

PRODUCTIVITY AND EMPLOYMENT IN SELECTED INDUSTRIES

B E E T S U G A R

by

Raymond K. Adamson

and

Miriam E. West

WORKS PROGRESS ADMINISTRATION, NATIONAL RESEARCH PROJECT

In cooperation with

NATIONAL BUREAU OF ECONOMIC RESEARCH

Report No. N-1

Philadelphia, Pennsylvania

October 1938

**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.

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

C O N T E N T S

Chapter	Page
PREFACE.	xv
INTRODUCTION	xvii
I. A DESCRIPTION OF THE BEET-SUGAR INDUSTRY	1
A definition of the industry	2
Nature of the industry and description of its processes	3
Market relations	9
Market for raw materials	9
Industrial organization.	11
The markets for sugar.	12
Development and growth of the industry	13
Regional development	18
Summary.	20
II. THE VOLUME OF EMPLOYMENT IN THE BEET-SUGAR INDUSTRY	22
Volume of employment in processing	23
Volume of employment in allied vertical segments of the industry	28
Growing and transporting sugar beets	28
Producing fuel for beet-sugar factories.	30
Producing machinery for beet-sugar factories.	32
Transporting and distributing sugar.	33
Other segments	35
Total volume of employment	35
Summary.	37
III. CHANGING PRODUCTION AS A FACTOR AFFECTING THE VOLUME OF EMPLOYMENT.	38
Relationship of production and employment changes	38
Absence of correlation with business cycles.	41
Factors influencing production of beet sugar	42
Fluctuations in consumption.	42
Sources of sugar consumed in the United States	45
Effect of United States tariffs upon domestic production of beet sugar.	47
Allocation of production under free-trade conditions.	48
Growth of the industry under protection, 1890-1913	50
Competition for the American market, 1914-1933	53

Chapter	Page
Fluctuations in the world price of sugar . . .	58
The quota system	61
Agricultural conditions.	65
Alternative crops.	67
Natural and other conditions affecting supply of beets	68
Summary.	69
IV. CHANGING UNIT LABOR REQUIREMENTS AS A FACTOR AFFECTING THE VOLUME OF EMPLOYMENT.	
	72
The problem of analysis.	72
Relationship of the sample to the industry as a whole.	74
Statistical problems of measurement.	78
The man-hour ratio	78
Labor requirements per 100-pound bag of sugar and per ton of beets sliced	78
Problems of comparability and of byproducts.	83
The standard man-hour ratio.	84
Capacity or size of plant.	84
Unit labor requirements for the campaign	85
Fluctuations in the man-hour ratio	85
Correlation of technological changes with changes in productivity	88
Analysis of fluctuations in unit labor requirements.	92
Increasing productivity in individual plants	93
Rates of change and contingent labor- reduction ratios.	97
Characteristics of individual plants correlated with productivity	99
Influence of size and age of plants.	99
Influence of organization and management	101
Influence of geographical location	102
Influence of the degree of mechanization	102
Evaluation of factors affecting average unit labor requirements.	103
Changing unit labor requirements in vertical segments of the beet-sugar industry	108
Total factory labor requirements per ton of beets sliced.	108
Intercampaign and campaign man-hour ratios.	109
Office man-hour ratios	112
Agricultural man-hours per ton of beets sliced	112
Changing technology in raising sugar beets.	113

CONTENTS

ix

Chapter	Page
Man-hour ratios for fuel consumed by beet-sugar factories	115
Man-hours embodied in machinery and equipment	117
Changing unit labor requirements in transporting and distributing sugar.	119
Summary of unit labor requirements in vertical segments of the industry.	120
Analysis of costs.	121
Proportioning the factors of production.	128
Summary.	129
 V. ABSORPTION AND DISPLACEMENT OF LABOR IN THE BEET-SUGAR INDUSTRY	 131
Effect of machinery installations.	131
Changes in utilization of labor associated with changes in production and productivity. . .	133
Seasonality and income	135
Future employment in the industry.	136
Government policy.	138
 Appendix	
A. GENERAL STATISTICAL DATA	142
B. STATISTICAL DATA PERTAINING TO INDIVIDUAL FACTORIES OR GROUPS OF FACTORIES.	154
C. ADJUSTMENTS OF CENSUS DATA FOR REGIONAL BREAK-DOWN	182
D. MEASUREMENT OF MAN-HOURS EXPENDED IN REFINING MOLASSES BY THE STEFFENS PROCESS.	183
E. MEASUREMENT OF MAN-HOURS EXPENDED IN PROCESSING PULP.	186
F. PRINCIPAL OCCUPATIONS IN THE BEET-SUGAR FACTORY. .	188

CHARTS AND ILLUSTRATIONS

Figure	
1. Acreage and production in beet-sugar industry, 1901-35.	15
2. Production of beet sugar, by regions, 1899-1931. . .	19
3. Employment in beet-sugar factories, 1899-1935. . . .	24
4. Seasonal pattern of employment in beet-sugar factories, 1903-33	27
5. Man-hours in four vertical segments of the beet-sugar industry, 1917-35.	34
6. Production and employment in beet-sugar factories, 1899-1935.	39
7. Indexes of production of beet sugar and all manufactures, 1919-36.	41

CONTENTS

CHARTS AND ILLUSTRATIONS—Continued

Figure	Page
8. Total and per-capita consumption and wholesale prices of refined sugar, 1899-1936.	44
9. Distribution by source of sugar consumed in continental United States, 1899-1932	46
10. Price differentials of raw Cuban sugar at New York and London, quarterly, 1922-31	54
11. Sources of refined sugar consumed in continental United States, 1921-32	56
12. Average New York sugar prices, 1899-1936	59
13. Indexes of wholesale prices of all farm products, refined sugar, and sugar beets, and of sugar-beet acreage harvested, 1899-1936	67
14. Total beets sliced, and index of beets sliced by sample factories, 1918-35.	77
15. Campaign man-hour ratios and percentage of sugar content and yield, 31 identical factories, 1917-35	82
16. Campaign man-hour ratios and percentage of sugar content and yield, all reporting factories, 1916-35	82
17. Indexes of man-hour ratios and beets sliced, 1917-35	87
18. Length of campaign, 1917-35.	88
19. Campaign man-hours per ton of beets sliced, all reporting factories, 1917-35	93
20. Campaign man-hours per ton of beets sliced, 31 identical factories, 1917-35.	95
21. Campaign man-hours per ton of beets sliced and average daily slicing, 31 identical factories, 1917-35.	96
22. Length of campaign, eastern and western factories, 1917-35.	106
23. Intercampaign man-hours per ton of beets sliced and length of campaign, 27 identical factories, 1928-35	110

TEXT TABLES

Table

1. Number of establishments, value of products, and capital investment in beet-sugar factories, 1899-1935.	16
2. Number of establishments and production of beet sugar, 1899-1935.	18
3. Employment in beet-sugar factories, 1899-1935.	23

CONTENTS

xi

TEXT TABLES—Continued

Table	Page
4. Index of seasonal employment in beet-sugar factories, 1903-33.	26
5. Employment in production of sugar beets, 1913-36 . .	29
6. Number of men required to produce fuel for beet-sugar factories, 1913-35	32
7. Number of men required to produce machinery for beet-sugar factories, 1917-35.	33
8. Average yearly man-hours of employment in four vertical segments of the beet-sugar industry, 1917-35.	35
9. Sugar beets sliced and beet sugar produced, 1899-1935	40
10. Comparative average total costs of refined sugars competing in the United States, 1929-31.	50
11. Rates of duty on sugar in United States tariff acts, 1897-1936.	52
12. Sugar-marketing quotas, 1934-36.	64
13. Summary of analysis of sample of beet-sugar factories	75
14. Campaign man-hour ratios and percentage of sugar content and yield, 31 identical factories, 1917-35	79
15. Campaign man-hour ratios and percentage of sugar content and yield, all reporting factories, 1916-35	80
16. Chain indexes of campaign man-hour ratios and beets sliced, 1917-35.	86
17. Campaign man-hours per ton of beets sliced and average daily slicing, 31 identical factories, 1917-35.	96
18. Standard man-hour ratios by size and age of factories, 1934	100
19. Standard man-hour ratios by size and age of factories, 1918	100
20. Standard man-hour ratios for factories classified by gross investment per daily campaign man-hour, 1928 and 1934.	103
21. Man-hours per ton of beets sliced and length of campaign, 27 identical factories, 1928-35.	110
22. Central-office man-hours per ton of beets sliced, 1927-35.	111
23. Agricultural man-hours per ton of sugar beets produced, 1913-36.	112
24. Fuel man-hours per ton of beets sliced, 1913-35. . .	116

TEXT TABLES—Continued

Table	Page
25. Machinery man-hours per ton of beets sliced, 1917-35	118
26. Man-hours per ton of beets sliced for three vertical segments of the beet-sugar industry, 1917-35 . . .	120

APPENDIX TABLES

A-1. Acreage and production in the beet-sugar industry, 1899-1936	142
A-2. Monthly employment in the beet-sugar industry, 1903-35	143
A-3. Estimated labor requirements for production of fuel for beet-sugar factories, 1913-35	144
A-4. Estimated labor requirements for production of machinery for beet-sugar factories, 1917-35 . . .	145
A-5. Estimated man-hours in four vertical segments of the beet-sugar industry, 1917-35.	146
A-6. Indexes of production of beet sugar and all manufactures, 1919-36	147
A-7. Per-capita and total consumption and wholesale price of sugar, 1899-1936	148
A-8. Sources of refined sugar consumed in continental United States, 1897-1932.	149
A-9. Price differentials of raw Cuban sugar at New York and London, quarterly, 1922-31.	150
A-10. Average wholesale price of sugar at New York, 1899-1936	151
A-11. Indexes of wholesale price of all farm products, sugar beets, and sugar and of acres of sugar beets harvested, 1899-1936.	152
A-12. Yield of sugar beets per acre and sucrose content of sugar beets, 1901-36	153
B-1. Analysis of sample of beet-sugar factories: Number of factories and production of granulated sugar, by region, 1918-35.	154
B-2. Analysis of sample of beet-sugar factories: Percentage distribution of factories and granulated-sugar production, by region, 1918-35.	155
B-3. Analysis of sample of beet-sugar factories: Average production of granulated sugar per factory, by region, 1918-35	155
B-4. Analysis of sample of beet-sugar factories: Quantity of sugar beets sliced and average quantity per factory, 1918-35	155

CONTENTS

xiii

APPENDIX TABLES—*Continued*

Table	Page
B-5. Analysis of sample of beet-sugar factories: Age distribution of factories in existence in 1934-35	156
B-6. Beets sliced in the United States and chain index of beets sliced by sample factories, 1912-35. . . .	157
B-7. Campaign operating and indirect man-hours per ton of beets sliced, by factory, 1912-35.	158
B-8. Intercampaign man-hours per ton of beets sliced, by factory, 1927-35.	163
B-9. Analysis of campaign man-hours per ton of beets sliced, all reporting factories, 1916-35.	165
B-10. Analysis of campaign man-hours per ton of beets sliced, 31 identical factories, 1917-35	166
B-11. Analysis of link relatives of campaign man-hour ratios, 1913-35	167
B-12. Index of campaign man-hour ratios, 1912-35.	168
B-13. Index of beets sliced per factory per day, 1917-35	169
B-14. Index of beets sliced, 1912-35.	169
B-15. Indexes of campaign man-hour ratios, 1917-35. . . .	170
B-16. Average number of net campaign days, 1917-35. . . .	170
B-17. Beets sliced and man-hour ratios, eastern and western factories, 1917-35.	171
B-18. Campaign, intercampaign, central-office, and factory-office man-hours per ton of beets sliced, 1927-35	171
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	172
B-20. Man-hours per ton of beets sliced embodied in machinery requirements, 27 beet-sugar factories, 1927-35, based on gross investment.	172
B-21. Cost per 100-pound bag of beet sugar, 1922 and 1929	173
B-22. Cost per 100-pound bag of beet sugar, 49 identical factories, by capacity, 1922 and 1929	174
B-23. Cost per 100-pound bag of beet sugar, 30 identical factories, by capacity and unit labor requirements, 1922 and 1929.	176
B-24. Cost per 100-pound bag of beet sugar, 49 identical factories, by area, 1922 and 1929	178

APPENDIX TABLES-Continued

Table	Page
B-25. Changes in employment of labor accompanying the installation of machinery in 26 beet-sugar factories, 1922-35.	180
B-26. Year-to-year net changes in utilization of labor, 31 identical factories, 1917-35	181
D-1. Standard man-hours per ton of beets sliced for beet-sugar factories, by type of Steffens operation and by geographical area, 1934.	184
E-1. Standard dry-pulp man-hours per ton of beets sliced, 1934.	187