

Deviations From Standard Procedure.- While the methods outlined for the standard procedure were applied in the majority of cases, not all the plants had sufficient data to allow the calculations to be performed. Either man-hours were not departmentalized, or criteria for determining relative labor requirements were not given, etc. In these cases information obtained from plants similar in regard to type of product, method of manufacture, set-up, location, etc. was utilized, and the ratios found in these plants were applied to the plant under consideration.

There is also a small number of plants for which, because of lack of other data, products had to be combined by giving them statistical weights suggested by the plant officials or based upon physical weights.

Whenever different grades of brick were listed separately, a thorough examination was conducted into the problem of difference in labor-time requirements, and if none could be found, the figures were combined into a simple aggregate.

External Comparability

Since the product in which output is finally expressed varies from plant to plant, the problem of external comparability arises. It was decided to ignore the differences in the weight of common brick and to consider all output measured in terms of common-brick equivalents as directly comparable.

For plants whose output was measured in face-brick units, an external comparability ratio of 1.25 was computed, based on information gathered during the process of solving the internal-comparability problem. Similarly, a ratio of 2.0 was established for output expressed in terms of 5" x 4" x 12" building tile and of 3.0 for 5" x 8" x 12" building tile.

CAPACITY OF BRICK AND TILE PLANTS

For the purposes of this survey capacity is defined as the total possible annual output of the plant, if allowance is made for ordinary and usual interruptions and if a continuous demand, an adequate fuel supply, and favorable labor and transportation conditions are assumed. It is assumed that capacity is best reflected in output figures and that a sustained period of 3 months' output is required to allow any estimate to be made.

The estimates for capacity were made as follows:

(1) When monthly production figures were available: The estimate was based upon the capacity indicated by actual output in the 3 consecutive most active months in those years for which this output was a peak, reduced by an allowance for necessary shut-downs for repairs and physical handicaps to operation during severe weather.

- (a) Preliminary estimate. The figure found by aggregating the 3 highest consecutive months was multiplied by 4 to give the annual output that would have been processed had operations been carried on at the peak rate.
- (b) Refined estimate. The preliminary estimate was subject to a correction designed to make allowance for seasonal fluctuations, necessary shut-downs, etc. The method consisted in finding the difference between the hypothetical preliminary estimate and actual annual output and assuming that 30 percent of this difference was due to inevitable interruptions and handicaps not caused by market conditions. The figure of 30 percent was based on miscellaneous data obtained from company officials and engineers. The preliminary estimate, minus 30 percent of the difference as described above, was therefore taken to represent actual capacity.

(2) When only annual production figures were available: In order to put plants with annual data on a comparable basis with monthly-data plants, the peak annual output figure had to be inflated to indicate capacity, since it is known that annual output is well below the level of both the preliminary and refined estimate for capacity output.

To find this inflator the typical relationship was computed between annual output and capacity for all plants having monthly data. In the course of this computation a marked degree of negative correlation was discovered between the amplitude of the seasonal peak production and the size of the plant, i. e., the percentage which actual output bears to attainable capacity decreases with decreasing size of the plants. Consequently, a different inflator was computed for every size group. The actual inflators used were the following:

| Output in millions of burned brick | Adjustment factor |
|---------------------------------------|----------------------|
| 18 or more | 109 |
| 17 | 111 |
| 16 | 113 |
| 15 | 115 |
| 14 | 117 |
| 13 | 119 |
| 12 | 121 |
| 11 | 123 |
| 10 or less | 125 |

(3) When there was a change in capacity: Frequently there is more than one peak year to be observed, and sometimes a trend in capacity is evident.

- (a) If no trend was evident, but 2 or 3 peak years, each having a decidedly different output level, were found, capacity was computed for every such year and was supposed to have changed by substantially equal increments during the intervening years.

Capacity for all years subsequent to the peak year preceding the post-1929 depression was ordinarily assumed as continuing at the figure estimated for the peak year. It is recognized that in some plants only small additions to machinery have been made, and equipment may have deteriorated so much during this period of slack operation that capacity actually declined. However, in the absence of definite evidence of the abandonment or deterioration of equipment, capacity has been considered to have remained unchanged from the last preceding peak.

- (b) Wherever a definite trend could be seen in the output data, as represented by the preliminary estimate, capacity was assumed to have changed to the extent indicated by these data.

Data permitting, all capacity estimates were checked by engineers' estimates based upon the rated capacity of equipment and machinery. In cases where that information was complete and reliable, it was given preference over the statistical estimate. If daily capacity of the machinery was known, output was computed on the basis of 258 days in the working year.

Equipment data were also used in checking changes in capacity evidenced by output data.

It was assumed that the length of the working week for the year or years from which the capacity estimate was obtained remained unchanged throughout the period covered by the survey. In cases where there was definite information on changes in the length of the working week, the capacity estimate was revised, on the assumption that a shortening of hours would be followed by a slightly less than proportionate decrease in capacity.

Finally, it must be remembered that since working hours are different in different plants, annual capacity may be based on an 8-hour day in one plant, a 9-hour day in another plant, and a 6-hour day in a third plant. This lack of uniformity somewhat impairs the comparability of the estimates.

STANDARD MAN-HOUR RATIOS

The standard man-hour ratio for a given plant for the period 1925-35 was defined as the average ratio for that plant when it was operating between 70 and 89 percent of capacity.

The figures for percentage of capacity utilized by each plant in each of the years 1925-35 were examined to determine the years in which the plant operated at a capacity between 70 and 89 percent. The average of the man-hour ratios for these years was designated as the standard man-hour ratio for that plant.

For plants which did not attain 70 percent of capacity during these years, the average of the man-hour ratios for the 3 years of highest capacity within the period 1925-35 was designated as a substandard ratio. These substandard ratios were adjusted on the basis of regression lines of man-hour ratios on capacity set up for each plant individually using all years available. The curve of regression was drawn freehand and projected to the 80-percent capacity line. In case a regression line was impossible because of an insufficient number of years, no standard man-hours were computed, and these plants were eliminated from all computations where standard man-hour ratios were used.

If a plant reached a percentage of capacity higher than 89 percent but did not produce within the specified range of 70-89 percent during the years 1925-35, the man-hour ratio for the higher capacity was taken, and this was designated as a super-standard man-hour ratio. These man-hour ratios were used as

calculated, on the assumption that once a high level of production in relation to capacity is reached, the man-hour ratio will not be much affected by the changes of a few points up or down in capacity utilized.

**CORRECTIONS IN THE MAN-HOUR RATIO FOR PERCENTAGE
OF CAPACITY UTILIZED**

Census Data, 1889-1935

An attempt was made to correlate the percentage of the capacity utilized with the percentage that the man-hour ratios for the corresponding years were of the trend of man-hour ratios at capacity production. This was done in order to eliminate the effects of the factor of capacity utilization upon man-hour ratios. The following method was employed:

It was assumed that production was at capacity in 1889, 1909, and 1925. In order to calculate capacity for the intervening years, a geometric interpolation was employed between the years 1889 and 1909 and between the years 1909 and 1925. From 1925-35 the trend from 1909-25 was extrapolated. This gave a capacity figure for each year from 1889 to 1935. The assumption was made that capacity was increased at approximately the same rate each year for the years from 1889 to 1909 and at the same rate for each year from 1909 to 1935. A similar method was used for the man-hour ratios. A geometric interpolation was used between the years 1889 and 1909 and again between the years 1909 and 1925, and the latter trend was extrapolated to 1935. This line was used to represent the trend of man-hour ratios at capacity.

The next step was to compute for each year the percentage that actual production was of capacity production and also the percentages that the actual man-hour ratios were of the trend of man-hour ratios at capacity. A scatter diagram was constructed, on which was plotted on the "Y" axis the percentages that actual man-hour ratios for each year were of the trend of man-hour ratios at capacity and on the "X" axis the percentages that the actual-production figures were of capacity-production figures. This revealed a fair degree of correlation between the two series of percentages, with the percentage of man-hour ratios decreasing at an increasing rate as the percentage of capacity utilized increased. A freehand curve was drawn to represent this relationship, and the values of "Y" were read corresponding to the

percentages of capacity utilized during each of the given census years. These may be seen in table 28, col. (2).

In order to correct for capacity utilized, the actual man-hour ratio for each year was then divided by the percentage of man-hour ratio to capacity man-hour ratio, read from the freehand curve. The resulting figures are shown in col. (4) of table 28. They are an estimate of what the man-hour ratio would have been if plants had been operating at capacity as defined above.

Plants in the Field Study, 1917-35

During the period covered by the field study, the fluctuations in capacity utilized were so great that all evidence of any trend in the man-hour ratios was obscured; hence the method used for the census data of correlating deviations from the trend could not be used. Therefore variations in the percentage of capacity utilized were correlated directly with variations in the chain index of man-hour ratios. A coefficient of correlation of $-0.8640.06$ was found between the two series, but it was decided that a curvilinear rather than a linear function represented the relationship; hence a freehand regression line of the index of man-hour ratios on percentage of capacity utilized was drawn through the scatter diagram, using the means of the various classes as guiding points.³ The deviations of the index of man-hour ratios from the regression line were read from figure 20 and are given in table A-23. These deviations were added algebraically to the ordinate of regression for 1925, 89.5, which represented the highest percentage of capacity utilized. This percentage of capacity was 80 percent. These new index numbers were then shifted to a 1929 base. They are shown in table A-23.

³See figure 20 and table 30.

APPENDIX C

PRINCIPAL OCCUPATIONS IN THE BRICK AND TILE PLANT¹

| CLASSIFICATION | DUTY |
|-------------------------------|--|
| CLAY PIT | |
| Shovel operator | Operates steam shovel and is usually "boss" of the pit. |
| Cable hooker | Hooks cable to clay car and keeps tracks in pit clear. |
| Gasoline or "dinkey" engineer | Operates engine which hauls clay cars. |
| Shovel man | Common laborer who digs clay by hand or works in front of shovel. |
| Mule skinner | Drives mules or horse when wagons are used for hauling clay. |
| MACHINE HOUSE | |
| Hoistman | Operates machine hauling clay up incline to machine house. |
| Dry-pan man | Operates brick-grinding machine. |
| Granulator man | Operates granulator which cuts up the clay. |
| Pugmill man | Operates mixer. |
| Rollerman | In charge of conical rolls. |
| Boilerman | Tends boiler. |
| Cutter | Tends cutting-machine operations. |
| Sander | Sands brick molds used in soft-mud plants. |
| Bumper | Jars brick molds in soft-mud plants to prevent bricks from sticking. |
| Belt boy or hacker | Removes brick from conveyor belt and stacks them on brick cars. |
| Pallet boy | Places empty metal pallets in position for brick to be dumped upon them. |

¹Workers engaged in these occupations comprise operating and indirect labor. The following are not included in this classification: Administrators, central- or factory-office workers, clerical employees, etc.

CLASSIFICATION

DUTY

DRIER AND BRICK KILN

| | |
|-------------------|---|
| Fireman | Tends fires in driers and kilns. |
| Kiln engineer | Supervises building of kilns and proper adjustment of equipment in drier and kiln. |
| Drierman | Moves brick car from machine house to dry kiln. |
| Crane operator | Operates electric cranes in highly mechanized plants. |
| Tosser and setter | Tosser tosses brick from car to setter who places brick properly in kilns and finally in trucks or common carriers after they are thoroughly dry. |
| Fan engineer | In charge of fans in driers and generating equipment in machine house. |
| Waller | Builds arches in brick kilns. |

OTHERS

| | |
|-------------------------|---|
| Superintendent, foreman | Supervises and directs plant operations. |
| Yardman | Usually "jack-of-all-trades", capable of filling in any unskilled or semiskilled jobs around the plant. |
| Trucker | Operates autotrucks in moving brick. |
| Watchman | Guards the plant when it is not in operation. |
| Miscellaneous | General repairmen, cart drivers, roustabouts, and common laborers. |

