OLEOMARGARINE.

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By John H. Garber.

Table 1 shows the totals for the manufacture of oleomargarine as reported at the censuses of 1880 to 1900, inclusive, with the percentages of increase for each decade.

Table 1.—COMPARATIVE SUMMARY, 1880 TO 1900, WITH PER CENT OF INCREASE FOR EACH DECADE.

	Date of census.			Per cent of increase.	
	1900	1890	1880	1890 to 1900	1880 to 1890
Number of establishments	24	12	15	100.0	[1] 20.0
Capital	$3,023,646	$634,532	$1,680,300	376.5	[1] 62.2
Salaried officials, clerks, etc., number	394	64	(2)	515.6	.....
Salaries	$412,012	$91,752	(2)	349.0	.....
Wage-earners, average number	1,084	264	599	310.6	[1] 55.9
Total wages	$534,444	$154,138	$212,952	246.7	[1] 27.6
Men, 16 years and over	1,007	252	561	299.6	[1] 55.1
Wages	$511,238	$150,918	(2)	238.8	.....
Women, 16 years and over	65	11	18	490.9	[1] 38.9
Wages	$21,009	$2,870	(2)	632.0	.....
Children, under 16 years	12	1	20	1,100.0	[1] 95.0
Wages	$2,197	$350	(2)	527.7	.....
Miscellaneous expenses	$2,489,784	$385,563	(3)	545.8	.....
Cost of materials used	$7,639,501	$2,175,264	$5,486,141	251.2	[1] 60.3
Value of products	$12,499,812	$2,988,525	$6,892,939	318.3	[1] 56.6

[1] Decrease. [2] Not reported separately. [3] Not reported.

While the industry was in existence prior to 1880, statistics concerning it first appear in the census reports for that year. From Table 1 it appears that there was a general decrease in the industry during the decade ending with 1890, followed by a large increase during the ten years ending with 1900. Oleomargarine is, however, frequently manufactured in connection with slaughtering and meat packing, and in such cases it is difficult to obtain data which relate exclusively to its production; it is possible that at prior censuses the statistics for oleomargarine so manufactured were not separately reported, and to this extent may fall short of representing the total for the industry. Of the 24 establishments reported for 1900, 8 manufactured oleomargarine in connection with slaughtering and meat packing.

Table 1 shows that from 1880 to 1890 the number of establishments decreased from 15 to 12; the capital from $1,680,300 to $634,532; and the products from $6,892,939 to $2,988,525. This large decrease is due, in part, to the fact that certain states—notably New York—enacted effective legislation antagonistic to the manufacture of oleomargarine, and the act of Congress of 1886 imposing a special yearly tax of $600 on manufacturers forced a few small producers out of business. The census report for 1880[1] shows 5 establishments in New York, with $645,500 capital and products valued at $5,338,753; in 1890 none were reported. At the census of 1890 there had not been time for a readjustment and redistribution of the industry, and the figures of the Tenth Census afford, therefore, a better basis of comparison than do those of the Eleventh Census. It appears from Table 1 that during the twenty years there was a net gain of 9 in the number of establishments, while the capital increased from $1,680,300 to $3,023,646, and the value of products from $6,892,939 to $12,499,812. In 1880 the average number of wage-earners was 599, and the wages paid, $212,952; by 1900 the number had increased to 1,084 and the wages to $534,444. The amount paid for miscellaneous expenses was not reported in 1880; of the $2,489,784 reported for this item in 1900, more than two million dollars were represented by the internal-revenue tax of 2 cents a pound.

The distribution by cities of the 24 establishments reported at the present census is as follows: Chicago, Ill., 6; Providence, R. I., 3; Indianapolis, Ind., 2; Washington, D. C., 2; Kansas City, Kans., 2; Kansas City, Mo., 1; Hammond, Ind., 1; East St. Louis, Ill., 1; Pittsburg, Pa., 1; Louisville, Ky., 1; Columbus, Ohio, 1; Cleveland, Ohio, 1; Houston, Tex., 1; Camden, N. J., 1.

The corporate form of organization predominates in this industry, 17 establishments being operated by incorporated companies, 4 by individuals, and 3 by firms or

[1] Report of Manufactures at the Tenth Census, page 62.

limited partnerships. Fifteen establishments were engaged in the manufacture of oleomargarine as a separate and independent business, 1 was more extensively engaged in manufacturing neutral lard for export, and the remaining 8 made the industry an adjunct to slaughtering and meat packing.

Table 2 presents a comparative statement of capital for 1890 and 1900, with the percentages of increase for the ten years.

TABLE 2.—COMPARATIVE SUMMARY, CAPITAL: 1890-1900.

ITEMS.	1900	1890	Per cent of increase.
Capital:			
Total	$3,023,646	$634,532	376.5
Land	200,868	32,234	523.2
Buildings	535,620	29,900	1,691.4
Machinery, tools, and implements	482,477	73,800	558.2
Cash and sundries	1,804,681	499,098	261.6

The capital is shown by Table 2 to have increased from $634,532 in 1890 to $3,023,646 in 1900, a gain of 376.5 per cent. The largest item for each year was that of cash and sundries, which includes cash on hand, bills receivable, unsettled ledger accounts, raw materials, stock in process of manufacture, finished products on hand, and other sundries. In 1900, $1,804,681 was reported for this item, and in 1890, $499,098, an increase of 261.6 per cent. In 1900 the value of the owned land and buildings, as reported by 13 establishments, was $200,868 and $535,620, respectively. The remaining 11 establishments paid $16,800 for rent of land and buildings. The $482,477 reported as invested in machinery, tools, and implements in 1900 represents the value of the equipment of all of the 24 plants, this part of the capital being owned by the manufacturer in every instance. The amount represents an average of $20,103 for each factory. The smallest amount reported for this item of capital from any plant was $500; the largest amount, $105,000. The equipment is singularly free from delicate and complex machinery, and is therefore subject to comparatively little deterioration through use.

Table 3 shows the quantity and cost of the different materials used and the quantity and value of products as reported for the census year 1900.

TABLE 3.—MATERIALS AND PRODUCTS: 1900.

ITEMS.	Quantity.	Cost of materials.	Value of products.
Materials:	*Pounds.*		
Total	114,748,633	$7,639,501	
Milk and cream	23,684,395	579,068	
Oleo oil	33,724,621	2,744,285	
Neutral lard	37,651,741	2,976,870	
Cottonseed oil	11,818,921	567,790	
Butter	396,956	61,176	
Salt	6,962,233	58,887	
Color	204,418	32,078	
Sugar	137,842	7,084	
Glucose	32,965	494	
Materials—continued:	*Pounds.*		
Stearin and oleo stock	134,541	$4,320	
Fuel and rent of power and heat		49,855	
Mill supplies		5,745	
All other materials		501,107	
Freight		50,792	
Products:			
Total	104,633,214		$12,499,812
Oleomargarine	104,633,214		12,286,357
All other products			213,455

This table shows that there were used during the census year 114,748,633 pounds of material to produce 104,633,214 pounds of oleomargarine, indicating a loss of 10,115,419 pounds in the manufacturing process. While there is a slight shrinkage through evaporation and other natural causes, the principal loss is from the milk and cream, only part of which is absorbed or held by the oils in the churning process. Exclusive of milk and cream, the weight of ingredients was 91,064,238 pounds, or 13,568,976 pounds less than the quantity of oleomargarine produced. Except for slight shrinkage these materials return pound for pound in manufacturing, and it follows that the difference (13,568,976 pounds) represents the gain from 23,684,395 pounds of milk and cream used. It is calculated that the solid ingredients—those giving out pound for pound in the churning process—will gain from 10 to 20 per cent in weight through the absorption of butter fats and other constituents of milk. The largest factory in point of output manufactured more than 15,000,000 pounds of oleomargarine; the smallest, less than 50,000 pounds.

Table 4 shows the annual production of oleomargarine in the United States from 1886 to 1900, inclusive, as shown in the Report of the Commissioner of Internal Revenue for the fiscal year ending June 30, 1900.[1]

[1] Report of the Commissioner of Internal Revenue, 1900, pages 191, 390-393.

TABLE 4.—QUANTITY OF OLEOMARGARINE PRODUCED AND AMOUNT OF INTERNAL REVENUE RECEIVED THEREFROM, 1886 TO 1900, INCLUSIVE.

FISCAL YEAR ENDING JUNE 30.	Quantity produced.	TAXES.				
		Total.	General tax, 2 cents per pound.	Special taxes.		
				Manufacturers, $600.	Wholesalers, $480.	Retailers, $48.
	Pounds.					
On hand November 1, 1886	181,090	.....	.....	.....	.....	.....
1887 (from November 1, 1886)	21,513,537	$723,948	$435,924	$31,700	$101,400	$154,924
1888	34,325,527	864,140	653,355	17,150	70,376	123,259
1889	35,664,026	894,248	677,302	12,400	73,914	130,632
1890	32,324,032	786,292	619,206	11,700	55,318	100,068
1891	44,392,409	1,077,924	871,488	6,950	53,192	146,294
1892	48,364,155	1,266,326	945,675	10,400	106,086	204,215
1893	67,224,293	1,670,644	1,301,318	15,350	115,644	238,332
1894	69,622,246	1,723,480	1,328,558	11,250	107,394	276,278
1895	56,958,105	1,409,211	1,065,293	8,950	98,784	236,184
1896	50,853,234	1,219,432	952,475	15,725	72,264	178,968
1897	45,531,293	1,034,130	850,691	7,200	45,900	130,339
1898	57,516,136	1,315,781	1,107,775	7,600	44,272	156,134
1899	83,139,901	1,956,619	1,609,913	11,500	71,884	263,322
1900	107,045,028	2,543,785	2,085,273	15,450	97,919	345,143

From Table 4 it appears that 107,045,028 pounds were produced during the fiscal year ending June 30, 1900, which quantity differs from the 104,633,214 pounds reported to the Census Office and shown in Table 3. There was 1 establishment operating a portion of the census year that is not included in this report; a few establishments reported their output from their record of sales, which is not exactly identical with the amount manufactured, and the fiscal year does not correspond with the census year by one month. These facts explain the comparatively small discrepancy of less than two and one-half million pounds between the two tables.

The value of the 104,633,214 pounds of oleomargarine was $12,286,357, an average of 11.7 cents per pound. This amount represents the value at the factory, packed and ready for shipment, and includes the internal-revenue tax of 2 cents a pound, which must be paid on withdrawal for sale.

Table 5, prepared by the Treasury Department in response to a resolution of the House of Representatives, exhibits the quantity of oleomargarine shipped into each state for the fiscal year ending June 30, 1899.[1]

Table 6 shows the quantity, and destination value, of the oleo oil and oleomargarine exported during the fiscal year ending June 30, 1900.[2]

[1] Senate Report, No. 2043, 56th Congress, second session, page 90.
[2] Commerce and Navigation, 1900, Vol. II, pages 873–877.

TABLE 5.—QUANTITY OF OLEOMARGARINE SHIPPED INTO EACH STATE FOR FISCAL YEAR ENDING JUNE 30, 1899.

STATE OR TERRITORY.	Number of dealers.	Pounds.	Per cent of total.	STATE OR TERRITORY.	Number of dealers.	Pounds.	Per cent of total.
Alabama	21	226,053	0.3	Nebraska	73	1,024,985	1.3
Alaska	5	18,080	(1)	New Hampshire	19	455,588	0.6
Arkansas	35	380,389	0.5	New Jersey	296	5,875,975	7.4
Arizona	5	78,767	0.1	New Mexico	12	115,850	0.1
California	.....	74,923	0.1	New York	14	222,788	0.3
Colorado	55	1,123,537	1.4	Nevada	.....	625	(1)
Connecticut	5	134,255	0.2	North Carolina	9	110,244	0.1
Delaware	48	40,475	0.1	North Dakota	18	7,710	(1)
District of Columbia	61	816,848	1.0	Ohio	1,005	8,880,969	11.1
Florida	82	590,225	0.7	Oklahoma	10	117,398	0.1
Georgia	61	495,004	0.6	Oregon	3	41,250	0.1
Illinois	2,020	18,638,921	23.4	Pennsylvania	717	11,433,341	14.3
Idaho	3	58,224	0.1	Rhode Island	333	3,594,984	4.5
Indiana	306	3,923,228	4.9	South Carolina	24	258,159	0.3
Indian Territory	21	152,278	0.2	South Dakota	4	55,432	0.1
Iowa	3	79,922	0.1	Tennessee	83	714,640	0.9
Kansas	186	1,658,544	2.1	Texas	162	1,518,264	1.9
Kentucky	217	1,490,577	1.9	Utah	.....	8,450	(1)
Louisiana	140	1,043,502	1.3	Vermont	1	2,990	(1)
Maine	17	102,274	0.1	Virginia	121	1,159,400	1.5
Maryland	58	1,791,950	2.2	Washington	5	63,345	0.1
Massachusetts	108	2,083,889	2.6	West Virginia	172	1,206,865	1.5
Michigan	109	2,092,521	2.6	Wisconsin	23	714,742	0.9
Minnesota	30	1,343,865	1.7	Wyoming	5	39,547	0.1
Missouri	231	3,133,313	3.9	Total	.....	79,695,744	100.0
Mississippi	17	104,622	0.1				
Montana	.....	446,022	0.6				

[1] Less than one-tenth of 1 per cent.

TABLE 6.—QUANTITY AND VALUE OF OLEO OIL AND OLEOMARGARINE EXPORTED DURING THE FISCAL YEAR ENDING JUNE 30, 1900.

COUNTRIES TO WHICH EXPORTED.	Oleo oil.		Oleomargarine.	
	Pounds.	*Value.*	*Pounds.*	*Value.*
Total	146,739,681	$10,503,856	4,182,536	$109,083
Europe:				
Austria-Hungary	73,634	4,786		
Belgium	2,892,778	212,457	58,265	6,073
Denmark	8,628,948	675,053		
France	167,047	10,800		
Germany	26,780,986	2,104,818	448,769	37,049
Italy	250	15		
Malta, Gozo, etc			1,470	157
Netherlands	85,976,848	5,912,334		
Portugal			2,000	200
Sweden and Norway	13,500,332	960,047	17,990	1,400
Turkey in Europe	88,370	7,050		
United Kingdom	7,265,764	512,745	364,712	34,074
North America:				
Bermuda	2,537	201	32,015	3,786
British Honduras	1,050	152	7,880	1,097
Quebec, Ontario, Manitoba, etc	27,494	1,906	3,066	245
Newfoundland and Labrador	709,817	54,353	107,473	7,200
Honduras			260	31
Nicaragua			3,035	397
Mexico			9,194	993
Miquelon, Langley, etc			2,800	310
West Indies—				
British			1,466,638	146,959
Cuba			516,463	60,693
Danish			116,890	8,530
Dutch			41,605	3,280
French			157,200	13,501
Haiti			50,088	4,989
Porto Rico			219,140	22,776
Santo Domingo			9,784	906
South America:				
Brazil	4,652	391	100	18
Colombia			118,777	9,675
Ecuador			837	106
Guiana—				
British	3,000	270	133,236	14,638
Dutch			59,700	5,486
Asia:				
Chinese Empire			7,626	670
East Indies—British			2,300	328
Hongkong			1,560	194
Japan	6,049	656	41,309	4,412
Oceania:				
British Australasia	607,625	45,572		
Hawaii			118,396	11,800
Africa:				
British Africa			66,908	7,102
Portuguese Africa	2,500	250	50	8

From Table 6 it will be seen that about one-third of the oleomargarine exported went to the British West Indies; the next largest quantity was purchased by Cuba. The largest European purchasers were Germany and the United Kingdom. None of the oleo oil was consigned to the West Indies, but the Netherlands, Germany, Norway-Sweden, Denmark, and the United Kingdom received nearly all that was exported.

Table 7, based on commercial estimates, shows approximately the annual production of oleomargarine in European countries.

TABLE 7.—ANNUAL PRODUCTION OF OLEOMARGARINE IN EUROPEAN COUNTRIES.

COUNTRY.	Quantity produced.	Quantity imported.
	Pounds.	*Pounds.*
United Kingdom	82,000,000	110,000,000
Denmark	35,000,000	4,500,000
Norway	22,000,000	
Sweden	22,000,000	
Germany	220,000,000	
Netherlands	123,000,000	
Belgium	20,000,000	

Table 7 indicates that Germany is the greatest producer of oleomargarine, with a product of 220,000,000 pounds, followed by the Netherlands with 123,000,000 pounds. According to the figures of this table, the United States, with an output of more than 100,000,000 pounds, ranks third in production.

HISTORICAL AND DESCRIPTIVE.

Oleomargarine was first manufactured in France. In 1869 the French war office, at the instance of Napoleon III, who was desirous of discovering a substitute for butter that would keep longer and also increase the dietary of the poor, offered a prize for the best substitute, which was won by M. Mége-Mouries, a Parisian chemist. After a series of observations and experiments, Mége-Mouries was persuaded that the butter fat contained in milk was absorbed from the animal tissues of the cow, and his attention was then directed to the discovery of a process that would separate from beef fat the oil similar to that in milk. The method finally devised by him for the manufacture of oleo oil (called then oleomargarine or oleomargarine oil) was to heat finely minced beef fat with water, carbonate of potash, and small fragments of fresh stomachs of sheep, to a temperature of about 115 degrees Fahrenheit. The influence of the heat, together with the pepsin contained in the sheep's stomach, separated the fat from the cellular tissue. This fatty matter was then

removed and when cool was subjected to hydraulic pressure sufficient to separate the stearin. The oleo oil was then churned with milk and water in the proportion of 10 pounds of oleo oil to 4 pounds of milk and 3 pints of water. The resulting compound was washed and declared ready for use.[1]

The industry was early introduced into the United States, but statistics of its manufacture prior to 1886 are unreliable. In that year Congress passed an act regulating its manufacture and imposing a tax of 2 cents a pound on the product. From that date more exact information is obtainable. In 1887 there were 21,513,537 pounds made, and the present report shows a product of nearly five times that amount.

In the manufacture of oleomargarine so much depends on the handling of the constituent oils and the manipulation of the temperatures by which they are surrounded throughout the different stages of the process, that equipment for live steam, ice water, and refrigeration is the indispensable requisite of every establishment. Aside from this, the equipment consists principally of the machinery of power, melting tanks, mixing tanks, milk receptacles, churns, and machine butter workers. The butter workers are such as are used in creameries throughout the United States. In some factories the churns are similar to those used in creameries, but oftener they are large, upright, jacketed caldrons in which the milk and color are mixed with the melted oils by a violent churning or stirring produced by revolving or rotating agitators inside. By the introduction of steam into the jacket the operator controls the temperature and the degree of liquefaction until the churning process is complete. By the same means any considerable quantity of oleomargarine is prevented from congealing on the side of the churn while the contents are being drawn off. The equipment is generally of American manufacture. Only 2 factories visited by the writer were supplied with foreign machinery, which was imported from the centers of oleomargarine manufacture in Europe.

The number and character of the ingredients of oleomargarine make them susceptible of almost an infinite number of combinations, and each manufacturer has his own working formula. So much depends on the handling of the oils and the regulation of temperatures surrounding them at each successive step, that different manufacturers using the same quality of ingredients in similar combination will secure vastly different results. A formula for each of three distinct grades of oleomargarine, of general manufacture, is given below to show the use of different ingredients and their variation in quantity.

[1] Appleton's Annual Cyclopædia, 1882; also Universal Cyclopædia, 1900, Vol. 2, page 253.

Formula 1.—Cheap Grade.

	Pounds.
Oleo oil	495
Neutral lard	265
Cottonseed oil	315
Milk	255
Salt	120
Color	1¼
Total	1,451¼

will produce from 1,265 to 1,300 pounds of oleomargarine.

Formula 2.—Medium High Grade.

	Pounds.
Oleo oil	315
Neutral lard	500
Cream	280
Milk	280
Salt	120
Color	1½
Total	1,496½

will produce from 1,050 to 1,080 pounds of oleomargarine.

Formula 3.—High Grade.

	Pounds.
Oleo oil	100
Neutral lard	130
Butter	95
Salt	32
Color	½
Total	357½

will produce about 352 pounds of oleomargarine.

Practically all the oleomargarine manufactured in the United States is made by the simple process of churning a melted mixture of oleo oil and neutral lard with milk, cream, or melted butter to give it the butter flavor, and coloring matter to give it any desired shade of yellow in semblance of butter. In the cheap grades cottonseed oil is often substituted for a portion of oleo oil and neutral lard, but never to the total exclusion of either. After the churning process the whole is salted and put upon the market in a variety of forms, as demanded by the various classes of consumers. The different forms in which it is packed for market are well shown by the following extract from a circular of information issued by one of the large manufacturers:

"Our Butterine is packed as follows:

"Solids in 10, 20, 25, 30, 40, 50, and 60 lb. tubs; also in 25, 28, and 50 lb. record packages (tin-lined).

1 lb. bricks in 10, 28, 30, 48, and 60 lb. cases: also 48 lb. tubs.

2 lb. bricks in 30, 48, and 54 lb. cases.

3 lb. bricks in 54 lb. cases.

5 lb. bricks in 50 lb. cases.

1 lb. rolls in 42, 56, and 62 lb. tubs; also in 10 and 50 lb. cases.

1 lb. country rolls in 37 and 50 lb. tubs and 50 lb. cases.

1 lb. long rolls in 42 and 62 lb. tubs.

1 lb. prints in 37 and 50 lb. tubs; also 50 and 60 lb. cases.

2 lb. rolls in 32, 52, and 62 lb. tubs; also 10 and 56 lb. cases.

2 lb. country rolls in 52 lb. tubs and 50 lb. cases.

1, 2, and 3 lb. rolls, assorted, in 62 lb. tubs.

3 lb. rolls in 54 lb. cases.

5 lb. rolls in 60 lb. cases.

9½ lb. rolls in 57 lb. cases."

Cottonseed oil is used as a partial substitute for oleo oil and neutral lard. It never fully replaces either, but is added to some combination of those two ingredients to cheapen the finished product. It is a liquid within the range of temperature to which butter is exposed, and its use is, therefore, limited to such a proportion in any formula as will not soften the product beyond the usual consistency of butter. Its use would doubtless increase largely were it not for the fact that no process has been discovered that will take away its characteristic flavor. To make a high-grade oleomargarine it is absolutely essential that all its constituent oils respond fully to the neutralizing treatment by which their characteristic odors and flavors are removed, so that they will take on the flavor of butter from the aromatic principles of the milk or cream with which they are churned. Cottonseed oil, when forming any considerable proportion of oleomargarine, betrays its presence, and those manufacturers making a specialty of high-class table products have discontinued its use altogether.

Oleo oil is obtained from beef fat by the processes of settling, crystallization, and pressure, which separate it from the stearin and the fiber. Its manufacture is more widely distributed than that of neutral lard, but is principally confined to the large packing houses, which supply their own oleomargarine departments and also the independent manufacturers and the export trade. By independent manufacturers is meant those who produce oleomargarine exclusively, in contradistinction to those who subordinate it to slaughtering and meat packing. None of the independent manufacturers make their own oleo oil.

After the animal is slaughtered the fat is removed and placed in a vat of warm water, where it is thoroughly washed to remove blood and adhering impurities. It is then chilled and hardened with a bath of ice water, after which it is finely comminuted by cutting machines and melted in steam-jacketed caldrons at a temperature of about 160 degrees Fahrenheit. Slowing revolving agitators keep the fat moving until the melting process is complete, when the whole is allowed to settle. The settling process is accelerated by the addition of salt, which is scattered over the entire surface of the liquid and settles the fiber or "scrap" to the bottom. After the first settling, the clear oil is carefully siphoned to a second series of jacketed caldrons, usually on the floor below, where more salt is added, and the temperature controlled until a second settling is completed. This demembranized fat is now siphoned into mounted vats and allowed to stand from three to five days in a temperature favorable to the crystallization of the stearin, a part of which forms a crust over the top and the remainder settles to the bottom, leaving the clear oil between. It is a common phenomenon in the crystallization of various substances whose specific gravity is not greatly in excess of the mother liquid that, cooling first at the top, a portion of the substance which is being crystallized out forms a crust over the surface and the remaining portion is precipitated. When the vats have stood the required time the crust is broken into fine particles and the whole is given a thorough mechanical mixing which leaves it of a mushy consistency. It is then wheeled to a revolving table surrounded by skilled workmen who wrap the mixture into small packages with canvas cloths—each containing about 3 pounds—which are built into the presses. The oleo oil is then separated by great pressure, slowly and gradually applied, and flows from the presses into a large receiving tank on the floor below, from which it is piped to the oleomargarine department or is drawn into new oak tierces and allowed to harden in preparation for shipment to independent manufacturers or for export. Figure 1 shows two presses, one filled and the other in process of being filled.

All manufacturers of oleo oil follow substantially the method above described, but the system of grading and the character of the fat selected differ greatly. The number of grades manufactured is from three to five, and, when the market is active and prices are high, about all the fat taken in slaughtering, both from cattle and sheep, is worked into one grade or another. The oil made from sheep fat can not be neutralized, and retains the characteristic odor and flavor of the animal to such degree as to be unfit for the oleomargarine demanded in American markets. It is exported to Europe, where there is demand for cheaper oils. With the beef fats the character of the animal from which they are taken is the most potent factor in the selection. Some manufacturers work into their highest grade of oleo oil practically all the fat taken from a good steer, and make one or two lower grades from the fat of cows and "canners." Other manufacturers make their highest grade from the caul and other selected fats of the best beeves, using certain intestinal and other lower forms, together with that taken from poorer animals, in making from one to three lower grades. As previously indicated, the manufacture of oleo oil is more widely distributed than that of neutral lard, and, while it is largely confined to the big packing houses, considerable quantities are made in large cities, outside the centers of the packing industry, from fats collected in part from abattoirs and in part from retail butchers.

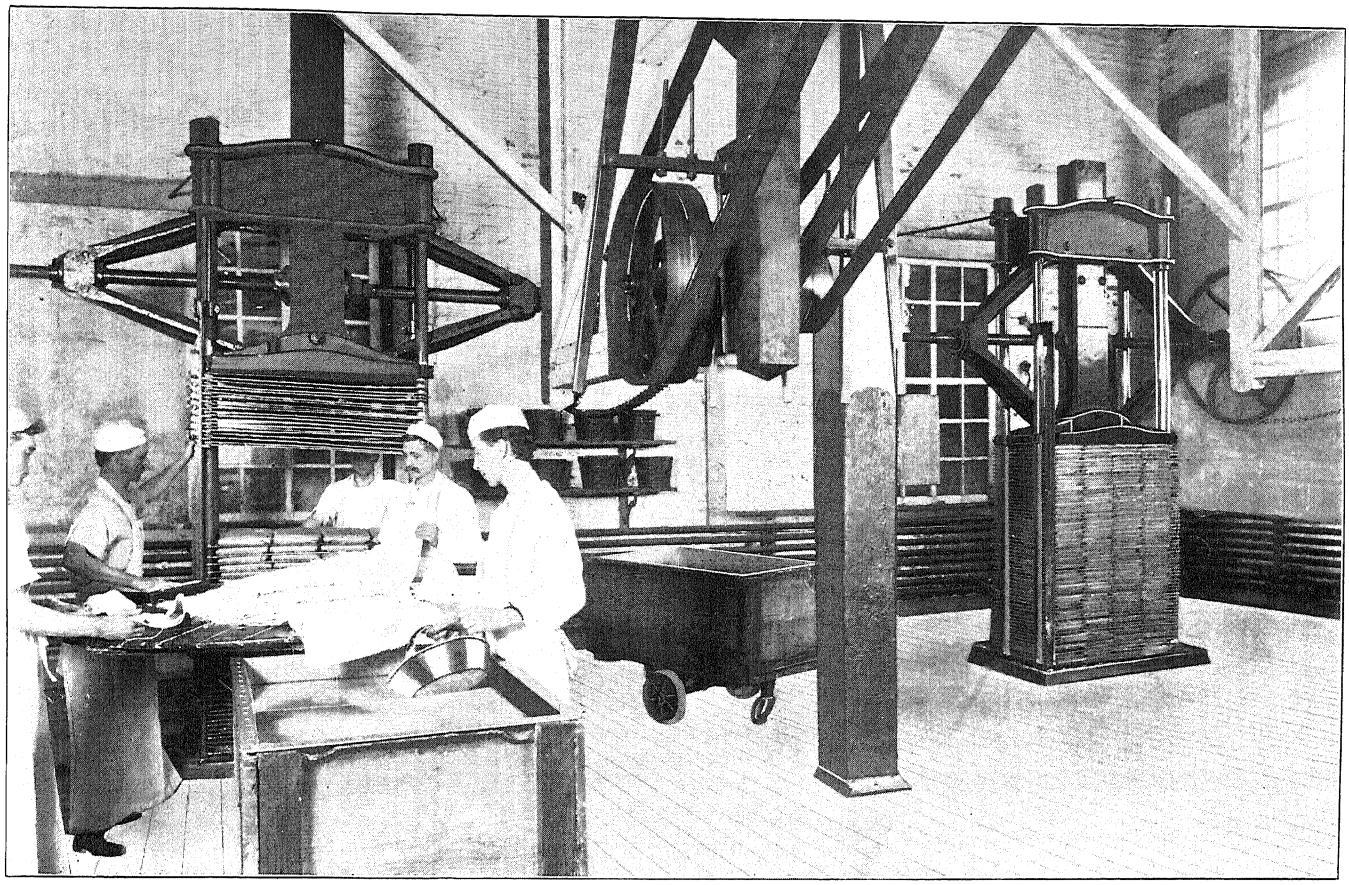


FIG. 1.—SEPARATING OLEO OIL FROM THE STEARIN OF THE FAT, BY PRESSURE.

FIG. 2.—CHURNING OLEOMARGARINE.

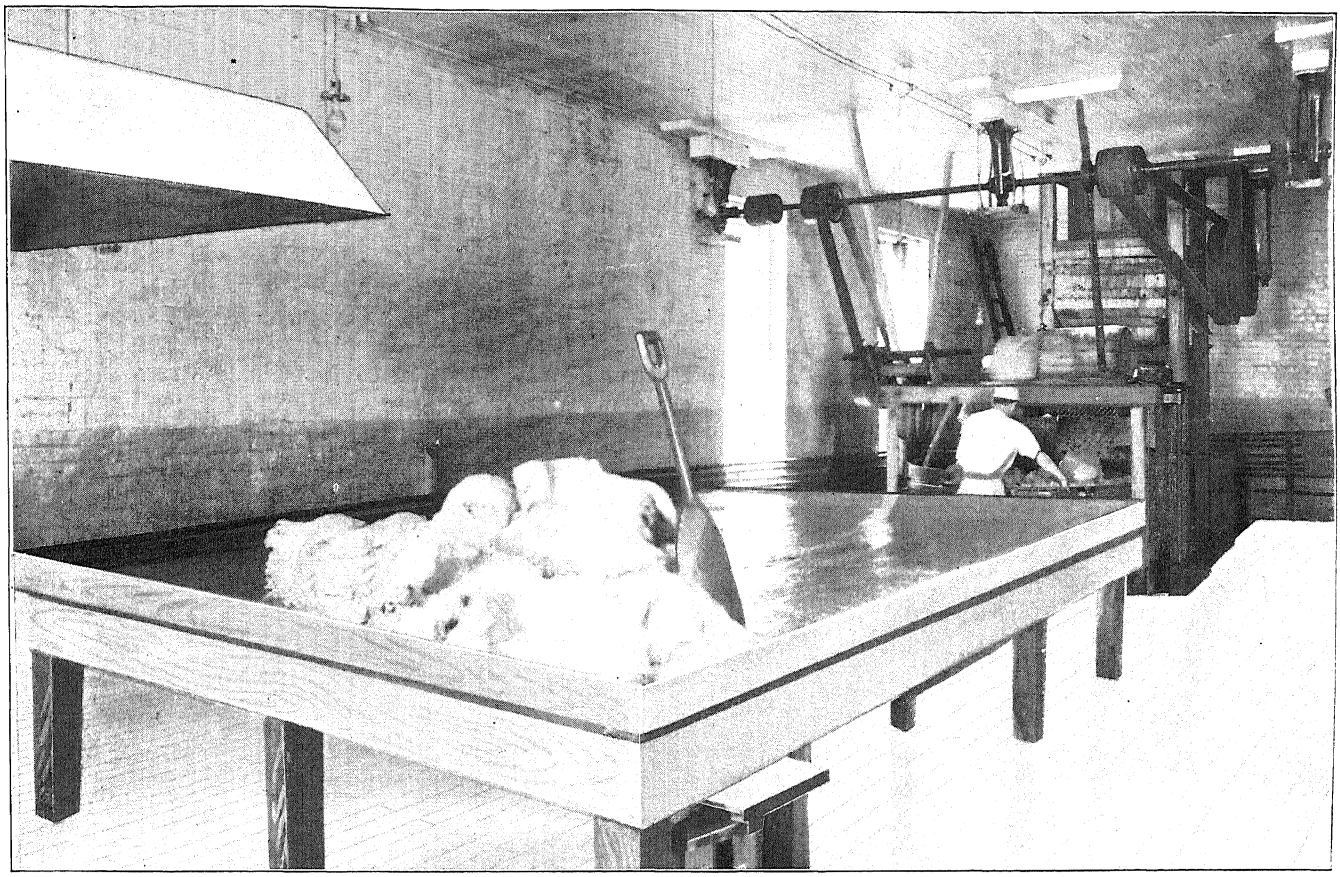


FIG. 3.—THE "WORKING" AND SALTING PROCESS AFTER CHURNING AND TEMPERING.

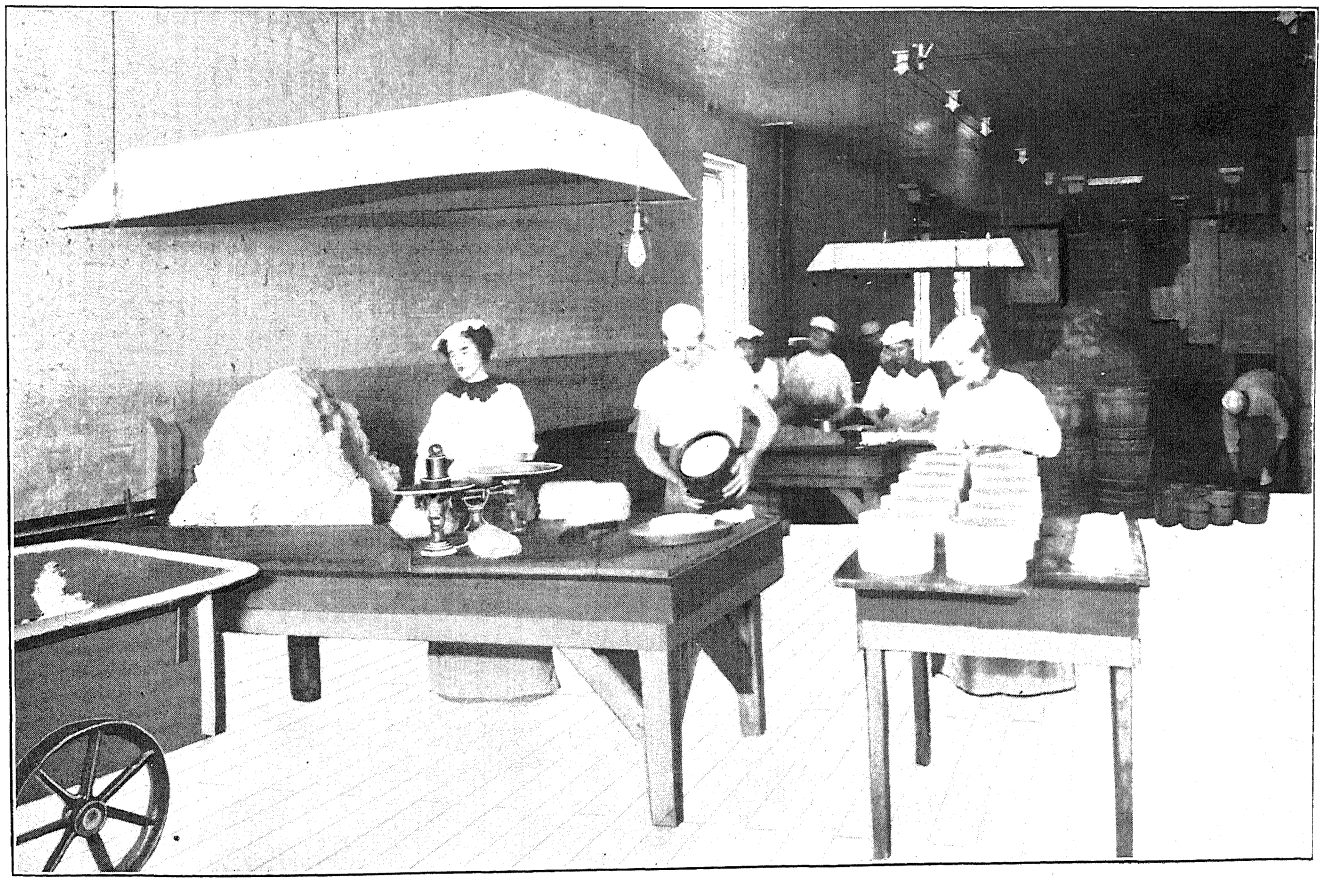


FIG. 4.—PACKING OLEOMARGARINE FOR MARKET.

The quantity of oleo oil obtained by the process described is, by weight, about 50 per cent of the fat treated. About 28 per cent is tallow and stearin and the remainder is lost in shrinkage. The quantity obtained from each beef is difficult of exact determination because it varies so greatly with the size and condition of the animal when slaughtered.

Compared with oleo oil, the manufacture of neutral lard is a simple process. Two grades are made—one from the leaf, the other from the back fat of the hog. Its manufacture is almost exclusively confined to large packing houses, but there are independent manufacturers of oleomargarine located near the packing centers who prefer to buy the fat as it is taken from the animal and work it into neutral by their own process. In the packing plants the leaf fat is taken from the animal immediately after killing, hung on mounted racks, and wheeled into refrigerators to remove as quickly as possible all animal heat. It is next chopped finely or reduced to pulp by machinery and melted in jacketed kettles exactly similar to those used for oleo oil. When the melting process is complete it is allowed to settle, the precipitation of the fiber being accelerated by the addition of salt, as in the case of oleo oil. After the settling process the clear oil is siphoned to a receiving tank, and what is not used in oleomargarine is tierced for shipment. A good quality of leaf fat will produce by careful handling about 90 per cent of its weight in neutral, and each animal will yield an average of eight or nine pounds. Comparatively little neutral is made from back fat. The amount used, however, depends much on the relative demand for neutral and ordinary lard products, as it is sometimes more advantageous to work fats into one form than another. The oil made from back fat retains more of the flavor peculiar to lard and, like the lower grades of oleo oil, is less free from stearin or other undesirable constituents. Some packing houses mix a small per cent of back fat with the "leaf" in making their highest grade of neutral, and oleomargarine manufacturers sometimes use both grades of the finished oil in combination. The difference in price between the two is usually slight, and neutral made exclusively from "leaf" is generally sought. Independent manufacturers of oleomargarine, who make their own neutral lard, give the fat a more extended treatment than that described as the process of the packers. In addition to the separation of the fiber by the process of settling, the clear oil is drawn into a large vat of salt water at a low temperature, where it is again chilled and hardened, and is allowed to remain for several hours. It is then placed on shelves to drain, and is again melted when ready for churning. This treatment carries the neutralizing process to a higher degree of perfection and improves the texture of the oil.

After a detailed description of the methods of manufacturing its principal ingredients, the manufacture of oleomargarine itself may be described briefly. In those independent plants where both oleo oil and neutral lard are purchased for use, melting tanks are provided for each, in which they are melted separately, after being taken from the tierces in which they are shipped. They are then piped or pumped to a mixing tank mounted on weighing scales, where the exact proportions demanded by the working formula are ascertained. If cottonseed oil is required by the formula, a separate tank for it is usually provided. If butter is to be used instead of milk or cream, a separate melting tank is also provided for that. After the oils are melted and weighed into the mixing tank together, the mixture is piped or pumped into the churn, where it receives the milk and coloring matter. The whole mass is then churned together, as previously described. In the packing houses liquid oleo oil and neutral lard are piped from the oil room direct to the weighing tank. After churning, the liquid oleomargarine is allowed to flow into a vat of ice water, which chills and hardens it before crystallization can take place. It is next shoveled into mounted cars and wheeled to the "tempering room," where it stands for several hours, until sufficiently softened for the machine butter workers. After the salt has been worked through it, it is put up in marketable form and stored in refrigerators to await shipment. Figure 2 represents an actual scene in a churning room of a large factory. At the left of the picture is seen a quantity of oleomargarine which has just been taken from the chilling vat after churning, and is ready for the "tempering room." At the right the contents of a churn are being drawn off into the chilling vat. The pipe descending from the ceiling brings a stream of ice water from a reservoir above into immediate contact with the stream of liquid oleomargarine for the purpose of chilling it as quickly as possible. Figure 3 represents the working and salting process, and figure 4 a scene in the preparation of the finished product for market.

While there is substantial uniformity in the process of manufacture, there is great diversity in the grades and combinations of material used and, consequently, in the character of the finished article. The cheapest grades of oleomargarine found on the market are made from the lowest grades of oleo oil and neutral lard, to which is added the limit of cottonseed oil, and the whole is churned with skimmed milk or buttermilk, salted with common salt, and colored with the cheaper grades of coloring matter. These low-grade oils may be manufactured from "scrap" fat and made firm by the addition of more stearin or other similar substances so that a greater proportion of cottonseed oil can be added to the combination. Sometimes glycerin is added to give the product a glossy appearance, and sugar or glucose to sweeten or give texture. The highest grades are made from pure oleo oil and neutral lard of best qual-

ity, churned with whole milk, cream, or creamery butter, salted with Ashland salt, and colored with annatto or other coloring matter. The number of grades manfactured varies from two to six, but all large factories receive orders for special lots to be made in a prescribed way. One factory visited by the writer made only two grades—the higher from high-class oils churned with whole milk, the other from low-grade oils churned with the same. In this case the quality of the oleo oil and neutral was the only basis of grading the finished product. In another factory the lowest grade manufactured was a combination of the best oleo oil and neutral churned with whole milk. Three higher or more expensive ones were made with the same oils, each depending for its rank on the amount of pure cream or creamery butter added in the churning process. A large proportion of the independent manufacturers are making a specialty of the higher grades, which include only the best oleo oil and neutral, the grade being determined from the quantity and character of the dairy product added.

Table 8 presents in detail the statistics for the industry, by states and territories, as collected by the Twelfth Census for the census year ending May 31, 1900.

TABLE 8.—OLEOMARGARINE MANUFACTURE, BY STATES AND TERRITORIES: 1900.

	United States.	Illinois.	Indiana.	Rhode Island.	All other states and territories.[1]
Number of establishments	24	7	3	3	11
Character of organization:					
Individual	4	1	.....	.....	3
Firm and limited partnership	3	1	.....	.....	2
Incorporated company	17	5	3	3	6
Capital:					
Total	$3,023,646	$1,131,835	$137,393	$702,299	$1,052,119
Land	$200,868	$40,674	$17,700	$31,494	$111,000
Buildings	$535,620	$165,686	$15,700	$100,000	$254,234
Machinery, tools, and implements	$482,477	$150,236	$24,500	$77,949	$229,792
Cash and sundries	$1,804,681	$775,239	$79,493	$492,856	$457,093
Proprietors and firm members	10	3	.....	.....	7
Salaried officials, clerks, etc.:					
Total number	394	120	27	25	222
Total salaries	$412,012	$110,784	$27,790	$31,626	$241,812
Officers of corporations—					
Number	8	6	.....	2	.....
Salaries	$13,100	$11,100	.....	$2,000	.....
General superintendents, managers, clerks, etc.—					
Total number	386	114	27	23	222
Total salaries	$398,912	$99,684	$27,790	$29,626	$241,812
Men—					
Number	348	90	24	19	215
Salaries	$373,698	$82,238	$25,790	$27,506	$238,164
Women—					
Number	38	24	3	4	7
Salaries	$25,214	$17,446	$2,000	$2,120	$3,648
Wage-earners, including pieceworkers and total wages:					
Greatest number employed at any one time during the year	1,331	662	91	147	431
Least number employed at any one time during the year	865	408	48	103	306
Average number	1,084	528	70	127	359
Wages	$534,444	$273,084	$38,968	$52,796	$169,596
Men, 16 years and over—					
Average number	1,007	491	62	111	343
Wages	$511,238	$261,655	$36,378	$47,856	$165,349
Women, 16 years and over—					
Average number	65	35	8	16	6
Wages	$21,009	$11,129	$2,590	$4,940	$2,350
Children, under 16 years—					
Average number	12	2	.....	.....	10
Wages	$2,197	$300	.....	.....	$1,897
Average number of wage-earners, including pieceworkers, employed during each month:					
Men, 16 years and over—					
January	1,138	582	64	113	379
February	1,136	583	63	116	374
March	1,143	579	66	115	383
April	1,035	493	63	113	366
May	925	442	58	108	317
June	818	372	51	101	294
July	816	364	59	99	294
August	854	378	58	100	318
September	914	423	56	111	324
October	1,060	523	66	115	356
November	1,110	573	65	118	354
December	1,135	575	73	120	367
Women, 16 years and over—					
January	77	44	8	17	8
February	77	44	7	18	8
March	77	41	9	18	9
April	66	37	5	18	6
May	62	34	7	16	5
June	49	25	7	13	4
July	41	18	5	13	5
August	53	25	8	14	6
September	60	34	8	16	2
October	69	33	11	18	7
November	72	39	9	18	6
December	77	41	10	19	7
Children, under 16 years—					
January	16	3	.....	.....	13
February	16	3	.....	.....	13
March	15	2	.....	.....	13
April	13	2	.....	.....	11

[1] Includes establishments distributed as follows: District of Columbia, 2; Kansas, 2; Kentucky, 1; Missouri, 1; New Jersey, 1; Ohio, 2; Pennsylvania, 1; Texas, 1.

TABLE 8.—OLEOMARGARINE MANUFACTURE, BY STATES AND TERRITORIES: 1900—Continued.

	United States.	Illinois.	Indiana.	Rhode Island.	All other states and territories.[1]
Average number of wage-earners, including pieceworkers, employed during each month—Con.					
Children under 16 years—Continued.					
May	12	2	.....	.....	10
June	8	2	.....	.....	6
July	8	2	.....	.....	6
August	8	2	.....	.....	6
September	9	3	.....	.....	6
October	7	.....	.....	.....	7
November	16	3	.....	.....	13
December	16	3	.....	.....	13
Miscellaneous expenses:					
Total	$2,489,784	$1,386,148	$228,726	$121,912	$752,998
Rent of works	$16,800	$11,280	$750	$1,000	$3,770
Taxes, not including internal revenue	$11,314	$4,447	$2,640	$1,460	$2,767
Rent of offices, insurance, interest, and all sundry expenses not hitherto included	$2,461,670	$1,370,421	$225,336	$119,452	$746,461
Materials used:					
Total cost	$7,689,501	$3,353,904	$702,749	$912,912	$2,669,936
Milk and cream—					
Pounds	23,684,395	10,023,531	3,081,093	1,653,743	8,926,028
Cost	$579,068	$255,968	$40,275	$35,898	$246,927
Oleo oil—					
Pounds	33,724,621	15,582,919	2,916,120	4,230,000	10,995,582
Cost	$2,744,235	$1,192,239	$229,511	$386,728	$935,757
Neutral lard—					
Pounds	37,651,741	17,561,013	3,494,856	3,335,100	13,260,772
Cost	$2,976,870	$1,348,416	$280,656	$292,636	$1,055,162
Cottonseed oil—					
Pounds	11,818,921	4,585,760	1,921,656	1,456,300	3,855,205
Cost	$567,790	$222,002	$89,93	$72,455	$183,399
Butter—					
Pounds	396,956	168,552	9,864	29,165	189,375
Cost	$61,176	$31,770	$2,466	$4,958	$21,982
Salt—					
Pounds	6,962,233	3,697,680	969,766	402,600	1,892,187
Cost	$58,887	$30,531	$8,541	$2,013	$17,802
Color—					
Pounds	204,418	93,931	24,038	12,003	74,446
Cost	$32,078	$12,162	$4,363	$2,441	$13,112
Sugar—					
Pounds	137,842	804	.....	80,800	56,238
Cost	$7,084	$44	.....	$4,040	$3,000
Glucose—					
Pounds	32,965	.....	32,965	.....	.....
Cost	$494	.....	$494	.....	.....
Stearin and oleo stock—					
Pounds	134,541	28,824	.....	26,190	79,527
Cost	$4,320	$1,890	.....	$1,833	$597
Fuel	$45,611	$21,776	$3,500	$6,302	$14,033
Rent of power and heat	$4,244	$3,027	$1,100	.....	$117
Mill supplies	$5,745	$1,979	$100	$1,860	$1,806
All other materials	$501,107	$232,100	$41,809	$92,113	$135,085
Freight	$50,792	.....	.....	$9,635	$41,157
Products:					
Total value	$12,499,812	$5,852,413	$1,107,284	$1,345,133	$4,194,982
Oleomargarine—					
Pounds	104,633,214	45,574,073	10,596,071	10,433,996	38,029,074
Value	$12,286,357	$5,769,678	$1,107,284	$1,220,623	$4,188,772
Value of all other products, including by-products	$213,455	$82,735	.....	$124,510	$6,210
Comparison of products:					
Number of establishments reporting for both years	10	3	1	3	3
Value for census year	$8,545,780	$4,903,128	$709,014	$1,345,133	$1,588,505
Value for preceding business year	$6,196,185	$3,120,564	$625,000	$1,256,043	$1,194,578
Power:					
Number of establishments reporting	21	6	2	3	10
Total horsepower	1,356	764	35	133	424
Owned—					
Engines—					
Steam—					
Number	22	8	1	3	10
Horsepower	1,281	710	20	133	418
Rented horsepower	75	54	15	.....	6
Establishments classified by number of persons employed, not including proprietors and firm members.					
Total number of establishments	24	7	3	3	11
Under 5	2	.....	.....	.....	2
5 to 20	6	3	.....	1	2
21 to 50	8	.....	3	1	4
51 to 100	3	2	.....	.....	1
101 to 250	2	.....	.....	1	1
251 to 500	3	2	.....	.....	1

[1] Includes establishments distributed as follows: District of Columbia, 2; Kansas, 2; Kentucky, 1; Missouri, 1; New Jersey, 1; Ohio, 2; Pennsylvania, 1; Texas, 1.

SALT.

SALT.

By Edward W. Parker, *Expert Special Agent.*

It has been the custom in United States census inquiry to include salt production among manufacturing industries. Salt itself is a mineral, but it is not clear whether the process by which it is obtained should be regarded as manufacturing or as a method of mining. Rock salt is undoubtedly a mining product, but as it is considered in connection with salt manufacture by artificial heat or by solar evaporation, it is included in the present report. Salt is the only mineral product which enters directly into consumption as food, and while a considerable quantity is used for other purposes, by far the larger portion is consumed as food either directly or indirectly.

The history of the manufacture in this country covers the entire period subsequent to the early settlement by the English. The first salt was produced in Virginia prior to 1620, and in the various reports of the Federal Census mention is made of not less than 32 states in which salt has at some period been produced in considerable quantities. The early process consisted in the production from sea water, either by exposure to evaporation under the sun's rays, or sometimes by boiling in pans or kettles until the dissolved salt was deposited. About the close of the Eighteenth century the manufacture was begun from brine obtained from natural salt springs, following the same crude processes used in the manufacture of salt from sea water.

At the present time, however, comparatively little salt is made from sea water, or brine from natural springs, and some of that so obtained is evaporated by artificial heat. Nearly all the evaporated salt is now obtained by sinking wells to the salt body, pumping fresh water into the wells, and withdrawing the brine after it has become well saturated. Practically all the product from natural salt water, by solar evaporation, is made along the shores of San Francisco Bay in California, and Great Salt Lake, Utah. With these two exceptions the evaporated product is almost entirely obtained from deep wells.

Salt manufactured by artificial heat is made in kettles, open pans, vacuum pans, and grainers, the heat being applied either directly or by steam. In blocks where kettles or open pans are used, the heat is usually applied directly and the brine is boiled. In grainers and vacuum pans steam heat is used. The grainer process is essentially American; the brine in this process is evaporated from rectangular vats about 12 inches deep, in which are suspended coils of pipe carrying either live or exhaust steam, according to local conditions. The brine is usually kept agitated mechanically, so that the salt which is formed on top will be broken up and precipitated. In some instances the salt is removed from the bottom of the pan by mechanical scrapers; in others, hand labor is employed. The grainer process seems to be the most popular method in the United States, and most of the finer grades of table and dairy salts are produced either by this or by the vacuum-pan process.

Solar salt is made in vats or ponds, covered and uncovered. At Syracuse, N. Y., the ponds are supplied with movable covers. No covers are used in Utah or California, as the operations in those states continue only during the dry season.

Rock salt is mined and prepared for use in the states of New York, Kansas, Louisiana, and California. It is now produced in greater quantities than solar salt. A more extended presentation of the method of mining rock salt follows in the description of salt manufacture in Kansas.

Four different units of measure are employed in the industry. At the solar salt works, Syracuse, N. Y., and at some of the salt blocks along the Ohio River in Ohio and West Virginia, the bushel of 56 pounds is used as the unit. At the rock salt mines in New York state, and at Avery Island rock salt mines in Louisiana, the long ton of 2,240 pounds is used as the unit, while the short ton of 2,000 pounds is the usual unit at the rock salt mines in Kansas and at the solar works along the shores of San Francisco Bay and Great Salt Lake. In nearly every other instance the barrel of 280 pounds is adopted. In the compilation of this report the barrel of 280 pounds net is used as the unit, and when the quantities have been reported in other units of measurement they have been reduced accordingly.

Table 1 shows the totals for the industry as returned at the censuses of 1850 to 1900, inclusive, with the percentages of increase for each decade.

TABLE 1.—COMPARATIVE SUMMARY, 1850 TO 1900, WITH PER CENT OF INCREASE FOR EACH DECADE.

	DATE OF CENSUS.						PER CENT OF INCREASE.				
	[1] 1900	1890	1880	1870	1860	1850	1890 to 1900	1880 to 1890	1870 to 1880	1860 to 1870	1850 to 1860
Number of establishments	159	200	268	282	399	340	[2] 20.5	[2] 25.4	[2] 5.0	[2] 29.3	17.4
Capital	$27,123,364	$13,437,749	$8,225,740	$6,561,615	$3,692,215	$2,640,860	101.8	63.4	25.4	77.7	39.8
Land	$3,494,587	$4,287,784	(3)	(3)	(3)	(3)	98.1	.....	.....	.....	.....
Buildings	$8,358,018	$4,255,896	(3)	(3)	(3)	(3)	96.4	.....	.....	.....	.....
Machinery, tools, and implements	$4,523,294	$2,703,868	(3)	(3)	(3)	(3)	67.3	.....	.....	.....	.....
Cash and sundries	$5,747,465	$2,190,201	(3)	(3)	(3)	(3)	162.4	.....	.....	.....	.....
Salaried officials, clerks, etc., number	406	[4] 200	(3)	(3)	(3)	(3)	103.0	.....	.....	.....	.....
Salaries	$499,748	[4] $189,049	(3)	(3)	(3)	(3)	164.3	.....	.....	.....	.....
Wage-earners, average number	4,774	4,255	4,289	2,953	2,213	2,786	12.2	[2] 0.8	45.2	33.4	[2] 20.6
Total wages	$1,911,140	$1,593,442	$1,260,023	$1,146,910	$371,954	$753,360	19.9	26.5	9.9	208.3	[2] 50.6
Miscellaneous expenses	$760,539	$674,183	(5)	(5)	(5)	(5)	12.8	.....	.....	.....	.....
Cost of materials used	$3,335,922	$1,826,770	$2,074,049	$1,760,670	$1,054,780	$1,051,419	82.6	[2] 11.9	17.8	66.9	0.3
Value of products	[6] $7,966,897	[7] $5,484,618	$4,829,566	$4,818,229	$2,289,504	$2,177,945	45.3	13.6	0.2	110.4	5.1

[1] The report for the Twelfth Census is for the calendar year 1899.
[2] Decrease.
[3] Not separately reported.
[4] Includes proprietors and firm members, with their salaries; number only reported in 1900, but not included in this table. (See Table 6.)
[5] Not reported.
[6] Exclusive of 4,520,796 barrels of salt valued at $1,171,948, an intermediate product in the manufacture of chemicals, and included in the report of that industry. Includes products other than salt to the value of $65,061.
[7] Includes products other than salt to the value of $43,315.

Table 1 shows that the production of salt in the United States has increased continuously since 1850. In the half century from 1850 to 1900 the capital increased from $2,640,860 to $27,123,364, while the value of products increased from $2,177,945 to $7,966,897. In contrast with the increase in capital and products, the number of establishments shows a marked decrease since 1860. At the census of 1860 there were 399 establishments, while only 159 are shown at the census of 1900, a decrease of 60.2 per cent. During the last twenty years the development of the industry has been most rapid, the capital having increased from $8,225,740 to $27,123,364, a gain of 229.7 per cent. The products in the same period increased from $4,829,566 to $7,966,897, or 65 per cent, while the number of establishments decreased from 268 to 159, a loss of 40.7 per cent. The decrease in the number of establishments is due to the abandonment of many small plants along the Atlantic coast and in some of the interior districts where salt was manufactured from brine springs; also to the consolidation of a number of large establishments, particularly in New York, Ohio, Michigan, Kansas, Utah, and California.

From 1890 to 1899 the number of establishments decreased from 200 to 159, or 20.5 per cent. The capital increased from $13,437,749 to $27,123,364, or 101.8 per cent, and of this increase the greatest gain was shown in the item of live capital, which increased from $2,190,201 to $5,747,465, or 162.4 per cent.

The cost of materials increased from $1,826,770 in 1890 to $3,335,922 in 1899, or 82.6 per cent. The cost of the barrels, boxes, cartons, bags, cooperage stock, and cloth for sacks purchased, amounting in 1899 to $1,837,122, formed the most important factor in the cost of materials.

The next most important item of expense was that for fuel, which, in 1899, amounted to $991,248. The expense for fuel in 1890 was $745,917. No separation was made of any of the other items included in the cost of materials in 1890. For 1899, besides the cost of packages and fuel, the following items were separately reported: mill supplies, $192,777; rent of power and heat, $2,111; all other materials, $189,747; and freight, $122,917; a total of $507,552. While the cost of fuel, $991,248, represents the amount actually reported for this item of expense in 1899, there are also large quantities of fuel consumed, particularly in Michigan, where salt blocks are operated in connection with the manufacture of lumber, the salt operations being carried on largely to utilize sawdust and other waste. In such cases nothing is reported for the cost of fuel. The detailed statistics as to materials used and miscellaneous expenses are presented in Table 6.

In 1890 the value of products was $5,484,618, and in 1899, $7,966,897, an increase of 45.3 per cent. In general, however, owing to a decline in the price of salt, the increase in the value of the product does not adequately represent the growth of the industry. A better index of growth is afforded by the quantity produced, which, as presented in Table 2, shows an increase of 30.2 per cent from 1850 to 1860, 38.4 per cent from 1860 to 1870, 69.3 per cent from 1870 to 1880, 74.6 per cent from 1880 to 1890, and 45.9 per cent from 1890 to 1899. Comparison with the corresponding figures for the value of salt (see Table 1) shows that the price declined continuously until 1890, except during the decade from 1860 to 1870, when the quantity increased 38.4 per cent, while the value rose 110.4 per cent. It should be remembered, however, that values in 1870 were expressed in a currency which was at a discount in gold, and should, therefore, be reduced about one-fifth for purposes of comparison with other census years.

In 1899, in addition to the 159 active establishments, 10 idle establishments were reported, with a capital of $1,737,150.

Table 2 presents a comparative statement of the quantity of salt manufactured by the various processes, as reported at the censuses of 1880, 1890, and 1900, with the percentage that each constitutes of the total; and also a statement of the total quantity reported at each census from 1850 to 1900, inclusive.

TABLE 2.—QUANTITY OF EACH KIND OF SALT MANUFACTURED, AND PER CENT OF TOTAL.

KINDS OF SALT.	1900[1]		1890		1880		1870		1860		1850	
	Quantity, barrels.	Per cent of total.	Quantity, barrels.	Per cent of total.	Quantity, barrels.	Per cent of total.	Quantity, barrels.	Per cent of total.	Quantity, barrels.	Per cent of total.	Quantity, barrels.	Per cent of total.
Total	15,187,819	100.0	10,406,860	100.0	5,961,060	100.0	3,521,221	100.0	2,543,440	100.0	1,952,768	100.0
Rock salt	2,543,679	16.7	1,413,281	13.6	62,400	1.0	(2)	.....	(2)	.....	(2)	.....
Solar salt	910,974	6.0	1,443,262	13.9	903,555	15.2	(2)	.....	(2)	.....	(2)	.....
Salt made by the boiling process	[3] 11,733,166	77.3	7,550,317	72.5	4,995,105	83.8	(2)	.....	(2)	.....	(2)	.....

[1] The report of the Twelfth Census is for the calendar year 1899.
[2] Not separately reported.
[3] Includes table salt, 1,866,058 barrels; common fine, 6,866,126 barrels; common coarse, 2,635,282 barrels; packers', 182,930 barrels; milling, 96,178 barrels; other grades, 86,592 barrels.

The varieties of salt were not reported until 1880. In that year the product of the United States amounted to 29,805,298 bushels of 56 pounds, or 5,961,060 barrels of 280 pounds net. At the census of 1890 it was 52,034,360 bushels, or 10,406,860 barrels, an increase of 74.6 per cent. At the Twelfth Census, which covered the calendar year 1899, it reached 75,939,095 bushels, or 15,187,819 barrels, an increase over 1890 of 45.9 per cent, and over 1880 of 154.8 per cent. The production in 1899 does not include 4,520,796 barrels of salt valued at $1,171,948, which formed an intermediate product in the manufacture of chemicals in Michigan, New York, and Pennsylvania, and were included in the report for the chemical industry. Including this intermediate product the total output in 1899 amounted to 19,708,615 barrels, valued at $9,073,784. In addition to the salt product there were obtained, as by-products, 279,437 pounds of bromine, valued at $64,921, and other products not classified, to the value of $140.

This table emphasizes the decrease in the manufacture of solar salt as compared with the growth of the salt industry. In 1880 the output was 903,555 barrels, forming 15.2 per cent of all salt produced; while in 1899 the product was 910,974 barrels, forming but 6 per cent of the total production. The production of rock salt, on the other hand, increased from 62,400 barrels in 1880, when it formed but 1 per cent of the total salt production, to 2,543,679 barrels in 1899, forming 16.7 per cent. More than 90 per cent of this rock salt is mined in New York and Kansas. (See Table 6.) Salt made by the boiling process shows a steady increase for each decade. The increase from 1880 to 1899 was 6,738,061 barrels, or 134.9 per cent.

Table 3 presents the statistics of the number of establishments in each state in which salt was made in 1899, together with a statement as to the number and square feet of the covers or ponds in use, and the number of grainers, kettles, open pans, or vacuum pans used in the manufacture by evaporation.

TABLE 3.—COVERS OR PONDS, AND EVAPORATING APPARATUS, BY STATES: 1900.

STATES AND TERRITORIES.	Number of establishments.	COVERS OR PONDS.		Grainers.	Open pans.	Kettles.	Vacuum pans.
		Number.	Square feet.				
United States	159	35,222	109,921,360	522	264	411	40
California	24	474	62,062,800	.....	2	.....	1
Kansas	8	30	144,656	13	36	.....	.....
Michigan	53	2,009	545,300	273	17	5	19
Nevada	3	2	30,000	.....	.....	.....	.....
New York	38	32,295	8,176,948	92	43	338	9
Ohio	10	4	12,320	83	38	31	5
Oklahoma	4	13	92,120	2	21	.....	.....
Texas	3	14	135,680	24	2	.....	.....
Utah	5	39	38,610,728	.....	.....	1	.....
West Virginia	4	.....	.....	23	.....	36	.....
All other states[1]	7	342	110,808	12	105	.....	6

[1] Includes establishments distributed as follows: Illinois, 1; Louisiana, 2; Massachusetts, 2; Pennsylvania, 1; and Virginia, 1.

It appears from Table 3 that the 24 establishments in California used the solar process almost entirely, there being but 2 open pans and 1 vacuum pan in the state, while there were 474 covers or ponds, having an area of 62,062,800 square feet, or 56.5 per cent of the total area in the United States. Utah shows for the solar process 5 establishments, with an area of 38,610,728 square feet for 39 covers or ponds, and for the evaporating process but 1 kettle. The relation of climate to the manufacture of solar salt is clearly seen from the statistics of California and Utah. Because of the dryness of their climate, these states offer exceptional advantages for the development of the solar process, and of the 109,921,360 square feet of covers or ponds in the United States, these 2 states contain 100,673,528 square feet, or 91.6 per cent of the total. Nevada, with 3 establishments, uses the solar process entirely. In New York the ponds for evaporation by solar heat are provided with movable covers; by this means the rains are kept from the brine and the process is considerably accelerated. This state had 38 establishments, and while the solar process still showed an area of 8,176,948 square feet for the 32,295 covers or ponds, the evaporating

apparatus consisted of 92 grainers, 43 open pans, 338 kettles, and 9 vacuum pans. The remaining states represent less than 1 per cent of the square feet area in covers or ponds, and practically use the boiling process entirely.

In the last decade manufacturers have made great progress in the production of the finer grades of salt, particularly those for table and dairy use, and for the preservation of fish and meats. Much of the increase shown in production was due to the development of the large meat-packing establishments and, in a lesser degree, to the development of the dairy industry. The extensive use of the chlorination process of extracting gold and silver from ores has required large amounts of the lower grades of salt.

It is interesting to note the extent to which salt of domestic production has supplanted that of foreign manufacture, as seen by the following statement:

	1880	1890	[1] 1899
	Barrels.	*Barrels.*	*Barrels.*
In warehouses at the beginning of the year	204,814	196,854	34,940
Domestic production	5,961,060	10,406,860	15,187,819
Imports	3,442,753	1,807,285	1,379,925
Quantity available	9,608,627	12,410,999	16,602,684
Exports (domestic)	4,436	15,292	90,001
Exports (foreign)	23,680	12,588	18,629
In warehouses at the end of year	197,359	209,673	62,689
Net consumption	9,383,152	12,173,446	16,431,365
Net imports	3,419,073	1,794,697	1,361,296
Per cent of net imports to consumption	36.4	14.7	8.3

[1] Calendar year ending December 31.

This statement shows that in 1880 imported salt formed 36.4 per cent of the domestic consumption; in 1890 it had fallen to 14.7 per cent; while in 1899 it was only 8.3 per cent. Reducing to pounds the figures presented above, it is found that the total domestic consumption in 1880 was 2,627,282,560 pounds; in 1890 it was 3,408,564,880 pounds; and 4,600,782,200 pounds in 1899. The population of the United States was [1] 50,189,209 in 1880; [2] 62,979,766 in 1890, and [2] 76,149,386 in 1900. From these figures it is seen that the per capita consumption in these three years was, respectively, 52.3, 54.1, and 60.4 pounds.[3]

Table 4 shows the total quantity of salt produced in each state during the census years of 1890 and 1900, the rank of each state according to the quantity of product, and the percentage that the product of each state is of the total for the United States.

[1] Includes population of Alaska, but exclusive of population of Indian Territory (Oklahoma and Indian Territory in 1890 and 1900) for which there are no figures for 1880.

[2] Exclusive of population of Hawaii.

[3] The figures for the production of salt are for the calendar year 1899, while those for the population are for 1900—no others being available.

TABLE 4.—QUANTITY OF SALT MANUFACTURED IN EACH STATE, AND PER CENT OF TOTAL, 1890 AND 1900.

STATES AND TERRITORIES.	RANK.		[1] 1900		1890	
	[1] 1900	1890	Number of barrels of salt manufactured.	Per cent of total output.	Number of barrels of salt manufactured.	Per cent of total output.
United States	.....	.....	15,187,819	100.0	10,406,860	100.0
Michigan	1	1	5,206,510	34.3	3,729,110	35.8
New York	2	2	4,894,852	32.2	3,226,250	31.0
Kansas	3	3	1,645,350	10.8	1,140,799	11.0
Ohio	4	5	1,460,516	9.6	409,514	3.9
California	5	7	640,420	4.2	255,828	2.5
Texas	6	.....	312,436	2.1	(2)	.....
Utah	7	4	235,671	1.5	626,429	6.0
West Virginia	8	6	221,534	1.5	285,461	2.7
Louisiana	9	.....	208,850	1.4	(2)	.....
Virginia	10	.....	151,391	1.0	(2)	.....
Pennsylvania	11	8	140,000	0.9	172,400	1.7
Illinois	12	.....	56,782	0.4	(2)	.....
Nevada	13	9	7,671	0.1	26,250	0.2
Oklahoma	14	.....	4,856	(3)	.....	.....
Massachusetts	15	.....	980	(3)	(2)	.....
All other states [4]	.....	.....	.....	.....	536,819	5.2

[1] The report of the Twelfth Census is for the calendar year 1899.

[2] Included with all other states in 1890.

[3] Less than one-tenth of 1 per cent.

[4] Includes Illinois, Kentucky, Louisiana, Massachusetts, Texas, and Virginia, not separately shown in 1890.

SALT PRODUCTION BY STATES.

The first attempt at salt making is recorded in Beverly's History of Virginia, in which it is stated that as early as 1620, "a salt work was set up at Cape Charles on the Eastern Shore." What success attended this effort is not stated.[4]

Prince's Chronological History of New England states that an attempt to manufacture salt was made at Plymouth, Mass., in 1624, but was not successful. Prior to the Revolutionary War, salt was not manufactured in the colonies in large quantities, and it is probable that the supply was procured from England or from other foreign sources. The commencement of hostilities cut off importations, and a system (extensive for that period) of making salt by boiling sea water was developed around New Bedford and on Cape Cod. This industry continued until after the War of 1812, when importation was resumed and the works were allowed to fall into decay. Foreign salt was sold in the American markets at that time for 50 cents per bushel, which was considered a very low figure. It is now sold for from 25 to 30 cents a barrel of 5 bushels, or about one-tenth of the early price.

Salt making from brine other than sea water began in the later years of the Eighteenth century. In the report on manufactures for the Eighth Census, it is stated that salt works were said to have been erected on Big Beaver Creek, in western Pennsylvania, in 1784, but no reference was made to the success of the enterprise. In New York the first salt made by white men

[4] United States Agricultural Report, 1858. Historical sketch of salt manufacture, by Wm. C. Dennis.

was produced in 1788. At Avery Island, La., in 1791, an unsuccessful attempt was made to make salt from brine. The first salt furnace in what is now West Virginia was built in 1797 on the Kanawha River near the present city of Charleston, and in the following year the first salt was produced in Ohio at what is now known as the Old Scioto Works.

CALIFORNIA.—The first salt made or "harvested" in California appears to have been a purely natural product. Along the shores of Alameda Bay are what were formerly known as "tide lands," covered by the high tides of June and July. Here were a number of natural sinks or ponds where the water was retained and, not being reached by the tides of the late season, was evaporated by solar heat, leaving small quantities of salt. The Spaniards, Mexicans, and Indians gathered this salt annually until about 1852, although the harvest amounted to only a few bushels. In that year the discovery was made that the land was public domain (school lands), and it was purchased from the state at a price said to have been $1.25 per acre. During the following year levees were built for the more complete retention of the salt water. The harvest for that year, it is said, amounted to 40 or 45 tons, and was sold for $50 per ton. In the following year other levees were built, and the harvest amounted to about 150 tons, which sold for about $40 per ton. From this time the number of people engaged in the industry increased, but no attempts were made for a number of years to improve the quality of the product, and as the supply increased the prices fell until they reached as low a figure as $2 per ton.

The first attempt to improve the quality appears to have been made in 1864, when the Crystal Salt Works were built. These works consisted of ponds for receiving and settling the sea water so as to precipitate the gypsum and other impurities which were less soluble than the salt. The mother liquor, or bittern, which remained in the brine after the salt itself was precipitated, was drained off, and a salt of high quality obtained.

The manner of making the settling and evaporating ponds and of preparation for market is thus described by Mr. A. A. Oliver, of Mount Eden, Cal.:[1] "The land having been cleared of grass and weeds is first diked with a good levee 3 or 4 feet high. It is then partitioned off into reservoirs of different sizes for receiving and evaporating the water. Crystallizing ponds are excavated and platforms for stacking the salt are built. The ground is principally peat, overlaying blue clay; the crystallizing ponds are dug in the peat, of which enough is left to form a bottom or carpet in the pond, the salt crystals being readily removed from the peat floor. There are usually 7 evaporating reservoirs to a plant, the brine being drawn from one to another as it strengthens and decreases in volume by evaporation. The last 3 are called lime ponds, because large quantities of gypsum and other matter, precipitated before the salt, settles in them. The brine is retained in the seventh reservoir until it reaches a density of 25° Baumé. When this strength of brine is attained, the crystallizing ponds are filled to a depth of 10 or 12 inches and the brine evaporated until 29° by the hydrometer is reached. The mother liquor is then drawn off and the salt gathered up and conveyed into warehouses to drain. This completes the solar process.

"Much of the salt is sold after drying in the warehouses, but many thousands of tons are taken to refining works in San Francisco, where it is more thoroughly dried by artificial heat and ground into various grades for chlorination works, packing houses, and silver mills, and for dairy and table uses. The regular trade winds which blow in the summer months are quite strong in this locality, and greatly aid evaporation."

Owing to overproduction, the industry for a number of years has not been in a prosperous condition. During 1899 the management of all the large works along San Francisco Bay passed into the hands of the Federal Salt Company, and it is believed that with a restricted production and conservative management, the industry may be made a profitable one.

While the principal salt works in California are located on San Francisco Bay, small quantities of salt are produced in other places in the state. There are salt works at Salton, in Riverside county. In a portion of the Colorado Desert which is below the level of the sea, salt water is pumped from wells and evaporated. At National City, in San Diego county, salt is made by the evaporation of water from San Diego Bay. A small amount of rock salt, which is said to be very pure and transparent, has been mined in San Bernardino county 30 miles south of Danby; as many as 5,000 tons have been mined there during one year, but only 250 tons were mined in 1899. The distance from railroads prevents a larger production. A small amount is made from saline springs near Sites, in Colusa county, and at Black Lake, in San Luis Obispo county.

The report on manufactures for the Eighth Census contains the first official record of the salt production of California, which was then reported as 44,000 bushels, or 8,800 barrels. The production reported at each subsequent census has been: In 1870, 34,971 barrels; in 1880, 176,949 barrels; in 1890, 255,328 barrels; and in 1899, 640,420 barrels.

ILLINOIS.—There was 1 establishment producing salt in Illinois in 1899, as in 1890. The works are located at St. John, Perry county, and as this establishment is the only one in the state, the statistics are combined with those for other states having less than 3 establishments.

KANSAS.—The first salt made in Kansas was obtained from marshes which are scattered over the central part of the state. The pioneer travelers, hunters, and trad-

[1] Eighteenth Annual Report of the United States Geological Survey, 1896-97, Part 5, page 1310.

ers were led by buffalo paths to these marshes, which are the salty remains of decomposed saline strata; they are large, shallow lakes, which dry up almost entirely in the summer, leaving a thin white scale of salt deposited over a large area of grassless territory. Along the banks of these marshes salt works were constructed, similar to those described as used by the ancients. Stone arches were erected about the kettles in which the brine was evaporated, and chimneys were built in order to economize fuel and heat as much as possible. Until 1868, these crude factories were the only ones in Kansas. As late as 1870, salt obtained in this way was worth as much as 10 cents a pound,[1] equivalent to $28 per barrel.

In 1867 a company erected a plant and began drying brine at Solomon City, where wells were sunk and good brine struck at about 75 feet. A second solar plant was erected by William Dewar at Solomon City in 1874. No record of any salt manufactured in Kansas was obtained until the Tenth Census, in 1880, in which year a total production of 2,000 barrels was reported. The development of the industry between 1880 and 1890 was marked by one of the most remarkable changes which took place in that region during the decade. The product of Kansas in 1890, as reported by the Eleventh Census, was 1,140,799 barrels, while in 1899 it reached a total of 1,645,350 barrels. It was not until the latter part of the decade from 1880 to 1890, however, that salt manufacture in Kansas assumed importance as an industry. In 1887 the state experienced a period of great activity in the development of coal mining and other industries. In the search for petroleum or gas a large body of rock salt was struck near Hutchinson. The people who owned the wells in which the salt was found were much disappointed at finding neither coal oil nor gas in large quantities, and did not at once appreciate the real value of the discovery, but an important industry was soon built up, as is shown by the statistics above presented, and some of this salt, particularly the dairy and table brands, now finds its way into the markets of the Eastern states.

A small amount of salt was made by solar evaporation in Kansas in 1899, but the greater portion of the product was evaporated in the 13 grainers and 36 open pans shown in Table 3. The use of kettles has been abandoned, and no vacuum pans have been introduced into the state. The amount of rock salt produced in Kansas was not reported separately at the Eleventh Census. The quantity produced in 1899 amounted to 468,029 barrels.

A body of rock salt was discovered at Lyons, in Rice county, in 1887, by prospectors in search of oil or natural gas.[2] The drill penetrated the body of salt at a depth of 800 feet, and passed through it only on reaching a depth of 1,100 feet. In 1890 a company was organized by business men at Lyons, Kans., and St. Louis, Mo., and a shaft was sunk at a point about three-fourths of a mile from the city of Lyons. The shaft penetrated the bed of salt to a depth of 265 feet, making the total depth of the shaft from the surface 1,065 feet, there being some 30 or 40 feet of salt below the bottom of the shaft.

On sinking the shaft through this 265 feet of salt strata, 15 workable veins of rock salt, ranging from 4 to 18 feet in thickness, and separated by veins or layers of shale, from one-fourth of an inch to 5 feet in thickness, were penetrated. A vein of salt 18 feet in thickness and of exceptional purity was selected for mining purposes, the lower 10 or 12 feet of this vein being mined. From the bottom of the shaft the mine is laid off somewhat similarly to the streets of a city, the main streets, 25 feet in width, running east and west, and the cross streets, of the same width, running north and south. From these cross streets rooms or chambers are driven, having a width of 50 feet, there being pillars 50 feet in thickness left standing between the chambers. It is in these chambers that the principal mining operations are carried on.

The rock salt is at first undercut with mining or channeling machines operated by compressed air; holes are made in the salt with air drills, and dynamite, exploded by electricity, brings the salt down to the floor of the mine. The loose salt is loaded on cars, each holding about 2 tons, conveyed to the shaft by underground railroads, and hoisted to the top of a five-story mill building directly over the mouth of the shaft. It is dumped automatically from the mine cars into crushers over dumps and passes by gravity down through different sized crushers to the screen room below, where, by screens of various sizes, it is separated into 9 different grades. Thence it is conveyed to large bins, from which it is loaded into railway cars.

LOUISIANA.—The southern coast of Louisiana is marked by a striking topographical and geographical feature, consisting of 5 islands or mounds which rise from the otherwise marshy land. These islands range in height from a few feet to about 250 feet. They are arranged in a practically straight line running northwest and southeast. They are known as Jefferson or Orange Island, Weeks Island, Avery Island, Cote Blanche, and Belle Isle. All of these, except Cote Blanche, have been prospected for salt, which has been struck at a comparatively shallow depth in each case. No knowledge of the thichness of the beds, however, has yet been obtained. On Jefferson Island a drill penetrated to a depth of 2,100 feet without passing through the salt bed.

So far as known, the first attempt to manufacture salt in Louisiana was made in 1791,[3] on Avery Island, the discovery being made by a man named John Hays, who came across a brine spring while hunting. The

[1] Eleventh Annual Report of the Kansas Bureau of Labor, 1895, quoted in the Eighteenth Annual Report of the United States Geological Survey, 1896–97, Part 5, page 1306 et seq.

[2] Report of the Kansas Bureau of Labor, 1893.

[3] Eighteenth Annual Report of the United States Geological Survey, 1896–97, Part 5, page 1296 et seq.

attempt to manufacture salt from this spring was, however, not a success, as the supply of brine was not sufficient to pay the expenses of operation. During the War of 1812 the price of salt was so advanced that operations were resumed, and continued there until 1815, when the work was stopped. It was not again resumed until 1861, when, on account of the blockade of the southern seaports, salt became expensive. As the supply of brine was not sufficient to meet the requirements, an attempt was made to deepen the wells, and in May, 1862, a body of rock salt was encountered at a depth of about 16 feet. The mining of rock salt in pits was then introduced, and about ten pits were dug, the salt being found at from 14 to 20 feet below the surface. No official record of the salt taken from these works was kept, although it is said that there were from 400 to 600 men employed, and that 22,000,000 pounds were mined during the 11 months they were in operation.

The Report of the American Bureau of Mines, published in 1867, stated that this method of pit mining would possibly endanger subsequent successful shaft mining. This prediction was borne out, as the shaft afterwards sunk to the salt body had to be abandoned because of surface waters penetrating to the works. The first shaft sunk on Avery Island was a small one, 8 by 8 feet and 83 feet deep. This shaft was leased afterwards to the American Salt Company, which continued it to a depth of 190 feet and extended galleries east and west to distances of 270 and 370 feet respectively, crosscuts being made from these galleries.

The problem of marketing the product of the mines proved to be so serious that the mining company cut a channel through two miles of marsh to deep water, and considerable trade was thus developed with Galveston, New Orleans, and Mobile. Transportation was further improved in 1886 by the construction of a branch railroad from New Iberia. The later owners of the mines experienced much difficulty in keeping back surface water from the mine works, and were finally compelled to abandon the shaft. In 1897 a shaft was sunk some distance from the old one, and the new works were equipped with all modern appliances. The new shaft was sunk 500 feet before any attempt at working the property was begun. It was evidently believed that by sinking the shaft to this distance all danger from surface waters would be obviated.

Until 1898 all the production of Louisiana had been from mines at Avery Island. In 1898 the Gulf Company of Morgan City sunk a shaft on Belle Isle, but, through a misapprehension as to the conditions, the galleries were driven out from the shaft at too shallow a depth, and the surface waters, percolating through the thin stratum of soil and the roof of salt, forced an abandonment of the work. A new shaft was then sunk at the distance of about a quarter of a mile from the first. An evaporating plant was erected beside the original works and a considerable quantity of brine salt was made there in 1899, the grainer process being used.

The entire production of Louisiana in 1899 was 208,850 barrels. In 1890 Louisiana was included with "all other states." In 1880 the production was reported as 62,400 barrels, and in 1870 as 25,600 barrels. No production was reported at the census of 1860.

Massachusetts.—Many years ago a considerable amount of salt was made in Massachusetts from sea water, but this industry has almost entirely disappeared. The total amount made in Massachusetts in 1899 was 980 barrels. There was only 1 establishment engaged in the manufacture at the Eleventh Census, and the state was not reported separately. In 1880 the production amounted to 1,915 barrels, not quite double the production in 1899. In 1870 it amounted to 4,569 barrels, and in 1860 to 6,305 barrels.

Michigan.—Michigan was for a number of years the leading state of the Union in the manufacture of salt. Its salt springs were used by the Indians, but salt manufacture is of comparatively recent date. On March 4, 1838, the governor of the state approved an act directing the state geologist to bore for salt at one or more of the salt springs. An appropriation of $3,000 was made for the purpose, and the state geologist was directed to report the result of his investigation to the next session of the legislature. The report was made January 1, 1839, and states: "The brine springs of our state, like those of Ohio, Pennsylvania, and Virginia [now West Virginia], emanate from a rock which lies deep, being covered with a mass of rock and earthy matter which it is necessary to penetrate. In this respect they differ most essentially from those of New York." Other work was done by the state in 1840, 1841, and 1842, but no satisfactory results were obtained.

It remained for private enterprise to establish the industry in the Saginaw Valley. The first well was bored in 1859, at what is now Saginaw.

The census report covering the fiscal year ending May 31, 1860, gives the production for the state as 472 barrels. This was the beginning of an important industry, but irregularities in manufacture soon developed the necessity of a state salt inspection, and a law was enacted in 1869 establishing the office of State Salt Inspector. By this time the industry had developed so that the production amounted to over 550,000 barrels.

The census report for 1870 shows that the production in Michigan amounted to 796,263 barrels; in 1880 it was 2,485,177 barrels; in 1890 it was 3,729,111 barrels; and in 1899 it was 5,206,510 barrels.

Nevada.—There were 3 establishments in the state of Nevada engaged in this industry in 1899. No production was reported for this state at any previous census. The salt is made from brine springs, a portion of it being used locally for domestic purposes, or for the reduction of silver in works using the chlorination

process. The entire production was obtained by solar evaporation.

NEW YORK.—Lemoyne, a French Jesuit explorer, in his journal, published in 1653, mentioned the salt springs of western New York, which were at that time well known to the Indians. In 1770[1] salt from the Onondaga region was in use among the Delaware Indians, and was sold by them in Albany and as far north as Quebec to the pioneer whites. The first salt made by white men in this district was in 1788.

New York was the first state to pass any law regulating the manufacture of salt. This was done as early as 1797, and for over one hundred years the state maintained control of the Onondaga salt reservation, furnishing the brine to those who paid for it. The state built and repaired the settling tanks from which the brine was delivered to the lessees. The law regulating the manufacture of brine on the Onondaga reservation was amended a number of times after enactment. At first, 4 cents per bushel was charged on all salt made, and each lessee was required to manufacture not less than 10 bushels a year and prohibited from charging more than 60 cents per bushel. In 1805 the rate was reduced to 3 cents per bushel; in 1812 it was advanced to 12½ cents, in order to raise revenue for the construction of the canals of the state. The duty was reduced to 6 cents in 1834 and to 1 cent in 1846, which rate was continued until the state sold its title to the lands in 1898, a little over one hundred years after assuming control.

The sale of the state's interest in the Onondaga reservation was due to the fact that the revenue obtained from the sale of the brine was less than the expense of keeping up the works.

Table 5 presents a statement of the amount of salt produced during the one hundred years from 1797, when the works were first put in operation.

[1] Eighteenth Annual Report of the United States Geological Survey, 1896-97, Part 5, page 1290 et seq.

TABLE 5.—SALT PRODUCTION OF THE ONONDAGA DISTRICT, NEW YORK, FOR ONE HUNDRED YEARS.

YEARS.	Total.	Solar.	Fine.	YEARS.	Total.	Solar.	Fine.
	Bushels.	*Bushels.*	*Bushels.*		*Bushels.*	*Bushels.*	*Bushels.*
1797	25,474		25,474	1847	3,951,355	262,879	3,688,476
1798	59,928		59,928	1848	4,737,126	342,497	4,394,629
1799	42,704		42,704	1849	5,083,569	377,735	4,705,834
1800	50,000		50,000	1850	4,268,919	374,732	3,894,187
1801	62,000		62,000	1851	4,614,117	378,967	4,235,150
1802	75,000		75,000	1852	4,922,533	633,595	4,288,938
1803	90,000		90,000	1853	5,404,524	577,947	4,826,577
1804	100,000		100,000	1854	5,803,347	734,474	5,068,873
1805	154,071		154,071	1855	6,082,885	498,124	5,584,761
1806	122,577		122,577	1856	5,966,810	709,391	5,257,419
1807	175,448		175,448	1857	4,312,126	481,280	3,830,846
1808	319,618		319,618	1858	7,033,219	1,514,554	5,518,665
1809	128,282		128,282	1859	6,894,272	1,345,022	5,549,250
1810	450,000		450,000	1860	5,593,247	1,462,565	4,130,682
1811	200,000		200,000	1861	7,200,391	1,884,697	5,315,694
1812	221,011		221,011	1862	9,053,874	1,983,022	7,070,852
1813	226,000		226,000	1863	7,942,383	1,437,656	6,504,727
1814	295,000		295,000	1864	7,378,834	1,971,122	5,407,712
1815	322,058		322,058	1865	6,385,930	1,886,760	4,499,170
1816	348,665		348,665	1866	7,158,503	1,978,183	5,180,320
1817	408,665		408,665	1867	7,595,565	2,271,892	5,323,673
1818	406,540		406,540	1868	8,666,616	2,027,490	6,639,126
1819	548,374		548,374	1869	8,662,237	1,857,942	6,804,295
1820	458,329		458,329	1870	8,748,113	2,487,691	6,260,422
1821	526,049		526,049	1871	8,374,956	2,464,464	5,910,492
1822	481,562		481,562	1872	7,930,925	1,882,604	6,048,321
1823	726,988		726,988	1873	7,460,357	1,691,359	5,768,998
1824	816,634		816,634	1874	6,029,300	1,667,368	4,361,932
1825	757,203		757,203	1875	7,179,446	2,655,955	4,522,491
1826	811,023		811,023	1876	5,392,677	2,308,679	3,083,998
1827	983,410		983,410	1877	6,427,983	2,525,335	3,902,648
1828	1,160,888		1,160,888	1878	7,176,197	2,788,754	4,387,443
1829	1,129,280		1,129,280	1879	8,322,162	2,957,744	5,364,418
1830	1,435,446		1,435,446	1880	7,998,750	2,516,485	5,482,265
1831	1,514,037		1,514,037	1881	7,917,236	3,011,461	4,905,775
1832	1,652,985		1,652,985	1882	8,340,180	3,032,447	5,307,733
1833	1,838,646		1,838,646	1883	7,497,431	2,444,374	5,053,057
1834	1,943,252		1,943,252	1884	6,942,270	2,353,860	4,588,410
1835	1,209,867		1,209,867	1885	6,934,299	2,439,332	4,494,967
1836	1,912,858		1,912,858	1886	6,101,757	2,772,348	3,329,409
1837	2,167,287		2,167,287	1887	5,695,797	3,118,974	2,576,823
1838	2,575,033		2,575,033	1888	5,657,367	3,115,314	2,542,053
1839	2,864,718		2,864,718	1889	5,365,039	2,916,922	2,448,117
1840	2,622,305		2,622,305	1890	4,928,122	2,726,471	2,201,651
1841	3,340,767	220,247	3,120,520	1891	3,948,913	2,113,727	1,735,186
1842	2,291,903	163,021	2,128,882	1892	4,405,674	3,122,789	1,282,885
1843	3,127,500	318,105	2,809,395	1893	3,065,906	2,332,052	733,854
1844	4,003,552	332,418	3,671,134	1894	3,227,253	2,355,394	871,859
1845	3,762,358	353,455	3,408,903	1895	3,214,124	2,608,289	605,835
1846	3,838,851	331,705	3,507,146	1896	2,806,600	2,464,422	342,178

During the first forty-four years only boiled salt was manufactured on the Onondaga reservation, and in this period the production increased from 25,474 bushels in 1797 to 2,622,305 bushels in 1840. The manufacture by the solar process began with the production of 220,247 bushels in 1841. In the same year the amount of fine salt made was 3,120,520 bushels, making a total product of 3,340,767 bushels. The salt-making industry on the Onondaga reservation continued to increase gradually until 1862, in which year 1,983,022 bushels of solar salt and 7,070,852 bushels of fine or boiled salt were produced, making a total product of 9,053,874 bushels. This was the largest product ever obtained. Since that time the production has shown a declining tendency, which from 1885 to 1896 was quite pronounced, the total output in the latter year amounting to only 2,806,600 bushels. Practically all this decrease has been in the manufacture of fine salt, which in 1896 had declined to 342,178 bushels, or only 4.8 per cent of what it was in 1862. This rapid decline, which is particularly noticeable from 1882 to 1896, was due in a large degree to the development of the Warsaw district, which began producing in 1883. The manufacturers in the Warsaw district were independent of state control, and their product was not subjected to the tax of 1 cent per bushel which was imposed upon the production of the reservation. The average price ranged between 25 and 30 cents per barrel containing 5 bushels. The tax, therefore, amounted to practically 20 per cent of the selling price.

The discovery of salt in the Warsaw district, which is in the county of Wyoming, was made near the town of Wyoming in 1880 by parties drilling for oil. The oil was not found, and very little salt was made from this well. In the fall of 1882 a well was sunk to the salt bed and the manufacture began the following year. Sixteen other companies were afterwards formed. The initial production, in 1883, amounted to 600,000 bushels, or 120,000 barrels. In 1890 the production had increased to 7,732,060 bushels, or 1,546,412 barrels. The production in this district in 1899 is not separately published.

The opening of the Genesee district was nearly contemporaneous with that of the Warsaw district, the first well being put down in the spring of 1883, and the manufacture beginning the same year. The initial output was 80,000 barrels of common fine salt. Of the 3 companies which began operations in 1884 and the 3 which began in 1885 only 1 survives.

The Ithaca or southern New York district was developed in 1895. The production from this region has not been particularly important.

The mining of rock salt in New York began in December, 1885. The first shaft of the Retsof Mining Company was located near York, Livingston county. In 1892 shafts were sunk near Leroy, Genesee county, and at Livonia and Greigsville, Livingston county, and shipments of salt were made from these mines that same year. The shaft of the Retsof mine is 1,100 feet in depth; the Lehigh shaft, near Leroy, 804 feet; the Livonia shaft, 1,432 feet; and the Greigsville shaft, 1,150 feet. Three of these companies have since passed out of existence, and all the rock-salt mining in the state of New York is now carried on by one company.

The production of rock salt in New York state varies from 150,000 long tons to 250,000 long tons annually, according to the market requirements.

Ohio.—The first attempt at salt making in Ohio was made in 1798 at what is now called the Old Scioto Salt Works, located on Salt Creek, a branch of the Scioto River in Jackson county. At this time the wells were dug only to the rocks below the surface soil, the brine flowing through the rock crevices into the wells. The brine was weak, full of bittern, and no attempt was made to purify the product even by draining. The brine was evaporated in kettles, from which it was transferred directly to pack horses and transported to other settlements, where it was sold for $3 and $4 per bushel. This continued as late as 1808. The brine springs were thought to be so important to the country, that when the territory of Ohio was admitted as a state, in 1802, a tract 6 miles square, embracing the wells, was set apart for the use of the state. Two other reservations were made, each of 640 acres or 1 square mile, one being in Muskingum county and the other in Delaware county.

The state legislature in 1804 enacted a law regulating the management of the salt reservations, and an agent or superintendent was appointed to lease lots to manufacturers, to inspect the salt made, and to carry out the other provisions of the law. A tax of 16 cents per year was imposed on each gallon of kettle capacity of the plant, no one being allowed to have less than 600 nor more than 4,000 gallons to a furnace. The revenue to the state, however, did not exceed $500 in any one year, and as better discoveries were made on navigable streams, the old works became unprofitable, were abandoned, and the reservations sold. The exact date of the development of the other salt-producing properties in Ohio is not known, but it was probably about 1825.

There is no record as to the quantity made in Ohio prior to 1860, in which year, according to the census, the product amounted to 348,640 barrels. In 1870 the product of Ohio amounted to 579,730 barrels. In 1880 it had decreased to 530,060 barrels. Between 1890 and 1899 the production increased rapidly, and amounted in the latter year to 1,460,516 barrels. From Table 3 it appears that there were in operation during 1899, 83 grainers, 38 open pans, 31 kettles, and 5 vacuum pans. There were also 4 covers or ponds, having an area of 12,320 square feet, in which solar salt was made. The principal grades produced in the state are table, dairy, and common fine.

OKLAHOMA.—Salt making began in Oklahoma as late as 1896. The works were established near the town of Okeene, on the banks of a branch of the Cimarron River, a creek whose waters are highly impregnated with salt. One of the first attempts at salt making was made by M.. J. M. White, who began evaporating the brine in an old stove kettle, afterwards using a galvanized wash tub. These were soon destroyed by the action of the salt, and he then experimented with an ordinary sorghum pan, meeting with more success. Others adopted the same method, and there are now 4 establishments engaged in the manufacture, although the original primitive plants are still used. There is comparatively little market for the salt, the demand being limited to a local consumption. The amount made in the territory in 1899 was 4,856 barrels, valued at $4,329.

PENNSYLVANIA.—The manufacture of salt in the state of Pennsylvania has ceased to be an industry of any moment, although at one time it was of comparative importance in the western part of the state. The industry has been mainly confined to the valley of the Conemaugh River, where it was quite firmly established early in the present century.

In the census report for 1860 it is stated that a company of Philadelphia and Pittsburg merchants erected salt works on Big Beaver Creek in 1784. In 1810 one establishment in Indiana county was reported as having made 600 bushels of salt, worth $1,000. About that time William Johnson commenced boring on the Conemaugh River, near the mouth of the Loyalhanna, struck an abundant fountain of salt water at the depth of 450 feet, and erected furnaces, pans, etc., by which he made about 30 bushels a day, and sold at a high price. Other wells were soon sunk to a depth of 300 to 600 feet in the coal measures of that region, and the price of salt was reduced as low as $1 per barrel, but afterwards fixed at $2, which afforded a profit. The pumps were first worked by horsepower and afterwards by small engines. In 1820 the business employed a capital of $33,000 in western Pennsylvania, and in 1826 there were 35 salt works on the Conemaugh and Kiskiminitas rivers, 3 on the Allegheny, and others were being constructed elsewhere, one of which was expected to yield 1,500 bushels daily. Salt was supplied at the works for from 20 to 25 cents per bushel, while it brought 50 cents in Kentucky, Ohio, and Illinois.

In Egle's History of Pennsylvania it is stated that about 1812 or 1813 the discovery of a salt spring was made by an old lady named Deemer at low-water mark of the Conemaugh River, about 2 miles above the present site of Saltsburg. This discovery shortly led to the development of an important industry in Indiana county. A well was sunk to the depth of 270 feet and an abundance of salt water found. The salt was manufactured by boiling the water in large kettles, using wood for fuel, and was sold at $5 per bushel. Afterwards, as the number of wells and plants increased, the price was reduced to $4 per bushel. Improvements were made in the methods of pumping the brine and manufacturing the salt; coal was used instead of wood for fuel, and steam engines instead of horsepower for boring and pumping. The place was known as the Great Conemaugh Salt Works. The same authority states that, between 1820 and 1830, 21 salt works, with a total of 24 wells, were in operation on the Conemaugh River in Westmoreland county. Mr. James M. Swank, in his report to the Centennial Commission, states that all but 3 of these works had been abandoned in 1876. Mr. Swank states that as early as 1811 salt works, which are reported to have produced considerable salt, were erected on the Sinnemahoning Creek, probably in what is now the county of Cameron.

The census report of 1820 makes a brief reference to salt manufacture in Pennsylvania in that year, but in most instances shows values only, without quantities. Armstrong county had 38 pans in operation, and the value of the product amounted to $18,000. Erie county had 18 kettles of 32 gallons each in operation. Indiana county had 32 pans and 190 kettles, the price being given as $1 per bushel. Westmoreland county had 6 establishments, and produced 70,000 bushels worth $1 per bushel.

The manufacture of salt was the only industry reported in Indiana county in 1820. The Gazetteer of Pennsylvania, published in 1832, shows that the total product of Pennsylvania in 1830 was 100,000 barrels of 5 bushels each, valued at $200,000. In 1840 it is reported to have been 549,478 bushels, an increase of about 10 per cent in the ten years. In 1850 there were 47 establishments, and the production amounted to 919,100 bushels, valued at $206,796.[1] In 1860 the number of establishments had decreased to 34, but the product had increased to 1,011,800 bushels, with a decrease in value to $196,916. A considerable decrease in the industry was shown in 1870, when there were 27 establishments, producing 579,970 bushels, valued at $187,312. In 1880 the number of establishments had been reduced to 16, but the product had increased to 851,450 bushels, with a decrease in value to $177,415. In 1890 there were only 3 of these establishments in Pennsylvania, but the product was a little more than that of ten years before, amounting to 862,000 bushels, valued at $156,398. In 1899 there was only 1 establishment in Pennsylvania, and the statistics were included under "all other states."

TEXAS.—The first salt well sunk in the state was begun at the town of Colorado in 1884. Salt was struck at a depth of 7 feet and the work of making from brine was begun in 1885. A second well was drilled in 1889 and completed before the close of the year. The manufacture of salt was begun at once, and

[1] So given in Vol. III, Report of Ninth Census, page 622. In the Digest of the Census of 1850, page 100, the value is given as $161,796, without the quantity of salt.

since that time the industry has assumed considerable importance. As there were only 2 establishments, the production of the state was not reported separately at the census of 1890.

In 1899 the product amounted to 312,436 barrels, valued at $256,900, a third establishment having been added during the decade. Of this product 10,000 barrels were made by solar evaporation and the rest by boiling, either in grainers or open pans. The greater part was made in grainers, of which there were 24 in use in the state. There were only 2 open pans operated.

UTAH.—The manufacture of salt in the territory of Utah began almost immediately after the advent of the Mormons in 1847. The first salt was harvested from the shores of Great Salt Lake in the following year. The water from the lake being thrown back upon the shore by the westerly winds prevailing in the spring, formed small pools of brine which evaporated during the warm, dry weather of July and August, leaving deposits of salt. This was scraped up and used for domestic purposes and for the curing of meats. The early settlers were supplied in this way until about 1860, when the idea was conceived of making dams in low places which would hold large quantities of water. Salt was made in this way in 1860, but no product is reported by the census of that year. The dams were flooded in the spring, and the salt deposited during the summer by solar evaporation. As the summer is generally dry, it is not necessary to cover the ponds, and the process of evaporation is practically a continuous one. At about this time the chlorination process for the reduction of silver from its ores was discovered, and the first use of salt from Great Salt Lake for this purpose is reported to have been made at the Alice mine in Butte, Mont. This was before the days of railroads, and the product was carried on the backs of mules from the lake to the mine at a cost of about $200 per ton.

It does not appear from the census records that this very largely increased the production from the lake, as the amount reported in 1870 was only 1,950 bushels. By 1880, however, the output had increased to 483,800 bushels, and a number of large companies had in the meanwhile been formed. By 1890 this output was still further augmented to a production of 3,132,143 bushels, valued at $144,300.

In 1899 Utah produced 235,671 barrels, equivalent to 1,178,355 bushels, nearly all of which was made by solar evaporation. In the making of salt by solar evaporation the pumps are started each year about the month of March, the brine being pumped into large reservoirs, each covering from 10 to 20 acres. As the brine becomes stronger it is drawn off into other reservoirs or sloughs covering from 3 to 15 acres. Sloughs are made with a hard clay bottom and with a levee thrown up 3 or 4 feet high around the sides to retain the brine and at the same time furnish a ditch on the outside to carry off fresh water. The sloughs are replenished from time to time during the summer, the reservoirs being kept stocked until September or October, by which time salt is deposited to the depth of from 3 to 6 inches. Harvesting then begins with wheelbarrows and tramway, the salt being stacked on the banks in large piles shaped something like a haystack, but not so high. A crust which answers every purpose of a shingle roof forms on each pile. This is the crude salt ready for market; it is hauled to the mills for refining purposes or is shipped in this crude state to the silver mills working under the chlorination process.

The latest improved machinery in the mills consists of revolving cylinders, roller burrs, and a series of sieves. The salt is hauled to a crusher, whence it is carried by hoppers to the heated cylinders, which deliver it perfectly dried to the roller burrs; thence it goes to the sieves. It is purified by means of a suction blower as it passes over the sieves. The impurities are lighter than the salt, and as it passes over the sieves the suction is set with just enough strength to take off the impurities and allow the salt to pass on to the bins, the different grades being conveyed to the proper bins by a series of hoppers.

VIRGINIA.—Since West Virginia was separated from Virginia, there has been only 1 establishment making salt in the latter state. This is located at Saltville, in the valley of the Shenandoah River. The production is combined with that of other states having less than 3 establishments engaged in the business.

Most of the Virginia product is used in the production of soda ash, bicarbonate of soda, etc., by an electrolytic process.

WEST VIRGINIA.—The early attempts at making salt in West Virginia were attended with many interesting incidents. They have been historically recorded in a contribution to a report on the resources of West Virginia by Dr. J. P. Hale, of Charleston, which was published in 1876 by the state board of centennial managers. According to this the principal points at which salt has been manufactured in the state are: Charleston, on the Kanawha River; Hartford, Mason City, Clifton, and other places in Mason county, along the Ohio River; near Birch on Elk River; and at a few other places on a small scale for local use. The seat of the industry at present is along the Ohio River in Mason county, there being but 1 establishment of any importance in the state outside of that county.

The earliest attempts were on the Kanawha River. The Kanawha "licks" were known to have been used by the Indians, and were the gathering places for buffalo, elk, deer, and other wild animals before the advent of the white man. The earliest settlement in this region was made in 1774 by Walter Kelly and family at the mouth of the creek bearing his name. They were all killed by Indians. Later, in 1785, when life in that section had become a little more secure, Joseph Ruffner, an enterprising farmer from the Shenandoah Valley of Virginia, purchased about 500 acres of land

at the mouth of Campbell's Creek from one John Dickinson, on Dickinson's representations as to the valuable salt springs on the property. Ruffner also purchased 900 acres, extending from a point on the Elk River to the Kanawha, and embracing the present site of Charleston. Joseph Ruffner did not live to see his design for making salt effected, but in transmitting the property to his sons, David and Joseph, he enjoined them to carry out his plans for building extensive salt works. All that the elder Ruffner had accomplished was the leasing of the "licks" to one Elisha Brooks, with the right to manufacture salt. Brooks, in 1797, erected the first salt furnace in Kanawha county, which was also the first one west of the Allegheny Mountains. It consisted of two dozen small kettles set in a double row, with a flue beneath, a chimney at one end and a fire bed at the other.

In order to obtain a supply of brine, Brooks sank two or three "gums" into the mire and quicksand of the lick and dipped up the brine with a bucket and sweep. In this crude way he manufactured about 150 pounds of salt a day, which he sold at from 8 to 10 cents a pound. No attempt was made to purify the salt from the bittern and other impurities, either organic or inorganic. This salt soon acquired a reputation for its strong, pungent taste and superior qualities for curing meat, etc. The presence of iron gave the salt a reddish tinge, and it became widely and favorably known as "that strong red salt from the Kanawha 'licks'."

In 1806 the two brothers Ruffner, inspired by the growing needs of an increasing population, began to look for the source of the brine springs in the hope of finding a larger and better supply. The history of their struggle, as recorded by Dr. Hale, is very interesting. They began by sinking a "gum," consisting of a hollow sycamore tree, which reached what they supposed was bed rock at 13 feet. With the primitive means at their command, even this little was accomplished only after much work and many and trying delays. Upon cutting at the bottom with crowbars, this bed was found to be shale only about 6 inches thick, which, when penetrated, furnished a larger stream of brine but much weaker than the "lick" at the surface. The brothers, disappointed at this result, decided to sink a well in the bottom land about 100 yards from the river, but after penetrating 45 feet of alluvial deposit they struck the same shale as at the "gum" with only a slightly brackish water.

They then decided to return to the "gum" and continue work until they struck bed rock, which they finally did at about 17 feet. The quantity of brine was small but of a strong quality. Encouraged by this, they decided to drill the rock. This was done by means of a long drill with a 2½-inch chisel bit attached at the upper end to a spring pole, and the pole to a rope. Boring by this means was slow, difficult, and tedious, but on November 1, 1807, at 17 feet in the rock, they struck a larger flow of strong brine. Continuing the work, at 28 feet a still larger and stronger flow was obtained. On January 15, 1808, at 40 feet in the rock, they found a stream large and strong enough for all their purposes and ceased boring.

But they had no pipes in which to bring the strong brine to the top of the ground undiluted by the surface seepage. These were finally provided by whittling out two half-tubes from long strips of wood, fitting the edges carefully together, and wrapping the whole from end to end with small twine. The brine came up free and strong from below, the "gum" floor was made water-tight, and from the "gum" the brine was raised to the surface by bucket and sweep. This is said to be the first rock-bored salt well west of the Allegheny Mountains, if not in the United States; it required a year and a half to complete it. The success is the surprising feature. As Dr. Hale says: "Without preliminary study, previous experience, or training; without precedents in what they undertook; in a newly settled country, without steam power, machine shops, skilled mechanics, suitable tools or materials, failure rather than success might reasonably have been predicted."

Meanwhile their furnace, a reproduction of Brooks's on a larger plan, was under construction and was completed in time for the brine. On February 8, 1808, the Ruffner brothers secured their first output, and immediately cut the former price of salt one-half, selling it at the unprecedentedly low figure of 4 cents per pound. The neighbors, who had watched the progress and result of the Ruffner struggle, began boring on their own lands with more or less success, and in 1817 there were about 30 furnaces and 15 or 20 wells in operation. Improvements in mechanical methods of raising the brine were adopted, the bucket and sweep giving way to the winch, and the winch in 1828 to steam. Coal, too, began to be used for fuel, David Ruffner being the enterprising pioneer in this as in the boring. In 1831 William Morris invented an ingenious but simple tool for boring salt wells. which is to-day used in boring oil and gas wells. It was the tool known as "slip" or "jar." Morris's invention was never patented, and, like the hydraulic ram, has not been improved upon.

In 1835 there were about 40 furnaces along the Kanawha River, producing annually about 2,000,000 bushels of salt. But the activity in the industry in West Virginia has since that time been transferred to the region along the Ohio River in Mason county. The change began in 1849. In this year Messrs. Williams & Stevens bored for salt water at West Columbia, and, striking a good flow of strong brine at 700 feet, erected the first salt furnace on the Ohio River. This was soon after sold to New York parties, and enlarged and improved by them to a capacity of 1,200 bushels per day. The second furnace on the Ohio was built in 1854 by a company formed by Hartford, Conn., parties. The first one was located at the southern limit of the coal exposures and the other at the northern limit. The third furnace was erected and wells were sunk at

Mason City, about halfway between the others. Within the next few years 10 more furnaces were erected, making a total of 13, with an annual capacity of 3,700,000 bushels. At the time of the writing of Dr. Hale's report (1875), 4 of these furnaces were idle, and the actual output from the 9 other furnaces was reported by him at 2,500,000 bushels, or 500,000 barrels.

The census report for 1860 shows that the production of salt in those counties of Virginia which were set off from that state and, in 1863, admitted as the state of West Virginia, amounted to 2,076,513 bushels, or 415,303 barrels. By 1870 the production had increased to 4,633,750 bushels, or 926,750 barrels, an increase of 123.2 per cent. During the next decade the industry in West Virginia suffered from the competition brought about by developments in other states, and in 1880 the production had declined to 2,679,438 bushels, or 535,888 barrels. In 1890 it had dropped to 285,461 barrels, and had further decreased in 1899 to 221,534 barrels.

As shown in Table 3, all the salt made in West Virginia is made by the boiling process. There were 4 establishments in 1899, one less than at the preceding census. The salt is made entirely in grainers and kettles, there being 23 grainers and 36 kettles in operation in the state during 1899.

Table 6 presents the detailed statistics for the industry, by states, as reported at the Twelfth Census for the calendar year 1899.

TABLE 6.—SALT MANUFACTURE, BY STATES AND TERRITORIES: 1900.[1]

	United States.	California.	Kansas.	Michigan.	Nevada.	New York.	Ohio.	Oklahoma.	Texas.	Utah.	West Virginia.	All other states.[2]
Number of establishments	159	24	8	53	3	38	10	4	3	5	4	7
Character of organization:												
Individual	56	15	2	15	1	10	1	4	.....	4	1	3
Firm and limited partnership	23	6	.....	11	1	3	2	.....	.....	.....	.....	.....
Incorporated company	80	3	6	27	1	25	7	.....	3	1	3	4
Capital:												
Total	$27,123,364	$757,895	$960,733	$4,759,865	$9,320	$17,231,864	$796,841	$2,555	$327,036	$646,850	$331,200	$1,299,205
Land	$8,494,587	$468,661	$68,732	$280,432	$3,350	$6,387,587	$78,047	$275	$54,493	$540,010	$160,500	$452,500
Buildings	$8,358,018	$36,000	$363,454	$884,128	$2,400	$6,143,385	$268,400	$335	$115,876	$23,740	$69,500	$450,800
Machinery, tools, and implements	$4,523,294	$102,511	$266,869	$1,067,072	$1,520	$2,388,407	$308,000	$204	$80,000	$25,011	$52,500	$281,200
Cash and sundries	$5,747,465	$150,723	$261,678	$2,528,233	$2,050	$2,362,485	$142,394	$1,741	$76,667	$58,089	$48,700	$114,705
Proprietors and firm members	81	28	2	29	3	5	3	4	.....	4	.....	3
Salaried officials, clerks, etc.:												
Total number	406	37	32	91	.....	157	48	.....	11	8	13	9
Total salaries	$499,748	$37,128	$36,010	$87,249	.....	$247,373	$42,218	.....	$17,070	$10,580	$13,540	$8,580
Officers of corporations—												
Number	87	5	9	24	.....	24	13	.....	4	1	7	.....
Salaries	$185,524	$9,600	$15,600	$31,879	.....	$94,365	$12,680	.....	$8,600	$2,100	$10,700	.....
General superintendents, managers, clerks, etc.—												
Total number	319	32	23	67	.....	133	35	.....	7	7	6	9
Total salaries	$314,224	$27,528	$20,410	$55,370	.....	$153,008	$29,538	.....	$8,470	$8,480	$2,840	$8,580
Men—												
Number	291	31	21	61	.....	121	29	.....	7	6	6	9
Salaries	$299,382	$27,288	$19,210	$52,665	.....	$144,624	$27,705	.....	$8,470	$8,000	$2,840	$8,580
Women—												
Number	28	1	2	6	.....	12	6	.....	.....	1	.....	.....
Salaries	$14,842	$240	$1,200	$2,705	.....	$8,384	$1,833	.....	.....	$480	.....	.....
Wage-earners, including pieceworkers, and total wages:												
Greatest number employed at any one time during the year	6,612	468	496	2,133	13	1,799	848	11	213	120	220	291
Least number employed at any one time during the year	4,179	178	420	1,342	5	1,116	636	4	135	38	128	177
Average number	4,774	267	450	1,449	7	1,279	678	7	191	59	190	197
Wages	$1,911,140	$109,774	$168,084	$619,883	$3,670	$542,909	$243,397	$1,100	$66,079	$23,702	$54,805	$78,287
Men, 16 years and over—												
Average number	4,337	260	429	1,340	6	1,137	543	7	179	58	186	192
Wages	$1,813,638	$107,604	$163,724	$595,041	$3,450	$509,436	$215,975	$1,100	$61,929	$23,537	$54,305	$77,537
Women, 16 years and over—												
Average number	378	6	21	71	1	133	133	.....	12	1	.....	.....
Wages	$86,007	$1,927	$4,310	$16,027	$220	$32,106	$27,102	.....	$4,150	$165	.....	.....
Children, under 16 years—												
Average number	59	1	.....	38	.....	9	2	.....	.....	.....	4	5
Wages	$11,495	$243	.....	$8,315	.....	$1,367	$320	.....	.....	.....	$500	$750
Average number of wage-earners, including pieceworkers, employed during each month:												
Men, 16 years and over—												
January	3,402	153	430	760	3	943	484	9	186	42	209	183
February	3,375	162	408	778	3	941	537	9	136	40	197	164
March	3,657	190	412	945	4	985	554	9	154	36	195	173
April	4,472	224	406	1,356	5	1,330	563	7	167	38	203	173
May	4,877	250	435	1,649	5	1,328	604	6	176	63	197	164
June	4,834	230	418	1,666	6	1,219	641	5	189	88	194	178
July	4,975	360	429	1,721	9	1,220	567	4	191	85	194	195
August	5,046	413	437	1,752	5	1,249	510	4	192	80	201	203
September	4,880	423	438	1,569	5	1,233	566	5	195	62	177	207
October	4,488	355	449	1,506	12	1,100	491	7	189	50	139	190
November	4,304	204	450	1,409	10	1,102	491	10	188	64	150	226
December	3,734	154	432	965	7	993	513	10	186	53	175	246
Women, 16 years and over—												
January	336	10	22	36	1	135	118	.....	13	1	.....	.....
February	325	10	23	46	1	118	118	.....	8	1	.....	.....
March	356	10	23	64	1	119	129	.....	9	1	.....	.....
April	403	6	21	80	1	149	132	.....	13	1	.....	.....
May	443	13	22	99	1	156	138	.....	13	1	.....	.....
June	384	2	17	98	1	125	127	.....	13	1	.....	.....
July	371	3	16	87	1	117	133	.....	13	1	.....	.....
August	372	3	19	82	1	123	130	.....	13	1	.....	.....
September	397	3	19	87	1	126	147	.....	13	1	.....	.....
October	385	3	23	67	1	143	134	.....	13	1	.....	.....
November	395	7	23	60	1	147	143	.....	13	1	.....	.....
December	369	5	22	50	.....	132	146	.....	13	1	.....	.....

[1] The report for the Twelfth Census is for the calendar year 1899.
[2] Includes establishments distributed as follows: Illinois, 1; Louisiana, 2; Massachusetts, 2; Pennsylvania, 1; Virginia, 1.

TABLE 6.—SALT MANUFACTURE, BY STATES AND TERRITORIES: 1900[1]—Continued.

	United States.	California.	Kansas.	Michigan.	Nevada.	New York.	Ohio.	Oklahoma.	Texas.	Utah.	West Virginia.	All other states.[2]
Average number of wage-earners, including pieceworkers, employed during each month—Continued:												
Children, under 16 years—												
January	17	1		1		4	1				5	5
February	17	1		1		4	1				5	5
March	27	1		5		10	1				5	5
April	66	1		44		10	1				5	5
May	69	1		45		11	2				5	5
June	75	1		51		11	2				5	5
July	82	1		58		11	2				5	5
August	87	1		64		10	2				5	5
September	67	1		46		10	3				2	5
October	74	1		53		10	3				2	5
November	68	1		46		10	3				3	5
December	59	1		36		9	3				5	5
Miscellaneous expenses:												
Total	$760,539	$30,990	$52,798	$193,915	$1,110	$329,701	$93,342	$350	$6,255	$24,065	$9,838	$18,175
Rent of works	$42,340	$9,458	$500	$650		$21,671		$246		$4,275		$5,540
Taxes, not including internal revenue	$71,067	$2,504	$5,793	$29,217	$110	$19,069	$6,656	$69	$2,235	$402	$2,404	$2,603
Rent of offices, insurance, interest, and all sundry expenses not hitherto included	$621,855	$19,028	$46,505	$140,548	$1,000	$288,161	$85,709	$35	$4,020	$19,388	$7,434	$10,027
Contract work	$25,277			$23,500		$800	$977					
Materials used:												
Total cost	$3,335,922	$116,712	$327,890	$1,095,780	$2,876	$958,302	$423,875	$1,235	$141,342	$31,759	$57,398	$178,753
Barrels, bags, sacks, cartons, etc., purchased	$997,503	$89,662	$49,072	$355,451	$2,612	$335,495	$52,388		$44,793	$25,288	$4,700	$38,042
Cooperage stock purchased	$775,411		$124,061	$352,014		$157,611	$89,268		$13,000		$15,548	$23,909
Cloth purchased for sacks	$64,208	$1,300		$3,708			$58,470	$230		$500		
Fuel	$991,248	$10,404	$119,036	$274,055	$157	$305,864	$149,239	$980	$40,399	$3,874	$25,500	$61,740
Rent of power and heat	$2,111	$1,721				$140				$250		
Mill supplies	$192,777	$2,632	$6,366	$50,312	$17	$63,767	$24,163		$4,150	$931	$1,600	$38,839
All other materials	$189,747	$8,442	$3,980	$24,355		$88,584	$32,222	$25	$5,000	$866	$10,050	$16,223
Freight	$122,917	$2,551	$25,375	$35,885	$90	$6,841	$18,125		$34,000	$50		
Products:												
Total value	$7,966,897	$380,193	$717,449	$2,460,538	$12,696	$2,698,691	$818,200	$4,329	$256,900	$139,488	$150,292	$328,121
Salt, including value of packages:												
Number of barrels	15,187,819	640,420	1,645,350	5,206,510	7,671	4,894,852	1,460,516	4,856	312,436	235,671	221,534	558,003
Value	$7,901,836	$380,193	$717,449	$2,451,964	$12,696	$2,698,571	$804,872	$4,329	$256,900	$139,488	$130,492	$304,882
Table and dairy salt—number of barrels	1,866,058	128,779	56,524	233,713	3,000	1,028,803	375,739	1,729	31,286	1,485	5,000	
Common fine	6,866,126	33,571	47,157	4,076,497	357	1,054,619	887,445	1,773	220,000		216,534	328,173
Common coarse	2,635,282	128,852	1,072,676	820,259	2,457	397,664	84,982	576	44,721	62,115		20,980
Packers'	182,930	47,143		19,119		4,318	112,350					
Coarse solar	910,974	282,122	714	17,743		523,724		778	10,000	75,893		
Rock salt, mined	2,543,679	250	468,029			1,866,550						208,850
Milling	96,178	7,200			71					88,907		
Other grades	86,592	12,503	250	39,179	1,786	19,174			6,429	7,271		
Bromine—												
Pounds	279,437			27,584			62,041				93,000	96,812
Value	$64,921			$8,554			$13,328				$19,800	$23,239
Value of all other products	$140			$20		$120						
Value of packages included in foregoing	$2,032,474	$98,992	$174,158	$826,958	$2,612	$515,311	$234,868	$100	$59,793	$25,788	$26,705	$67,189
Comparison of products:												
Number of establishments reporting for both years	114	17	5	39	3	25	8	4	2	3	3	5
Value for census year	$5,000,310	$270,143	$310,899	$1,627,181	$12,696	$1,658,958	$341,200	$4,329	$241,300	$135,738	$110,692	$287,174
Value for preceding business year	$4,405,762	$214,610	$211,911	$1,392,160	$6,500	$1,421,635	$474,089	$3,455	$197,000	$89,001	$105,900	$289,501
Processes employed:												
Covers or ponds—												
Number	35,222	474	30	2,009	2	32,295	4	13	14	39		342
Square feet	109,921,360	62,062,800	144,656	545,300	30,000	8,176,948	12,320	92,120	135,680	38,610,728		110,808
Grainers	522		13	273		92	83	2	24		23	12
Open pans	264	2	36	17		43	38	21	2			105
Kettles	411			5		338	31			1	36	
Vacuum pans	40	1		19		9	5					6
Power:												
Number of establishments reporting	117	11	7	48	1	28	10		2	4	4	2
Total horsepower	24,060	376	2,130	10,525	42	7,781	1,312		56	108	320	1,410
Owned—												
Engines—												
Steam—												
Number	380	9	18	133	3	150	37		3	2	16	9
Horsepower	23,104	238	2,052	10,149	42	7,776	1,052		37	90	318	1,350
Gas or gasoline—												
Number	13	7	1						2		1	2
Horsepower	182	93	8						19		2	60
Water wheels—												
Number	1									1		
Horsepower	8									8		
Electric motors—												
Number	8			6			2					
Horsepower	195			160			35					
Other power—												
Number	9		1	4			3			1		
Horsepower	521		70	216			225			10		
Furnished to other establishments	200			200								
Rented horsepower	50	45				5						
Establishments classified by number of persons employed, not including proprietors and firm members:												
Total number of establishments	159	24	8	53	3	38	10	4	3	5	4	7
No employees	2			1	1							
Under 5	22	6	1	7	1	2		3		1		1
5 to 20	53	9	3	19	1	15	1	1	1	2		1
21 to 50	33	5	2	8		8	4		1	1	2	2
51 to 100	38	4	1	16		8	3			1	2	3
101 to 250	6					4	1		1			
251 to 500	5		1	2		1	1					

[1] The report for the Twelfth Census is for the calendar year 1899.
[2] Includes establishments distributed as follows: Illinois, 1; Louisiana, 2; Massachusetts, 2; Pennsylvania, 1; Virginia, 1.

BEET SUGAR.

BEET SUGAR.

By GUILFORD L. SPENCER, *Expert Special Agent.*

Reports were received from 30 establishments engaged in the manufacture of beet sugar during the census year ending May 31, 1900, and also from 1 factory equipped for the industry, which was idle. While these factories are distributed in 10 states and 1 territory, it is impossible to publish separate totals, except for the states of California and Michigan, without disclosing the operations of individual establishments.

TABLE 1.—SUMMARY: 1900.

STATES AND TERRITORIES.	Number of establishments.	Capital.	OFFICERS OF CORPORATIONS.		SALARIED OFFICIALS, CLERKS, ETC.		WAGE-EARNERS.		Miscellaneous expenses.	Cost of materials used.	Value of products at works.
			Number.	Salaries.	Number.	Salaries.	Average number.	Total wages.			
United States	[1]31	$20,958,519	48	$114,300	302	$242,375	1,970	$1,092,207	$451,351	$4,303,796	$7,323,357
California	[1]8	10,139,780	11	39,900	111	77,980	909	480,072	169,449	2,243,580	3,499,996
Michigan	9	4,013,743	20	33,400	98	68,293	473	216,704	77,262	1,109,903	1,602,266
All other states	14	6,804,996	17	41,000	93	96,102	588	395,431	204,640	1,450,313	2,221,595

[1] Includes 1 idle establishment.

The total of "all other states," shown in this and subsequent tables, includes establishments distributed as follows: Colorado, 1; Illinois, 1; Minnesota, 1; Nebraska, 3; New Mexico, 1; New York, 2; Oregon, 1; Utah, 3; Washington, 1. The statistics for these factories are grouped in order to avoid disclosing the operations of individual factories.

Of the 31 factories, 29 were controlled by incorporated companies, and 2 by individuals.

TABLE 2.—CAPITAL INVESTED: 1900.

STATES AND TERRITORIES.	Total.	Land.	Buildings.	Machinery, tools, and implements.	Cash and sundries.
United States	[1]$20,958,519	$682,705	$3,891,371	$14,420,325	$1,964,118
California	[1]10,139,780	349,969	1,825,153	7,309,447	655,211
Michigan	4,013,743	143,036	925,980	2,414,349	530,378
All other states	6,804,996	189,700	1,140,238	4,696,529	778,529

[1] Includes 1 idle establishment.

The total capital invested in beet-sugar manufacture in 1899, the year's work reported in the present bulletin, was $20,958,519, of which $682,705 is reported for land, $3,891,371 for buildings, $14,420,325 for machinery, and $1,964,118 for cash on hand, bills receivable, unsettled ledger accounts, raw materials, stock in process of manufacture, finished products on hand, and other sundries. The item "land" is not intended to include farm lands, but in view of the considerable area required by the factories for storage, disposal of waste water, etc., and to provide for the future growth of the establishments, it has not been practicable to eliminate a small area now utilized for agricultural purposes. In many instances large tracts of land are owned by the companies and devoted to agriculture.

At the census of 1890 reports were received from only 2 beet-sugar factories, and, therefore, to avoid disclosing the operations of individual establishments, the statistics for the industry were not separately reported, but the value of the product is estimated by the writer to have been $340,000. No estimate of the capital invested can be made.

In 1879, 4 factories were in operation and were reported at the Tenth Census. The total capital invested was $365,000, and the value of the products was $282,572.[1] Few single factories reported in the Twelfth Census have so small an investment as the combined capital of the 4 in operation in 1879.

[1] See Tenth Census, Manufactures, pp. 94, 101, 127.

TABLE 3.—NOMINAL DAILY FACTORY CAPACITY, AND CAPITAL INVESTED PER TON OF BEETS: 1900.

STATES AND TERRITORIES.	Number of establishments.	Total capacity per day.	Average daily capacity per factory.	CAPITAL INVESTED PER TON OF DAILY CAPACITY.				
				Total capital.	Land.	Buildings.	Machinery and tools.	Cash and sundries.
		Tons.	*Tons.*					
United States..	[1] 31	[2] 19,110	616	$1,097	$36	$204	$754	$103
California	[1] 8	9,900	1,238	1,024	35	185	738	66
Michigan.....	9	4,100	456	979	35	226	589	129
All other states..	14	[2] 5,110	364	1,334	37	224	921	152

[1] Includes 1 idle establishment.
[2] Includes 1 auxiliary factory at which no sugar is manufactured, but juice is extracted from the beets and pumped to a central factory for treatment.

In estimating the capital required in the organization of new companies for the manufacture of beet sugar, an assumed average capital per ton of beets, daily factory capacity, is frequently used as a factor. It is for this reason that these figures are included in Table 3.

There are many conditions which modify the average capital invested per ton of nominal capacity. Among these are the following: (1) the cost of a large factory is less per ton of capacity than that of a small one; (2) freight charges for the transportation of machinery vary with the distance of the site of the factory from the foundry in which the machinery is made; (3) the cost is necessarily greater in the case of those factories which are equipped for the recovery of sugar from molasses, from which no more sugar can be profitably extracted by the process of crystallization; (4) many factories have machinery of relatively small capacity so disposed in a large building as to permit of increasing the capacity of the plant without additional expense for buildings.

The Michigan factories were built within two years and under similar conditions in the iron market; with one exception, they are of American construction.

TABLE 4.—NUMBER AND NOMINAL DAILY CAPACITY OF ESTABLISHMENTS IN 1900, 1899, AND 1898.

STATES AND TERRITORIES.	1900.		1899.		1898.	
	Number of establishments.	Nominal daily capacity in tons of beets.	Number of establishments.	Nominal daily capacity in tons of beets.	Number of establishments.	Nominal daily capacity in tons of beets.
United States.....	[1] 37	22,310	[2] 31	19,110	15	7,560
California	8	9,900	[2] 8	9,900	5	4,400
Colorado	3	1,850	1	350	.....	.....
Illinois	1	700	1	700	.....	.....
Michigan.....	10	4,450	9	4,100	1	400
Minnesota.....	1	400	1	400	1	400
Nebraska.....	3	1,260	3	1,260	2	660
New Mexico.....	1	200	1	200	1	200
New York.....	3	1,000	2	400	2	400
Ohio.....	1	400	.....	.....	.....	.....
Oregon	1	350	1	350	1	350
Utah	4	[3] 1,450	3	[4] 1,100	2	750
Washington	1	350	1	350	.....	.....

[1] Includes 2 idle establishments.
[2] Includes 1 idle establishment.
[3] Includes 2 auxiliary factories.
[4] Includes 1 auxiliary factory at which no sugar is manufactured, but juice s extracted from the beets and pumped to a central factory for treatment.

TABLE 5.—EMPLOYEES AND WAGES: 1900.

STATES AND TERRITORIES.	OFFICERS OF CORPORATIONS.		SALARIED OFFICIALS, CLERKS, ETC.				AVERAGE NUMBER OF WAGE-EARNERS AND TOTAL WAGES PAID.					
	Number.	Salaries.	Men, number.	Salaries.	Women, number.	Salaries.	Men, 16 years and over.	Wages.	Women, 16 years and over.	Wages.	Children, under 16 years.	Wages.
United States.....	48	$114,300	287	$235,657	15	$6,718	1,951	$1,085,218	4	$1,685	15	$5,304
California	11	39,900	107	75,687	4	2,343	903	477,306	3	1,565	3	1,201
Michigan.....	20	33,400	90	65,706	8	2,587	471	215,834	1	120	1	750
All other states.....	17	41,000	90	94,314	3	1,788	577	392,078	.....	.....	11	3,358

In beet sugar factories the length of the manufacturing year is dependent upon agricultural conditions. The factories are operated only a part of the calendar year, but after the close of the manufacturing season, many of the employees, especially foremen and skilled laborers, are engaged for a few months in making repairs and improvements. The majority return to work on farms or in other industries. The manufacture begins at a time when there is comparatively little demand for farm labor, except in harvesting sugar beets, and thus, in a measure, it fills out the year for the farm laborer. When comparing the average earnings with the averages reported for other industries, these facts should be considered.

TABLE 6.—COST OF MATERIALS USED: 1900.

STATES AND TERRITORIES.	Total.	Sugar beets.	Fuel.	Mill supplies.	Freight paid.	All other materials.
United States ...	$4,803,796	$3,485,320	$453,036	$18,933	$369,070	[1] $477,437
California.....	2,243,580	1,585,953	253,185	10,011	205,286	189,145
Michigan	1,109,903	902,592	90,969	2,840	26,839	86,663
All other states	1,450,318	996,775	108,882	6,082	136,945	201,629

[1] Includes $51,000, cost of sugar beet juice.

The small value of the products, $7,323,857, is due to an enormous shortage in the crop of sugar beets for the year ending May 31, 1900. In all branches of sugar manufacture the years of plentiful harvests must carry

the industry over the years of failure, and yield a return that will make the average earnings justify the investments.

Of the 16 new factories, 15 of which were operated for the first time in 1899, several were not completed when the harvest was ready, and in some instances there were serious losses from deterioration of the beets. As a whole, there was an apparent small profit earned by the factories; in certain cases handsome dividends were paid, in others there were heavy losses, and in many instances the factories little more than paid expenses.

In addition to the factories operated in the census year, 6, including 1 auxiliary factory at which beet juice was extracted but no sugar manufactured, were under construction for the crop of 1900. A report of these new factories not being required, the figures given are only approximate. The capital invested in new factories is $3,800,000, making a total of $24,758,519 for the new industry in the year 1900.

Of the 30 factories in operation during the census year, 10 reported the total value of their products for the preceding business year as aggregating $1,838,681. The same factories reported a product valued at $2,426,522 for the census year.

The acreage actually contracted for in 1899 was 135,305, as shown in Table 7. Because of the shortage of the crop in various parts of the country, particularly in California, beets were actually harvested from but 105,175 acres, and the average yield from this land, 8 tons (of 2,000 pounds) per acre, was very unsatisfactory. The average yield of beets for Germany[1] for the crops of 1896–97, 1897–98, and 1898–99, respectively, was 14, 14, and 13 tons per acre.

The acreage seeded for the crop of 1900, including that for 6 new factories having a total nominal daily capacity of 3,200 tons of beets, was only 123,400, whereas approximately 200,000 acres would have been required fully to supply the demand of the 36 factories in operation during that year.

[1] "Zeitschrift des Vereins für die Rübenzucker-Industrie des Deutschen Reichs." Supplement to the number for March, 1900.

TABLE 7.—ACREAGE IN BEETS, AND QUANTITIES AND COST OF BEETS USED, BY STATES: 1900.

STATES AND TERRITORIES.	TOTAL.			BEETS GROWN BY FACTORY PROPRIETORS.			BEETS GROWN BY TENANTS OF FACTORY PROPRIETORS.			BEETS GROWN BY CONTRACT BY OTHERS THAN TENANTS OF FACTORY PROPRIETORS.			AVERAGE QUALITY OF BEETS.	
	Acres in beets.	Tons of beets (2,000 pounds).	Cost.	Acres in beets.	Tons of beets (2,000 pounds).	Cost.	Acres in beets.	Tons of beets (2,000 pounds).	Cost.	Acres in beets.	Tons of beets (2,000 pounds).	Cost.	Per cent of sucrose.	Coefficient of purity.
United States	135,305	794,658	$3,485,320	10,239	23,241	$93,898	18,074	95,071	$430,479	111,992	676,346	$2,960,943	14.5	81.2
California	63,878	354,942	1,585,953	7,526	10,645	42,718	12,762	93,294	422,704	43,590	251,003	1,120,531	15.9	81.2
Michigan	37,034	205,925	902,592	28	218	511	.....	.....	.....	37,006	205,707	902,081	13.3	82.9
All other states	34,393	233,791	996,775	2,685	12,378	50,669	312	1,777	7,775	31,396	219,636	938,331	13.6	79.7

The average price paid per ton of 2,000 pounds of beets was as follows:

The United States		$4.39
California	$4.47	
Michigan	4.38	
All other states and territories	4.26	

In California 4 factories purchased beets at a fixed price, and 4 paid a price depending upon the results of the analysis. In Michigan 9 factories purchased on a basis of the analysis, paying $4 per ton for beets containing 12 per cent of sugar, with 3⅓ cents increase for each one-tenth per cent above 12, and a corresponding decrease for each one-tenth per cent below 12, as provided by the state bounty law, recently declared unconstitutional.

Of the factories in other parts of the United States, 8 purchased on a basis of the analysis of the beets, and 6 paid a fixed price. The New York factories paid $5 per ton for beets, irrespective of their sugar contents, in accordance with the state bounty law.

TABLE 8.—QUANTITIES OF MATERIALS USED: 1900.

STATES AND TERRITORIES.	Sugar beets.	Limestone.	Coke.	Sulphur.	Barrels.	Sacks.	FUEL.		
							Coal.	Oil.	Wood.
	[1] *Tons.*	[1] *Tons.*	[1] *Tons.*	[1] *Tons.*			*Tons.*	*Gallons.*	*Cords.*
United States	794,658	64,805	7,519	149	90,985	1,342,649	109,235	7,017,079	3,459
California	354,942	32,403	3,274	51	1,301	891,924	8,558	7,004,415	.....
Michigan	205,925	15,403	2,079	40	79,468	76,796	47,979	.....	.....
All other states	233,791	16,999	2,166	58	10,216	373,929	52,698	12,664	3,459

[1] Tons of 2,000 pounds each.

It is customary in compiling sugar statistics to report the miscellaneous materials used in percentage terms of the weight of beets worked, or the cost of such materials is reduced to a basis of one ton of raw material. The general totals furnished in reply to the census inquiries can not be used for the purpose of making such calculations.

It is apparent, however, from a study of the schedules, that the fuel consumption was large. Owing to the use of other fuels than coal in a number of factories, the consumption of coal per 100 pounds of beets can be figured only for Michigan factories, where it was 23 pounds. This proportion is nearly one and one-half times as great as in good European practice. In considering these figures, however, it should be noted that 8 of the 9 factories in Michigan were operated for the first time during the season of 1899–1900 and that there was doubtless a large coal consumption in testing plants, and during delays incident to adjusting new machinery. It should be stated further that the grade of coal used by these factories was inferior to that with which the European records have been made. The average cost of coal at the factories in Michigan was $1.90 per ton, or an average expense of 44 cents per ton of beets worked. Several of the Michigan factories used less than 16 pounds of coal per 100 pounds of beets.

The nominal horsepower of the boilers in American beet sugar factories is approximately 58,000.

TABLE 9.—QUANTITIES AND VALUES OF PRODUCTS: 1900.

STATES AND TERRITORIES.	TOTAL VALUE OF ALL PRODUCTS.	SUGARS.						MOLASSES.		BEET PULP.	JUICE.	LIME.	FERTILIZERS.
		Total.		Granulated.		Raw.							
		Pounds.	*Value.*	*Pounds.*	*Value.*	*Pounds.*	*Value.*	*Gallons.*	*Value.*	*Value.*	*Value.*	*Value.*	*Value.*
United States	$7,323,857	163,458,075	$7,222,581	115,686,356	$5,580,527	47,771,719	$1,642,054	[1]3,551,856	$25,102	$21,822	$51,000	$642	$2,710
California	3,499,996	86.741,713	3,490,318	43,839,911	2,049,726	42,901,802	1,440,592	1,708,501	.....	6,968	.....	.....	2,710
Michigan	1,602,266	33,708,283	1,600,284	32,737,098	1,561,100	971,185	39,184	821,100	1,225	241	.....	516	.....
All other states	2,221,595	43,008,079	2,131,979	39,109,347	1,969,701	3,898,732	162,278	1,522,255	23,877	14,613	51,000	126	.....

[1] Includes quantities for which no value could be given, also wastage.

Deducting the raw sugar reported to be melted in the crop of 1900 (3,462,700 pounds) from the total amount of raw sugar manufactured (47,771,719 pounds), there remain 44,309,019 pounds, which may be properly credited as this year's output of raw sugar, and the total output of granulated and raw sugar is therefore 159,995,375 pounds, or 71,427 tons of 2,240 pounds. White granulated sugar formed 72.3 per cent of the total quantity of sugar manufactured, and raw sugar for refining, 27.7 per cent.

A quantity of raw sugar or low grade massecuite is carried forward each year by most of the factories, which renders it impracticable to ascertain the exact quantity of sugar manufactured from the beets grown in any one year. Assuming that the factories operated in 1898 carried forward to the next crop relatively the same quantity of sugar as in 1899, and deducting this amount and crediting the sugar carried forward in 1899 to the crop of that year, we obtain a total of 161,474,100 pounds, or 203 pounds of sugar per ton of beets, or 10 pounds of sugar per 100 pounds of beets, as the yield from beets grown in the census year. In view of the high average percentage of sugar in the beets, as shown in Table 7, page 4, this yield is disappointing. It is probably in a measure due to the deterioration of beets at new factories not fully prepared for work when the roots were harvested. Such deterioration was reported at several factories.

Molasses.—The statistics of the quantity and value of the molasses product shown in Table 9 are misleading, since large quantities were reported for which no value could be assigned, and large quantities ran to waste. The value reported, $25,102, represents only the portion sold, or for which there was an assured market.

Beet Juice.—The beet juice reported was the product of an auxiliary plant and was pumped to the central factory.

Beet Pulp, Lime, and Fertilizers.—Beet pulp is a very valuable by-product in European beet sugar manufacture, and finds a ready market. At most of the American factories the demand for pulp is small, this by-product being frequently given to the farmers in consideration of its removal. The value of the pulp sold was $21,822. No figures could be obtained showing the quantity of pulp produced. Based on the usual yield of pressed pulp, the total product amounted to approximately 400,000 tons.

Small quantities of lime and lime-cake or filter press-cake were sold, the latter for use as a fertilizer. The value of the lime sold was $642, and of the lime-cake or fertilizer, $2,710.

For purposes of comparison the beet sugar production of Europe and the United States is given in Table 10.

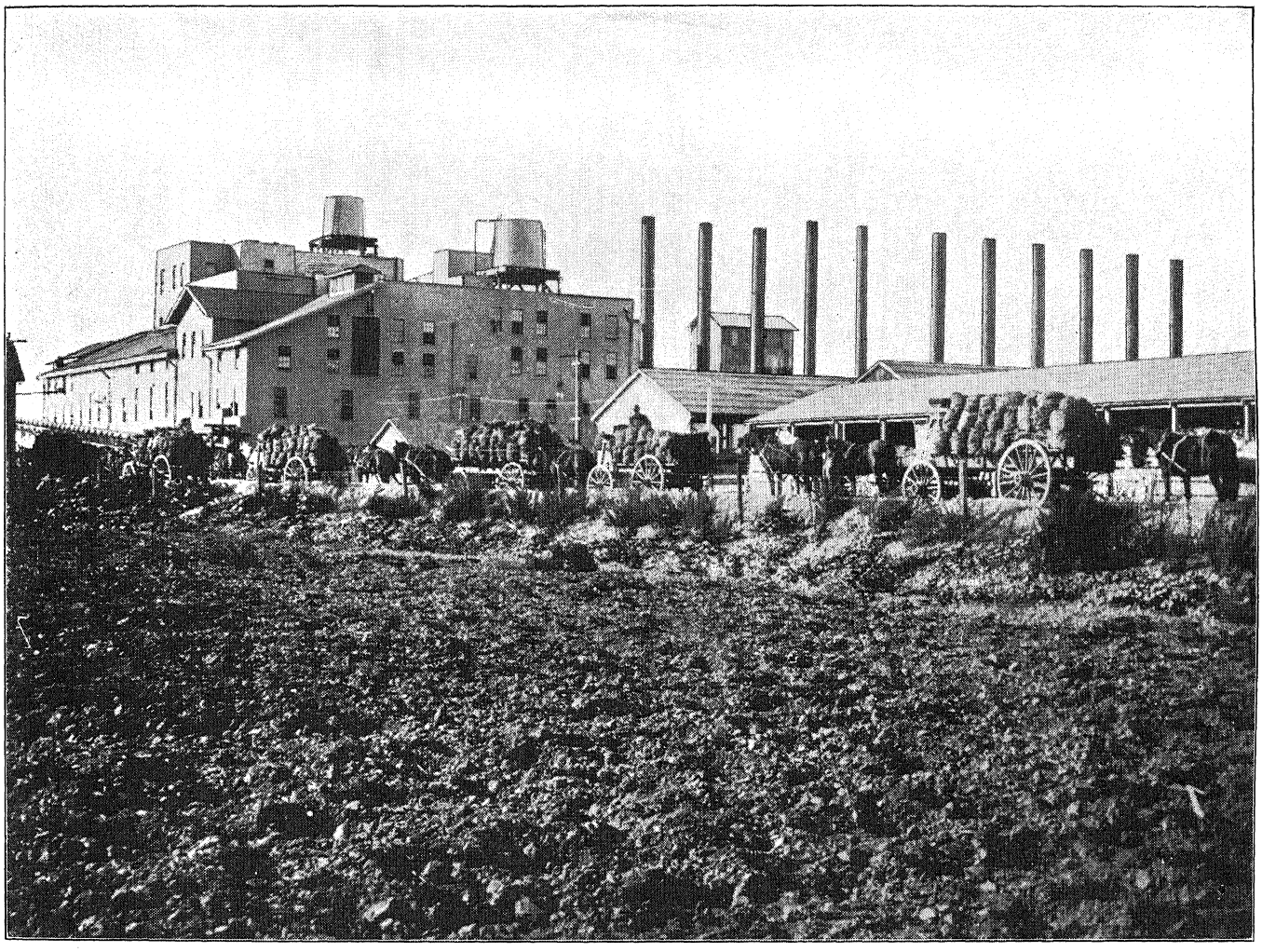


FIG. 1.—ALVARADO FACTORY, ALVARADO, CAL.—1900.

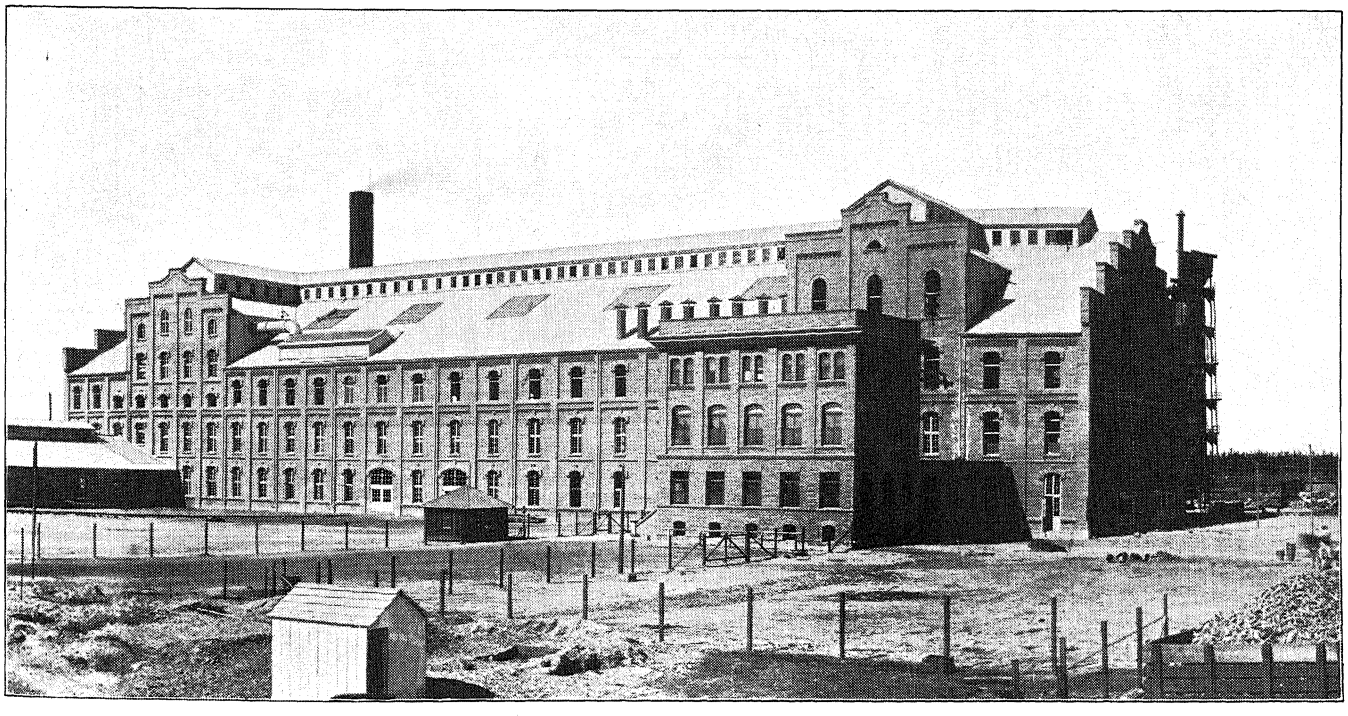


FIG. 2.—AMERICAN BEET SUGAR COMPANY'S FACTORY, OXNARD, CAL.

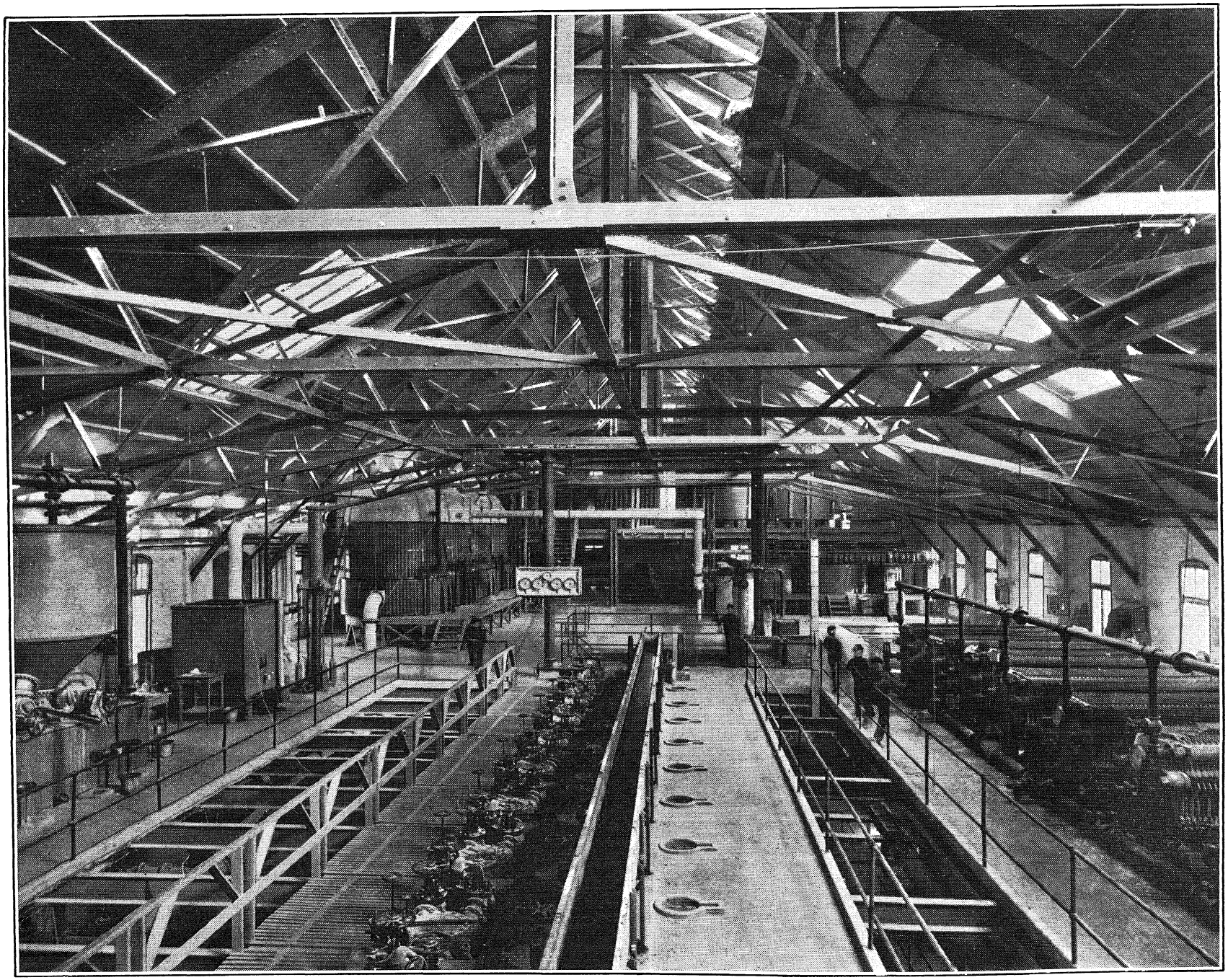


FIG. 3.—INTERIOR VIEW, STANDARD BEET SUGAR COMPANY'S FACTORY, LEAVITT, NEBR.

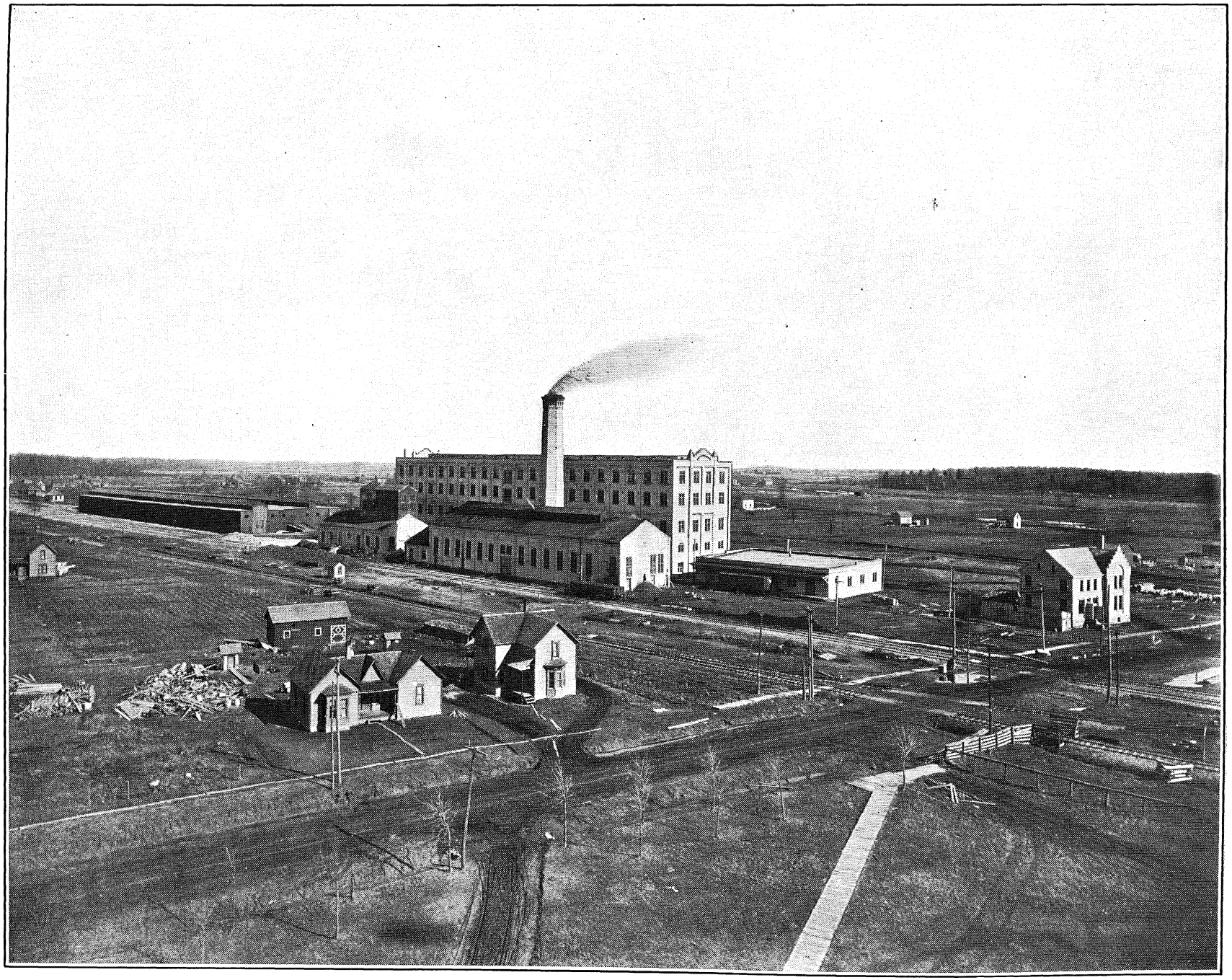


FIG. 4.—ALMA SUGAR COMPANY'S FACTORY, ALMA, MICH.

TABLE 10.—BEET SUGAR MANUFACTURED ON THE CONTINENT OF EUROPE AND IN THE UNITED STATES FOR THE YEARS 1897–98 TO 1899–1900.

[From Licht's Monthly Circular.]

	1899–1900. Tons of 2,240 pounds.	1898–99. Tons of 2,240 pounds.	1897–98. Tons of 2,240 pounds.
Germany	1,798,631	1,721,718	1,852,857
Austria	1,108,007	1,051,290	831,667
France	977,850	830,132	821,235
Russia	910,000	776,066	738,715
Belgium	304,000	244,017	265,397
Holland	171,029	149,763	125,658
Other countries	253,929	209,115	196,245
Total for Europe	5,523,446	4,982,101	4,831,774
United States	[1]71,427	[2]82,471	[2]40,399

[1] In tons of 2,240 pounds, deducting raw sugar carried over to 1900.
[2] Willett & Gray's Weekly Statistical Sugar Trade Journal, in tons of 2,240 pounds.

Historical.[1]—Until 1879 the history of the American beet sugar industry is a record of a series of failures.

The first experiments were made in 1830. There is no record of the quantity of sugar manufactured.

The history of the next experiments is also brief. David Lee Child in 1838–39 conducted small works at Northampton, Mass., and made 1,300 pounds of sugar, then discontinued the manufacture.

There is no record of further attempts until 1863, and from that time until 1876 a number of failures occurred in California, Illinois, and Wisconsin.

The first factory in California was erected in 1870, at Alvarado, the site of the first successful factory in the United States.

These works were operated until 1873, when it was proposed to remove them to another location. A new company was organized, which purchased the Alvarado machinery and removed it to Soquel, Santa Cruz county. E. H. Dyer, a stockholder of the Alvarado company, purchased the buildings, and in the face of many difficulties organized a company and installed new machinery. After a short time this company was reincorporated with larger capital, and operated the works until 1889 with varying success. The operations were hampered by imperfect and antiquated machinery, and these conditions, combined with lower prices of sugar, compelled another reorganization. In 1899 the property passed into the hands of the Alameda Sugar Company under the management of E. C. Burr, an experienced sugar refiner, who has rebuilt the factory and continued the manufacture with marked success.

The factory at Soquel, Cal., was in operation in 1879 and reported in the Tenth Census. It was operated at a loss for several years, and was abandoned about 1880.

The history of the manufacture at Alvarado is of great interest, since the success of these works, and the practical demonstration of the fact that suitable beets could be grown, led to the establishment of other factories, and were undoubtedly important factors in the development of the beet-sugar industry.

In 1879, 4 factories were in operation, 2 in California, 1 in Maine, and 1 in Delaware. The statistics of these factories, as published in the Tenth Census, are shown in Table 11.

TABLE 11.—STATISTICS OF BEET-SUGAR FACTORIES IN 1879, BY STATES, CENSUS OF 1880.[1]

STATES.	Number of establishments.	Capital.	WAGE-EARNERS.		Cost of materials used.	Value of products.
			Average number.[2]	Total wages.		
United States	4	$365,000	350	$62,271	$186,128	$282,572
California	2	215,000	150	39,131	104,724	162,988
Delaware	1	100,000	50	3,140	6,404	8,584
Maine	1	50,000	150	20,000	75,000	111,000

[1] Data from Tenth Census, Manufactures, pp. 94, 101, and 127.
[2] Men, 16 years and over.

Of these factories, 3 apparently yielded a small profit to their owners, but the history of the industry shows that, except 1 factory in California, at Alvarado, all were failures. The Alvarado factory, in fact, would possibly have followed the fate of the others, on account of its small capacity and antiquated machinery, had not additional capital been obtained. As already stated, the Alvarado Company was reorganized in 1889 upon a good financial basis and is still a prosperous establishment.

The favorable results obtained in the factory at Alvarado and the building of a factory at Watsonville, Cal., by Claus Spreckels, gave a new impetus to the sugar industry. Since then 35 factories have been built, or are building, in 11 states and 1 territory.

The Oxnard Brothers have been active in the development of the beet-sugar industry, and through their influence several large factories have been constructed.

In 1885 the factory at Alvarado was equipped with machinery of sufficient capacity to work approximately 125 tons of beets per day. The present Alvarado factory, owned by the Alameda Sugar Company, and equipped with modern American machinery, is shown in figure 1.

Beet sugar was not reported separately in the census of 1890, as only 2 factories were in operation. These factories were both located in California, and are still operated upon a largely increased scale. One of these factories a few years ago manufactured nearly 20,000 tons of sugar in a single season.

The quantity of beet sugar manufactured in 1889 was not separately tabulated in the report of the Eleventh Census. The quantity reported by the factories to the California state board of agriculture was 2,457 tons of

[1] Compiled largely from reports of William McMurtrie [In U. S. Dept. of Agriculture, Special Report No. 28 (1880), Appendix B] and H. W. Wiley [In U. S. Dept. of Agriculture, Division of Chemistry, Bulletin No. 27 (1890)].

[2] From U. S. Dept. of Agriculture, Division of Chemistry, Bulletin No. 5 (1885).

2,000 pounds, a large part of which was raw sugar. The total value of the product probably did not exceed $275,000. The average price paid for sugar beets was approximately $5 per ton. The total output of beet sugar in 1889 was less than 2 per cent of the total cane and beet sugar of domestic manufacture.

In 1897 the number of factories had increased to 9, with a total of 45,246 short tons[1] of sugar manufactured, or approximately 12 per cent of the total cane and beet sugar of domestic manufacture.

In 1899, as shown by the census statistics in this report, the number of factories operated was 30, with an output of 79,998 short tons of sugar, excluding 1,731 short tons of raw sugar melted in 1900, equivalent to the quantity melted in 1899 from the product of 1898. The total quantity of cane and beet sugar of domestic manufacture, as reported in Willett & Gray's Circular in 1899, was 229,537 short tons, showing that the production of beet sugar was then approximately 35 per cent of the total sugar produced in the country from sugar cane and beets.

The cane crop of 1899 was fully 100,000 tons below the average, but the beet crop was not over 50 per cent of what would reasonably be expected from the acreage seeded, hence the comparison is a just one.

The American beet-sugar factories now have a nominal daily capacity of 22,310 short tons of beets, and, when fully supplied with the raw material, should easily manufacture 240,000 short tons of sugar per annum.

From this brief historical sketch it is apparent that the period for which the statistics were gathered by the Census Office was one of the greatest activity in our beet-sugar industry. This fact has largely influenced the writer in devoting to the details of advancement more space than a strictly statistical report would require.

It should be stated that this period of great activity began in 1896, since which time 35 factories have been built, including 6 new ones for the crop of 1900. Of these 35 factories, 2 have failed. One, located at Menominee Falls, Wis., was not completed in time for the crop, and tests of machinery showed it to be practically a failure. This factory has never been operated and is not included in the statistics in this report. The second failure was that of the factory at Rome, N. Y. This factory was operated during three seasons, but was of small capacity and capital, and was not prepared to meet the sharp competition of other factories in the purchase of beets.

Federal and State Aid.—The bounty paid under the provisions of the tariff act of 1890 proved a powerful stimulus to investments in beet-sugar manufacture. Under this act domestic producers were paid a direct bounty for each pound of beet sugar manufactured. Since the repeal of this act, a protective tariff has favored the domestic manufacture of beet sugar.

Congress has for several years made appropriations to enable the Department of Agriculture to conduct investigations relative to the industry, and has also made provision for admitting beet-sugar machinery of foreign manufacture free of duty.

The Secretary of Agriculture has vigorously prosecuted the investigations intrusted to his Department. Printed information and beet seeds have been liberally distributed among farmers, and prospective investors have been accorded by the Department every facility to aid them in deciding upon locations for factories. The present Secretary, Hon. James Wilson, has been especially active in his efforts in behalf of the industry, and has done much toward the definition of those areas best suited to beet culture.

Several states have extended aid in the form of direct bounties, and have expended large sums for this purpose. The experience of the past few years as regards bounties has not always, however, been such as to encourage investments. Several state legislatures have repealed the bounty laws passed by their predecessors, and have even refused the payment of bounty already earned. The supreme court of Michigan has declared the bounty act of that state unconstitutional.

Local aid has been extended in a number of instances in the form of factory sites and exemption from taxation for a term of years.

Progress in Machinery and Methods.—The greatest advances in the past decade, in machinery, have been in the line of improvements rather than of new inventions.

There has been a marked improvement in labor-saving machinery, but perhaps the most notable advances have been in the convenient distribution of machinery and in the use of special devices in the transportation and handling of the raw materials, products, and by-products.

The climatic and labor conditions which obtain in localities in the United States suitable for the cultivation of the sugar beet and for the manufacture of beet sugar, have resulted in the development of mechanical devices which are used but little abroad. A person familiar with European machinery and factory construction, on inspecting the better class of establishments embodying American ideas and American construction, will at once notice the simplicity of arrangement and the graceful yet substantial design of the machinery.

Since the beet-sugar industry originated in Europe, and has there attained its greatest development, it is natural that we should have derived our processes of manufacture and the designs of much of our machinery from European sources.

Our builders have, in many instances, improved upon the foreign construction and have produced machinery

[1] U. S. Dept. of Agriculture. Special Report on the Beet Sugar Industry in the United States. (1898.) p. 160.

better adapted to American labor and climatic conditions.

Owing to the close study of foreign methods by our American builders and manufacturers, and to the considerable number of factory employees of foreign birth, it is impracticable in this review to confine these remarks to progress in machinery designed and built by Americans; frequently the suggestions leading to improvements have come directly or indirectly from abroad. Only those processes in use in this country will be mentioned.

Transportation, Unloading, and Storage of Beets.—The broad, level valleys of California permit the transportation of large loads of sugar beets in farm wagons. Loads exceeding 10 tons of beets have frequently been drawn to the factories in farm wagons of special construction. Inquiry in California indicates that the average load is from 7 to 8 tons of beets. The average in the beet districts of other states is probably less than 2, and doubtless in frequent cases does not exceed 1 ton per load. The economy of labor in the transportation of beets in California is evident from these figures.

The labor employed in hauling a load of 8 tons is no greater than for a load of 1 ton, and, by the use of mechanical devices for unloading, the actual cost for labor of delivering 8 tons of beets upon the cars or in the bins is little greater than for the delivery of a single ton. It should be noted, however, that the conditions in California are quite different from those of other beet sugar producing states.

The dry weather that usually prevails there during the greater part of the manufacturing season contributes to the delivery of roots with but little adhering soil. This condition is favorable to the use of mechanical dumping devices that can not be used to advantage in many other sections of the country.

A dumping device much used in California is usually termed the "net method." A net is stretched over the bed of the wagon and the beets are loaded upon it. The load is drawn alongside the car or bin, to which one edge of the net is then attached; the entire load is now discharged at one time by drawing on the opposite edge of the net by means of horses or a motor. In some instances the net and contents are lifted bodily by a traveling crane and the load deposited where desired in the bin.

A patented apparatus in use at a western factory consists essentially of a counterpoised tilting table, upon which the loaded wagon of beets is clamped, and by a simple manipulation its contents are dumped into the bin.

A tilting table is used at certain factories in discharging beets from railway cars. One of these factories has a capacity for dumping three cars, and another for dumping five cars at a time. The tables are tilted by hydraulic power and the beets fall directly into the sluices and are flushed into the factory.

The California factories have a very large receiving capacity. One of them can receive 1,000 tons of beets per day, by wagon alone, if necessary. Outside of California, mechanical devices for unloading beets are little used.

Many years ago certain French factories began the use of pipe lines in the transfer of beet juice from auxiliary or rasping stations to the central factory. This method is still used in Europe at several factories, but is not widely employed.

The exceptionally favorable conditions for beet production in Utah have led the Utah Sugar Company to increase its manufacture by means of outlying stations, according to the French system, devised by Linard. The Utah Sugar Company operated one auxiliary plant last year, and is equipping a second for the present season's work. These auxiliary plants have a combined capacity of from 700 to 800 tons of beets per day. A third auxiliary plant is now being built by this company for the crop of 1901–1902. The juice receives a part of its requirement of lime, and is then pumped approximately 20 miles through 5-inch pipe lines to the central factory. European experience has amply demonstrated that with proper precautions no loss of sugar need be feared in the use of pipe lines.

The construction of beet bins and sluices has been materially improved. The earlier bins were more or less experimental and of somewhat temporary construction. The modern factories now have substantial, well ventilated bins. In some instances the sluices are built of steel, which provides a very strong and convenient construction. In general, however, cement concrete is employed.

In those states where intense cold weather prevails during the greater part of the manufacturing season, the beet bins are constructed rather with a view to protecting the roots from thawing than for protection from frost. The experience of the American factories appears to have demonstrated that little loss of sugar is to be feared from the beets being frozen, but that, once frozen, every effort must be made to prevent thawing prior to manufacturing operations. In general, the bins are built of wood and wholly above ground. In cold climates, the bins in which beets are to be stored but a few days are often left open at the sides, and in some instances are not even roofed.

The American methods of constructing beet bins are much simpler than those employed in Europe, where these necessary adjuncts frequently involve a large outlay of capital. It is undoubtedly true that our abundant supplies of lumber at moderate cost have had their influence on the design and construction of the bins.

Factory buildings.—The advance in the methods of constructing factory buildings is especially noticeable. In modern American factories heavy brick walls, with roof and floors of wood, are no longer seen. Light walls, steel posts and beams, and concrete floors are the

rule. The machinery is entirely supported upon beams carried by posts, the walls serving only for protection from the weather. The absence of the heavy partition walls so common in European factories is noticeable.

In laying the floors, expanded metal, such as is frequently used instead of wooden lathing, is laid from beam to beam upon a temporary staging of lumber. The concrete, to a thickness of approximately 3 inches, is applied directly upon the metal. A floor of this class is not only fireproof, but is of great advantage in the event of leakage, or tanks overflowing.

The modern sugar-factory building is fireproof, and as there is no inflammable material stored in it, the formerly heavy item of fire insurance is practically eliminated.

A very hopeful sign for the future of the American beet-sugar industry is found in the evident belief on the part of the projectors of many of the factories that the industry has long since passed the experimental stage. This is evidenced by the large, substantial buildings and the arrangement of machinery so as to admit of readily enlarging the plant. With few exceptions, the factories built within the past ten years have been designed with a view to doubling their capacity, 350 or 500 tons of beets having been considered an economical starting point. In figure 2 a factory is shown which was originally designed for a capacity of 1,000 tons, with space for doubling. It has since been enlarged to 2,000 tons capacity. In the interior view, figure 3, the spaces provided for additional machinery may be noted in a similar, but smaller, factory by the same builders. Two of the old factories have been repeatedly enlarged, 2 factories have doubled, and 1 has nearly quadrupled its capacity. The beet-sugar building of to-day is lofty, and is prepared for almost any emergency that may arise in the development of new processes and new machinery.

Experience has demonstrated that the greatest problems in the American beet-sugar industry are to be found in the field rather than in the factory. It should not be assumed from this statement that suitable beets are difficult to grow in satisfactory quantities; the problem is to convince the farmer that with persistent effort and experience he will find sugar beets a surer and more profitable crop than many others.

Of the factories built in this country within the past few years, the most successful, mechanically considered, have been designed and built by Americans or by sugar engineers of foreign birth who have been long identified with the sugar industry in the United States.

In some instances, the experience of our manufacturers with foreign-built machinery has not been satisfactory. The American engineer has great aptitude in designing and placing machinery with a view to economy and to quality of product, and the American manufacturer demands that his factory shall include such conditions. He can unquestionably obtain these conditions at home and avoid the expensive experiences of certain factories.

This is not intended to be a sweeping condemnation of foreign-built factories, since we know there are builders in Europe as competent as any in the world. The writer's wish is simply to emphasize the fact that satisfactory machinery can be obtained in this country. The time has long since passed when it was necessary to go to Europe for sugar engineers or to find shops capable of designing or building beet-sugar machinery. There is not a single item of sugar machinery that our shops can not build, of as effective design as the most approved from foreign sources.

The advance in the beet-sugar industry in the past ten years has been so great that we now have several large shops prepared to execute orders for complete plants. The illustrations, figures 2 and 4, of American-built and equipped factories, are indicative of the great progress made in the beet-sugar industry.

Automatic scales of German manufacture are employed in many factories in weighing the beets. The scales provide a valuable check on the weight of raw material entering the factory. Automatic scales of American manufacture are also being introduced, to some extent, in weighing the finished product.

There has been but little improvement during the past decade in the design of the diffusion battery. Some advance may be noted in the construction of details, such as latches, etc., and heating by means of steam injectors appears to be growing in favor. The long desired invention of a satisfactory continuous process of diffusion seems to be as far from attainment as ever.

For the removal of the pulp various devices are used. The usual method is to discharge the by-product from the elevators into dump cars, to be carried to the silos or storage pile. Some factories, finding no market for the pulp during the past season, flushed it from the building with water, in one instance a distance of several miles, to the ocean. Aerial transportation of the pulp in cars suspended from a cable is practiced at several factories.

The systematic storage and care of pulp, so noticeable in Europe, is almost entirely lacking in this country. So far as the writer could learn, the return of a certain quantity of pulp to the beet grower is stipulated in the contracts of only one company. This is a very popular form of contract abroad, and in many districts it is doubtful whether beets could be obtained without it.

Hon. James Wilson, Secretary of Agriculture, who has been consistently encouraging the beet-sugar industry through his field agents and the publications of the Department, has wisely taken the ground that the most profitable expansion of the industry demands the utilization of the pulp in cattle feeding. He looks for the greatest advance to be made in those sections

where the farmer can be made to appreciate the feeding value of this by-product.

In Europe kilns have been constructed and used to some extent for desiccating pulp. Kilns of American design are being constructed at several factories. These kilns will make it possible to ship dry pulp, over long distances if necessary, to points where it will find a market. The dried material contains about 10 per cent of water, and may be used as an absorbent for molasses or other liquid food. It is claimed that a ready market awaits this product both at home and abroad.

The carbonatation apparatus has been improved. A few factories employ modern tanks 18 to 20 feet in depth. The use of cottonseed oil, which is displacing tallow in several factories for keeping down the foam in the carbonatation process, results in a considerable economy. Only one factory is equipped with the process of continuous carbonatation. Where all the factory conditions conduce to regularity of work, this process would probably prove a saving of labor.

Filtration plays an important part in the modern sugar factory. The juice and liquors are repeatedly filtered at the various stages of the manufacture. This demand for filtration led first to the invention of filter pockets, of which the formerly well-known Puvrez filter and filter pockets were forerunners, and from which the present mechanical filters were developed. The improvement in mechanical filtration has been limited to details of joints and fastenings.

Sand filters are being erected in one factory. A filter of the Denek type, but provided with a metal filtering surface, has been successfully employed as a depulper by the builder of two of the new factories. Two small filters of this type are sufficient for the removal of the fine pulp from the diffusion juice of 500 tons of beets a day.

A few years ago there was a tendency to increase the size of the filter presses, and a number of the so-called "monster" presses were built. These presses have apparently not proved as desirable in practice as was anticipated, and now few presses are built having a filtering area even as large as 1,000 square feet.

The improvement in the methods of removing the filter-press or lime-cake from the factory has been marked. This has been a very troublesome by-product with which to deal, especially in cold climates. The old method of discharging the lime-cake into cars is disappearing.

In a number of sugar houses, located where the climate is mild, the lime-cake is discharged into a conveyor or drag, and is mechanically removed from the building. Many factories in Nebraska and the states farther east discharge the lime-cake into a mixer, where it is beaten to a batter with waste water which is constantly flowing into the mixer. The thin batter overflows into a trough and is led to a settling pond. In a more recent construction the lime-cake batter is forced by a centrifugal pump through a 4-inch pipe, and deposited in the pond.

The settling pond is arranged to give the water a long travel with a slow current. By the time the water has reached the outlet it is reasonably clear. It is claimed that this water may be run into the rivers without perceptibly polluting them. One of the factories uses this method for the disposal of all its waste, including that from the Steffen saccharate process. In a few months after the close of the manufacturing season, the lime deposit dries, and may be removed from the bed of the pond with road scrapers.

With few exceptions the American factories manufacture only white granulated sugar of a very excellent quality. This sugar is manufactured without the use of boneblack, the bleaching of the juice being accomplished by sulphurous acid.

There has been no marked improvement in the apparatus for sulphuring the juice; the French and German types of sulphur stoves are used. In many factories the juice is treated with sulphurous acid in tanks somewhat similar to those employed in the carbonatation. In other factories a very rational continuous apparatus, built of wood, is used. This apparatus, when once regulated, is easily controlled without detailing a laborer specially for the purpose.

The Welner-Jelinck type and the ordinary vertical tube or "standard" multiple-effects are used for evaporating the juice by all but one of the factories. This latter factory uses an automatic multiple-effect, a recent American invention of the "film" type, but in which a copious circulation of the solution over the heating surfaces is maintained by mechanical means. This apparatus is widely used in the manufacture of cane sugar and in sugar refineries, but has not yet had an extended trial in the beet-sugar industry.

Apparatus of the Welner-Jelinck type, with horizontal tubes of small diameter, is used by the majority of the factories. One factory is equipped with a quintuple-effect evaporator, and all the others have quadruple-effects.

The vacuum-pans employed are of the usual form, and show no material progress, either in shape or distribution of the heating surface, over those employed ten years ago.

The brasmoscope, a foreign invention, is used to some extent in controlling the boiling of the low products. This is an instrument which is attached to the vacuum-pan, and enables a rapid estimate of the density of the massecuite to be made from temperature and pressure indications. By the use of this apparatus massecuites may be concentrated to a practically uniform density.

Probably the most important advance made in beet-sugar methods in the past few years, as illustrated in American factories, is the process of "crystallization in

movement." This process was invented in Germany. It consists in agitating the massecuite during the crystallization, and is usually applied in this country to the low products only. The apparatus consists of a large wrought-iron cylinder, fitted with a water jacket and agitators similar to those of a massecuite mixer. The average capacity of the apparatus is appproximately 35 tons of massecuite. As the name of the process implies, the massecuite is agitated and the crystals are kept in motion during the crystallization, thus constantly bringing their surfaces into contact with fresh portions of the sugar solution, and promoting a rapid increase in size. The massecuite is systematically cooled during the progress of the crystallization, thus forcing the sugar out of solution. A small centrifugal is employed in many factories to determine the most economical point at which to discontinue the operation.

This process has facilitated the management of the low products and reduced the time required for the crystallization to four or five days, instead of the several weeks formerly required. The crystallization movement has proven an economy of labor. It also permits systematic control of the crystallization of the sugar.

Vacuum crystallizers are being installed in a factory now building.

The most approved centrifugals for drying sugar are of American invention. American types of centrifugals are used wherever sugar is manufactured.

The only recent improvement in these machines worthy of special note is the water-driven centrifugal. A water motor is coupled directly to the spindle of the machine, and does away with belting and shafting. This device not only promotes the safety of the workmen, but renders each machine entirely independent of the others, and obviates the delays incident to belts and pulleys. A factory now building will be supplied with water-driven centrifugals.

Molasses Processes.—But two molasses processes are now in use in American factories, namely, the Steffen separation process and the osmose process. The former is a saccharate process, employing quicklime in an impalpable powder as a precipitant of the sugar; the latter, as its name implies, depends upon dialysis. Both processes are of foreign origin and have been in use many years.

A factory built for the crop of 1900 by E. H. Dyer & Co., at Fremont, Ohio, is equipped with a lead saccharate process, a German invention. In this process the molasses is mixed with caustic potash and lead carbonate. The nascent oxide of lead formed combines with the sugar, forming a saccharate of lead, which is collected and washed in a filter-press, then suspended in water and decomposed with carbonic acid; pure sugar is thus liberated, and the carbonate of lead precipitated is used in the treatment of a subsequent lot of molasses. The mother liquor which flows from the filter-presses is treated for the recovery of potash, soda, and other by-products.

Should this process prove satisfactory in the practical test of manufacture, it will enable the factory to utilize every by-product of the beet in the manufacture of readily salable material.

The development of molasses processes is well shown in Table 12, which presents the statistics of the German sugar industry, compiled by Ernst Glanz. Data prior to 1886 are omitted.

TABLE 12.—QUANTITIES OF MOLASSES TREATED IN GERMANY BY VARIOUS PROCESSES FOR THE EXTRACTION OF THE SUGAR.

CROP.	Osmose process.	Elution process.	Steffen's separation process.	Strontium process.	All other processes.	Total quantity of molasses treated.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
1886–87	7,315	93,589	35,537	104,104	14,400	254,945
1887–88	92,460	97,115	43,878	117,549	15,033	366,035
1888–89	51,598	73,839	34,762	121,356	11,022	292,577
1889–90	46,579	70,345	40,273	118,489	6,905	282,591
1890–91	73,209	79,735	50,980	121,530	10,048	335,502
1891–92	57,496	60,332	50,725	124,420	5,132	298,105
1892–93	25,614	44,897	49,336	127,130	4,628	251,605
1893–94	19,462	22,842	28,938	157,628	2,806	231,676
1894–95	15,883	28,111	34,293	184,431	.....	262,718
1895–96	24,601	24,019	31,425	214,632	.....	294,677
1896–97	10,966	21,135	32,403	255,830	2,041	322,375
1897–98	7,297	10,240	27,230	260,225	1,815	306,807
1898–99	4,342	3,598	20,616	249,307	2,265	280,128

An examination of these German statistics[1] indicates that the strontium process leads all others, both in the amount of sugar recovered and in the rate of increase in its application. In 1890 approximately 36 per cent of the sugar recovered by all molasses processes was obtained by the use of strontia. The per cent of increase has been rapid, and in 1899 nearly 90 per cent of the sugar recovered was obtained by this process.

The osmose and elution processes have rapidly decreased in the extent of their application, until at the present time they are little used, as is indicated by the statistical table.

The yield of sugar by the separation process (Steffen) reached its maximum in 1890. The output of sugar by this process decreased 35 per cent from 1890 to 1892, and has reached the production of 1892 but once since. The sugar yielded by this process is more than double the quantity by all other processes except the strontium. There is little probability of the extensive application of the strontium process in the United States, unless large deposits of suitable strontium-bearing minerals be discovered.

It is noticeable in these German statistics that the quantity of molasses treated by the various saccharate and other processes has varied within narrow limits during the past fifteen years. The quantity consumed in alcohol manufacture has varied more; but in fifteen years it has not exceeded 105,000 tons yearly, and in 1898 was only 51,666 tons, a figure approaching the average of several years.

The quantity exported has ranged as high as 111,000

[1] "Zeitschrift des Vereins für die Rübenzucker-Industrie des Deutschen Reichs." Supplement to the number for March, 1900. Translated and weights converted into tons of 2,000 pounds.

tons, while in 1898 it was only 7,234 tons. The quantity of molasses not accounted for in molasses processes, distillation, and export in 1898 reached the enormous quantity of 138,816 tons. The disposal of this molasses, with profit to the manufacturer, is a great problem. Some of it is fed to cattle, but the amount so used is only a small part of the surplus of this by-product. These are interesting figures, in view of the large production of molasses in our factories and the enormous losses incurred through the necessity of running much of the molasses product into the rivers. These figures are of value also in exhibiting the relative extent of the application of the various molasses processes.

Marked improvements have been made in laboratory methods and polariscopic instruments. The most progressive factories are using direct methods of analysis of the beets in control work and in fixing the purchase price of the beets. A few factories still adhere to the indirect method of analysis of beets, i. e., analysis of the juice, and conversion to terms of the weight of the beet by the use of an arbitrary factor. It is a fact well known to analysts that the proportion of juice in the beets is a very variable quantity, and that the use of an arbitrary factor introduces errors into the estimate of the sugar content. For this reason certain establishments have been in the habit of varying the factor from time to time, as in their judgment, based on tests, the beets varied in juice content. This has led to dissatisfaction on the part of the farmers. These factories, if they continue to purchase beets on test, will be compelled to keep pace with improvements in analytical methods, and purchase on the basis of the percentage of sugar in the beet as determined directly and without the arbitrary assumption of factors for conversion.

The direct methods of beet analysis have been so greatly simplified in the past few years that it is now possible to make a large number of tests with great accuracy and little labor. A notable improvement in polariscopes, conducive to accuracy and ease of manipulation, is in the addition of a pair of prisms which give a triple instead of a double field. This device enables a prompt and accurate adjustment to the neutral point to be made. Other improvements, aside from accuracy of adjustments of the various parts of the instrument, relate to the better protection of the optical parts from climatic influences, dust, and insects.

The improvements in mills and rasps for pulping the beet for analytical purposes have been numerous, as have also those in the other laboratory accessories. All the American factories have well-equipped laboratories and are more or less under chemical control.

Summary and Conclusion.—The statistics of the beet-sugar industry show that, after many years of manufacture on a small scale, it has assumed large proportions, and in the census year more than one-third of the domestic sugar product was obtained from the beet. This quantity of sugar, 70 per cent of which was suitable for immediate consumption, was produced in a year of extremely unfavorable agricultural conditions in the beet districts. The yield of beets per acre was less than half that of an average season. The factories could readily manufacture more than two and one-half times the quantity of sugar produced, if supplied with sufficient raw material.

The progress of the industry can not be measured by the returns of previous censuses, since beet sugar has been separately reported but once, by the census of 1880, and at that time the total capital invested in 4 establishments would not equip a modern factory of average capacity.

The schedules show that but 1 factory obtained sufficient beets, and that many were operated but a small fraction of their capacity. The average quantity of beets worked per factory was 26,489 short tons, and the average nominal capacity of the factories, based upon only 100 days' work, is more than 60,000 tons. The average length of the working season in the various states is not known, but for the United States it is probably nearer 140 days than 100 days. Notwithstanding the very adverse agricultural conditions which resulted in the small supply of raw material, the value of the products was larger than the expenditures. A number of factories earned a fair return on their investments, others paid expenses, and several lost heavily. The statistics demonstrate that beet-sugar manufacture is a commercial success in the United States.

RICE, CLEANING AND POLISHING.

RICE, CLEANING AND POLISHING.

By DANIEL C. ROPER, *Expert Special Agent.*

Reports have been received from 80 establishments engaged in rice, cleaning and polishing, in the United States, during the census year ending May 31, 1900. These establishments were located in 12 states, but it is impossible to publish separate totals for 6 of these states without disclosing the operations of individual establishments. The statistics of these 6 states are therefore grouped under the head of "all other states," and include establishments distributed as follows: California, 1; Mississippi, 2; New York, 2; Oregon, 1; Texas, 1; and Washington, 2. The statistics for Hawaii are not included in the general tables of this report, but are given separately in Table 5.

Table 1 is a comparative summary of the statistics of rice, cleaning and polishing, as returned at the censuses of 1880, 1890, and 1900.

Rice, cleaning and polishing, being of comparatively recent commercial development, was not reported at any census prior to 1880. Since that time the growth of this industry has been noteworthy, the number of establishments having increased from 22 in 1880 to 80 in 1900, a gain of 263.6 per cent; the capital from $562,200 in 1880 to $2,601,352 in 1900, a gain of 362.7 per cent; and the value of products from $3,133,324 in 1880 to $8,723,726 in 1900, a gain of 178.4 per cent.

TABLE 1.—COMPARATIVE SUMMARY OF RICE, CLEANING AND POLISHING, IN THE UNITED STATES, 1880 TO 1900, WITH PER CENT OF INCREASE FOR EACH DECADE.

	DATE OF CENSUS.			PER CENT OF INCREASE.	
	1900	1890	1880	1890 to 1900	1880 to 1890
Number of establishments	80	32	22	150.0	45.5
Capital	$2,601,352	$2,073,884	$562,200	25.4	268.9
Salaried employees	169	96	(1)	76.0	.....
Salaries	$182,033	$96,160	(1)	89.3	.....
Wage earners, average number	651	647	516	0.6	25.4
Total wages	$265,585	$223,433	$110,467	18.9	102.3
Men, 16 years and over	639	630	376	1.4	67.6
Wages	$262,042	$221,360	(1)	18.4	.....
Women, 16 years and over	(2)	9	94	.....	[3]90.4
Wages	(2)	$1,323	(1)	.....	.....
Children	12	8	46	50.0	[3]82.6
Wages	$3,543	$750	(1)	372.4	.....
Miscellaneous expenses	$230,203	$147,992	(4)	55.6	.....
Cost of materials used	$7,575,522	$5,601,206	$2,666,497	35.2	110.1
Value of products	$8,723,726	$6,693,196	$3,133,324	30.3	113.6

[1] Not separately reported. [2] None. [3] Decrease. [4] Not reported.

Table 2 presents, by states, the quantity and cost of rough rice milled, the quantity and value of products, the per cent of total rice milled by each state, and the average quantity of rice milled per establishment.

TABLE 2.—QUANTITY AND COST OF ROUGH RICE MILLED, QUANTITY AND VALUE OF PRODUCTS, PER CENT OF TOTAL RICE MILLED BY EACH STATE, AND AVERAGE QUANTITY OF RICE MILLED PER ESTABLISHMENT, BY STATES: 1900.

STATES.	Number of establishments.	ROUGH RICE MILLED.		PRODUCTS.			Per cent of total rice milled.	Average quantity of rice milled per establishment (pounds).
		Pounds.	Cost.	Total value.	Clean rice (pounds).	By-products[1] (pounds).		
United States	80	398,602,018	$7,184,208	$8,723,726	243,031,200	155,570,818	100.0	4,982,525
Alabama	4	193,500	3,435	4,816	116,660	76,840	(2)	48,375
Florida	4	575,640	8,850	13,995	350,466	225,174	0.1	143,910
Georgia	4	14,444,541	154,433	184,804	8,622,510	5,822,031	3.6	3,611,135
Louisiana	37	290,165,708	4,764,367	5,736,451	173,632,724	116,532,984	72.8	7,842,317
North Carolina	4	9,929,250	168,400	238,520	5,959,710	3,969,540	2.5	2,482,313
South Carolina	18	42,405,795	821,338	973,132	24,864,112	17,541,683	10.7	2,355,878
All other states[3]	9	40,887,584	1,262,885	1,572,008	29,485,018	11,402,566	10.3	4,543,065

[1] Includes hulls and waste.
[2] Less than one-tenth of 1 per cent.
[3] Includes establishments distributed as follows: California, 1; Mississippi, 2; New York, 2; Oregon, 1; Texas, 1; and Washington, 2.

The 80 establishments engaged in rice, cleaning and polishing in the United States during the census year, cleaned 398,602,018 pounds of rough rice, valued at $7,184,208. From this were obtained 243,031,200 pounds of clean rice, and 155,570,818 pounds of by-products. The total value of all products was $8,723,726. Included in the quantity of rice milled are 39,414,459 pounds of foreign rice, received principally from China and Japan, and handled by mills on the Pacific coast, in New York city, and in New Orleans. The products of

many rice mills do not reach commercial channels, and it is, therefore, impossible to itemize the value of products. The average consumption per establishment during the census year was 4,982,525 pounds, ranging from 48,375 pounds in Alabama to 7,842,317 in Louisiana. The Louisiana mills handled 72.8 per cent of the total quantity milled.

Table 3 presents the quantity of products and the per cent which each formed of the total product.

TABLE 3.—QUANTITY OF PRODUCTS AND THE PER CENT WHICH EACH FORMED OF THE TOTAL: 1900.

STATES.	Total pounds.	CLEAN RICE.		POLISH.		BRAN.		HULLS AND WASTE.	
		Pounds.	Per cent of total.	Pounds.	Per cent of total.	Pounds.	Per cent of total.	Pounds.	Per cent of total.
United States	398,602,018	243,031,200	61.0	15,134,648	3.8	69,265,012	17.3	71,171,158	17.9
Alabama	193,500	116,660	60.3	7,758	4.0	38,573	19.9	30,509	15.8
Florida	575,640	350,466	60.9	22,975	4.0	109,328	19.0	92,871	16.1
Georgia	14,444,541	8,622,510	59.7	435,528	3.0	2,604,964	18.0	2,781,539	19.3
Louisiana	290,165,708	173,632,724	59.8	11,491,319	4.0	50,243,288	17.3	54,798,377	18.9
North Carolina	9,929,250	5,959,710	60.0	368,010	3.7	1,934,730	19.5	1,666,800	16.8
South Carolina	42,405,795	24,864,112	58.6	1,648,211	3.9	8,640,421	20.4	7,253,051	17.1
All other states[1]	40,887,584	29,485,018	72.1	1,160,847	2.9	5,693,708	13.9	4,548,011	11.1

[1] Includes establishments distributed as follows: California, 1; Mississippi, 2; New York, 2; Oregon, 1; Texas, 1; and Washington, 2.

The by-products obtained in milling rice are polish (or flour), bran, and hulls. Polish is the fine dust taken from the grain in the final polishing process, bran is the product obtained from the grinding of the inner cuticle of the grain with the finer particles of hulls, and hulls are the outer husks of the grain. As shown in the above table, the component parts of the product of rice, cleaning and polishing, in the United States during the census year were: Clean rice, 61 per cent; polish, 3.8 per cent; bran, 17.3 per cent; and hulls and waste, 17.9 per cent. Thus, from a barrel (162 pounds) of rough rice is obtained an average of 99 pounds of clean rice, 6 pounds of polish, 28 pounds of bran, and 29 pounds of hulls and waste. Foreign rice is received in a partially cleaned condition and hence these ratios do not apply to it. Mills handling foreign rice show 74.9 per cent of clean rice, or 121 pounds per barrel of rough rice, and a very small percentage of waste. This accounts for the large percentage of clean rice shown for "all other states" in Table 3. "All other states" includes the states of New York, Washington, Oregon, and California, which mill foreign rice almost exclusively.

Both rice flour and bran are considered excellent feed for cattle and hogs, and are ground together by mills in Georgia and the Carolinas and sold for this purpose. Such a feed is valued at about $15 per ton. When sold separately the bran brings about $12 per ton and the flour $18. Owing to the large amount of starch in rice flour, it will not undergo fermentation with yeast, and hence can not be used alone in bread making, but mixed with wheat or rye flour it is used for this purpose. In Germany this product is used in making an imitation ivory, from which is manufactured doll heads and cheap jewelry. Starch, cement, paper, and other similar products are made from it. Hulls, which are a waste in most of the mills, are used by some of the larger ones as a fuel. Their recent use by the ice companies, canned goods factories, and crockery houses for packing purposes, is increasing the demand for them.

Table 4 presents, by decades, the quantity of clean rice produced in the United States from 1840 to 1900.

TABLE 4.—QUANTITY OF RICE GROWN IN THE UNITED STATES (IN POUNDS OF CLEAN RICE), BY DECADES, 1840 TO 1900.[1]

STATES.	1900	1890	1880	1870	1860	1850	1840
United States	250,280,227	128,590,994	110,131,373	73,635,021	187,167,032	215,313,497	80,811,422
Alabama	926,946	399,270	810,889	222,945	493,465	2,312,252	149,019
Arkansas	8,630	7,110	.....	73,021	16,331	63,179	5,454
California	.....	.....	.....	.....	2,140	.....	.....
Florida	2,254,492	1,011,805	1,294,677	401,687	223,704	1,075,090	481,420
Georgia	11,174,562	14,556,432	25,369,687	22,277,380	52,507,652	38,950,691	12,884,732
Illinois	.....	.....	.....	.....	.....	.....	464
Kentucky	.....	.....	.....	.....	.....	5,688	16,376
Louisiana	172,732,430	75,645,433	23,188,311	15,854,012	6,331,257	4,425,349	3,604,534
Michigan	.....	.....	.....	.....	716	.....	.....
Minnesota	.....	.....	.....	.....	3,286	.....	.....
Mississippi	739,222	676,746	1,718,951	374,627	809,082	2,719,856	777,195
Missouri	.....	.....	.....	.....	9,767	700	50
North Carolina	7,892,580	5,846,404	5,609,191	2,059,281	7,593,976	5,465,868	2,820,388
South Carolina	47,860,128	30,338,951	52,077,515	32,304,825	119,100,528	159,930,613	60,590,861
Tennessee	.....	.....	.....	3,399	40,372	258,854	7,977
Texas	7,186,863	108,423	62,152	63,844	26,031	88,203	.....
Virginia	4,374	360	.....	.....	8,225	17,154	2,956

[1] As reported to the division of agriculture, Census Office.

The production of rice in 1900 (growth of 1899), as reported to the division of agriculture, Twelfth Census, expressed in terms of clean rice, was 250,280,227 pounds. The quantity of foreign-grown rice milled in the United States during the census year was 39,414,459 pounds. By subtracting this foreign rice from the total mill consumption given in Table 2, 398,602,018 pounds, the quantity of rice of domestic growth milled is found to be 359,187,559 pounds. There were two establishments in Louisiana and one in Texas whose products were primarily flour and grist, but which reported having cleaned in connection therewith 18,251,112 pounds of rough rice from the crop of 1899. By adding this to the amount of domestic rice milled, the total quantity of rice of domestic growth milled in the United States during the census year is found to be 377,438,671 pounds. The quantity of clean rice obtained from this was 224,912,528 pounds. The excess in the quantity of rice grown over that milled, expressed in terms of clean rice, is 25,367,699 pounds, which represents the quantity of rice held by the farmers for seed, or cleaned by hand on the farm for domestic use, or milled in local gristmills and returned by them with all other unclassified products.

The acreage devoted to rice culture in the United States for the crop of 1899 was 351,344. The amount of seed required per acre varies from 114 to 135 pounds in the Carolinas and Georgia to from 50 to 80 pounds in Louisiana and Texas. The increase in acreage for the crop of 1899 was marked in all the states, but especially in Louisiana and Texas, where the acreage increased from 84,555 in 1889 to 210,396 in 1899. A small part of the seed used in this region came from Japan, but it is safe to assume that 30,000,000 pounds of domestic rough rice, equivalent to about 18,000,000 pounds of clean rice, was thus kept from the mills. The remaining difference of 7,367,699 pounds represents the quantity of rice cleaned by hand on the farms or milled and not separately reported by gristmills. In the upland rice-growing territory, where this product is grown only for domestic consumption, the quantity milled in connection with the gristmills was of such small importance that it was included in "all other products" in the reports of such establishments.

Table 5 is a summary of rice, cleaning and polishing in Hawaii during the census year.

TABLE 5.—SUMMARY FOR HAWAII, CROP OF 1899.

Number of establishments	41
Capital	$381,625
Salaried employees	18
Salaries	$12,100
Wage-earners, average number	173
Total wages	$49,124
Men, 16 years and over	171
Wages	$48,800
Children, under 16 years	2
Wages	$324
Miscellaneous expenses	$23,329
Cost of materials used	$481,925
Value of products, including custom work and repairing	$664,300
Pounds of rough rice milled	22,089,250
Average consumption of rough rice per establishment	538,762
Pounds of clean rice obtained	15,001,020
Production in pounds[1]	33,442,400
Acreage[1]	9,130
Average production per acre (pounds)	3,663

[1] As reported to division of agriculture, Twelfth Census.

The 41 establishments shown in the above table used 22,089,250 pounds of rough rice, and produced 15,001,020 pounds of clean rice, valued at $664,300. Of this amount 596,100 pounds, valued at $29,306, were imported, as shown in Table 8. The total production of the Hawaiian Islands was 33,442,400 pounds, expressed in terms of clean rice. The difference between this and the mill consumption is 18,441,380 pounds. It thus appears that less than one-half of the production was cleaned by the mills reporting. The remainder was either cleaned for domestic uses by primitive methods or held as rough rice for seed. The balance of trade in rice between the United States and the Hawaiian Islands is now in favor of this country, having become so within the past decade. The imports of rice from these islands decreased from 7,840,900 pounds in 1891 to 596,100 pounds in 1900, while the exports to them increased from nothing in 1891 to 6,619,188 pounds in 1900, as shown by Tables 10 and 11. The explanation of this is found both in the changed relationship between these countries and in the increased demand for rice in Hawaii, caused by the immigration in recent years of large numbers of Chinese and Japanese, who are very large consumers of rice. In Japan the per capita consumption of rice is 308.75 pounds yearly, while in the United States it is only 3.8 pounds.

Table 6 presents a comparison from 1890 to 1899 of the annual production of rice in the United States, exports and consumption of domestic rice, imports, exports, and net imports of foreign rice, total rice consumption, per cent of domestic product exported, per cent of consumption produced in the United States, and the per cent of consumption imported.

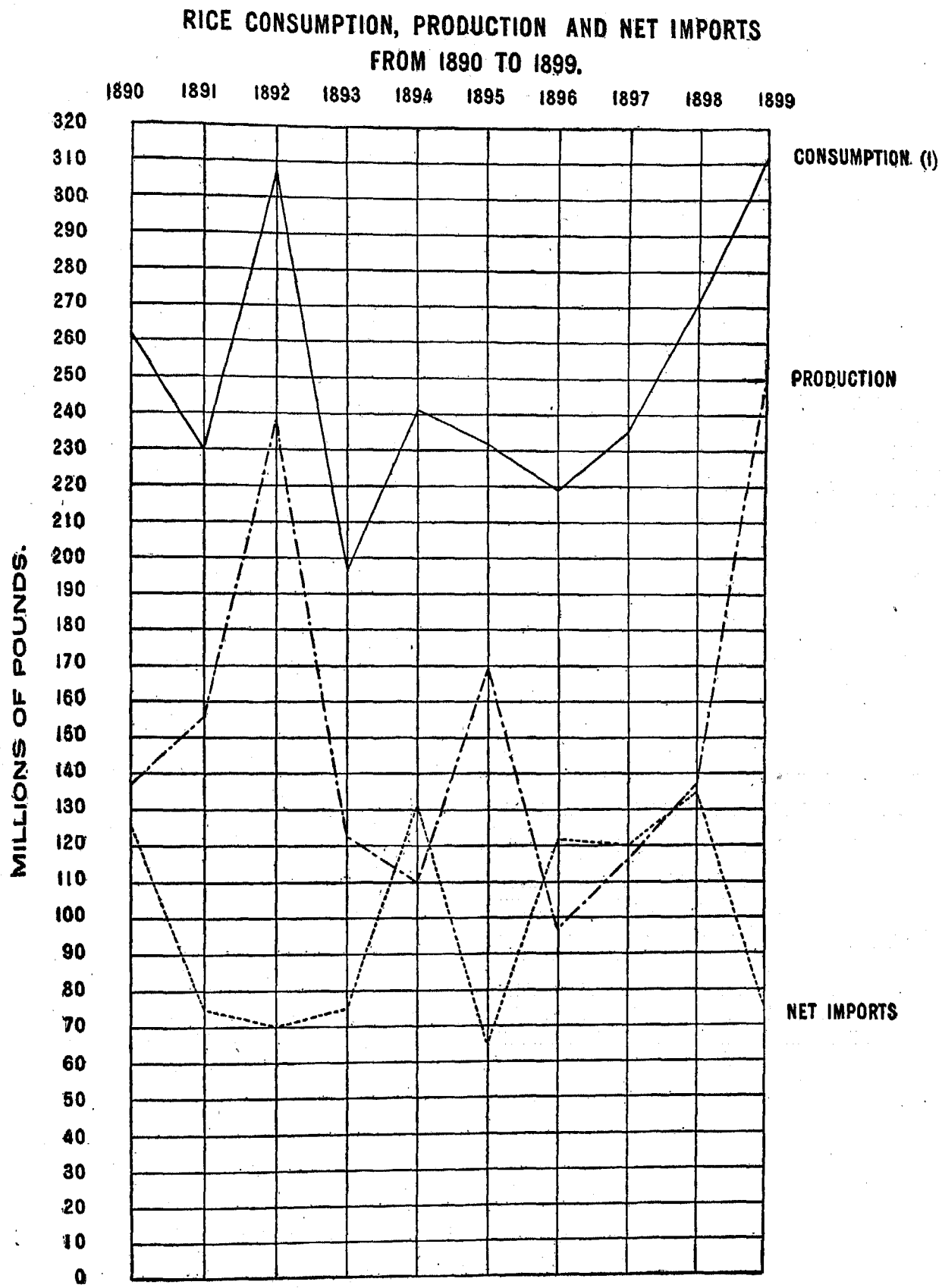
TABLE 6.—COMPARATIVE STATEMENT—PRODUCTION, EXPORTS, AND CONSUMPTION OF DOMESTIC RICE, IN POUNDS; IMPORTS, EXPORTS, AND NET IMPORTS OF FOREIGN RICE; TOTAL RICE CONSUMPTION; PER CENT OF DOMESTIC PRODUCT EXPORTED; PER CENT OF CONSUMPTION PRODUCED IN THE UNITED STATES; AND PER CENT OF CONSUMPTION IMPORTED: 1890 TO 1899.[1]

	1899	1898	1897	1896	1895	1894	1893	1892	1891	1890
Production[2]	250,280,227	136,990,720	116,301,760	96,886,400	168,665,440	109,820,800	122,865,160	237,546,900	155,665,600	186,800,000
Exports of domestic[3]	12,947,009	852,704	637,146	387,288	[4]1,346,876	124,296	763,425	756,992	(5)	540,620
Consumption of domestic	237,333,218	136,138,016	115,664,614	96,499,112	167,318,564	109,696,504	122,101,735	236,789,908	.....	186,259,380
Imports[3]	93,648,451	153,837,026	129,810,630	133,939,930	78,190,334	141,301,411	86,810,536	81,031,944	85,112,164	138,101,063
Exports of foreign[3]	18,267,687	19,114,698	10,305,694	11,607,684	13,619,466	10,271,357	11,877,253	10,870,572	10,591,923	8,119,574
Net imports	75,380,764	134,722,328	119,504,936	122,332,296	64,570,868	131,030,054	74,933,283	70,161,372	74,520,241	124,981,489
Total consumption	312,713,982	270,860,344	235,169,550	218,831,408	231,889,432	240,726,558	197,035,018	306,951,280	.....	261,243,869
Per cent of domestic product exported	5.2	0.6	0.5	0.4	0.8	0.1	0.6	0.3	.....	0.4
Per cent of consumption produced in the United States	75.9	50.3	49.2	44.1	72.2	45.6	62.0	77.1	.....	52.2
Per cent of consumption imported	24.1	49.7	50.8	55.9	27.8	54.4	38.0	22.9	.....	47.8

[1] The statistics of production cover the growth of the years indicated; the commercial statistics cover the year ending June 30, following.
[2] Statistics from 1891 to 1898, inclusive, compiled from statistics (Dan Talmage's Sons Co.), Bulletin No. 22, United States Department of Agriculture. For 1899, from reports to the division of agriculture, Twelfth Census.
[3] Statistical Abstract of the United States Treasury Department, 1900.
[4] 896,000 pounds damaged.
[5] Included in "rice bran, etc." Rice not reported separately.

The production statistics cover the growth of the years indicated, while those of imports and exports have to do with the same crop, but cover the fiscal years ending June 30, following. The consumption of domestic rice has been ascertained by deducting from the total production the quantity exported. This unexported quantity added to the net imports gives the total consumption. The net imports are the imports less the quantity of foreign rice reexported.

Table 6 shows the relation between the consumption of foreign and domestic rice in the United States for the past decade. Taking the period as a whole, there has been a general increase in both the production and consumption of rice. During the four years preceding 1899 the consumption of foreign rice showed a tendency to increase, the net imports having risen from 64,570,868 pounds in 1895 to 134,722,328 pounds in 1898. The percentage of the rice consumption imported during this period increased from 27.8 to 49.7. It is gratifying to note, however, that the large production of 1899 reduced the net imports for the fiscal year ending June 30, 1900, to the very low figure of 75,380,764 pounds, which was only 24.1 per cent of the consumption. Besides furnishing 75.9 per cent of its total consumption in 1899 this country exported 12,947,009 pounds of clean rice, or 5.2 per cent of the total production. The solution of the irrigation problem in Louisiana and Texas will enable the United States to show a rapid increase in the annual rice production during the next decade, undisturbed by the large variations shown in the crops of the past ten years. The rice territory along the Carolina and Georgia coast is subject to harvest storms, and the upland territory to drought. These disturbing factors will be largely offset by the increased territory made available by irrigation.



(1) CONSUMPTION 1891 ESTIMATED

The foregoing diagram illustrates graphically variations in production, in net imports, and in the total consumption of rice for the United States during the decade between 1890 and 1900. Each vertical line represents a year and each longitudinal line 10,000,000 pounds of rice. The line connecting the points where the quantity intersects the year forms the line of variation for the decade. Consumption statistics employed in this diagram cover the consumption of clean rice and not by-products.

Table 7 presents exports of rice, rice bran, meal, and polish, and imports of rice, rice flour, rice meal, and broken rice, 1891 to 1900

TABLE 7.—EXPORTS OF DOMESTIC RICE, AND RICE BRAN, MEAL, AND POLISH, AND IMPORTS OF RICE, AND RICE FLOUR, RICE MEAL, AND BROKEN RICE, YEARS ENDING JUNE 30, 1891 TO 1900.[1]

YEARS.	EXPORTS.						IMPORTS.					
	Total.		Rice.		Rice bran, meal, and polish.		Total.		Rice.		Rice flour, rice meal, and broken rice.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
1900	41,066,417	$667,387	12,947,009	$500,364	28,119,408	$167,023	116,679,891	$2,279,036	93,648,451	$1,904,915	23,031,440	$374,121
1899	15,334,689	118,809	852,704	38,511	14,481,985	80,298	204,177,293	3,930,149	153,837,026	3,152,771	50,340,267	777,378
1898	6,200,987	62,999	637,146	27,501	5,563,841	35,498	190,285,315	3,746,833	129,810,680	2,793,111	60,474,685	953,722
1897	3,905,754	34,730	387,288	14,617	3,518,466	20,113	197,816,134	3,517,160	133,939,930	2,555,960	63,876,204	961,200
1896	[2]15,031,554	93,754	[2]1,346,876	14,117	13,684,678	79,637	146,724,607	2,185,579	78,190,334	1,274,574	68,534,273	911,005
1895	1,623,336	16,454	124,296	4,687	1,499,040	11,767	219,564,320	3,445,512	141,301,411	2,353,974	78,262,909	1,091,538
1894	10,766,249	112,139	763,425	19,884	10,002,824	92,255	142,161,817	2,374,885	86,810,536	1,540,992	55,351,281	833,843
1893	13,711,798	153,334	756,992	25,126	12,954,806	128,208	147,483,828	2,790,151	81,031,944	1,598,625	66,451,884	1,191,526
1892	10,256,796	89,340	([3])	([3])	10,256,796	89,340	148,103,688	3,030,883	85,112,164	1,933,447	62,991,524	1,097,436
1891	3,490,895	59,714	540,620	33,012	2,950,275	26,702	214,363,582	4,559,540	133,104,063	3,170,132	81,259,519	1,389,408

[1] Commerce and Navigation of the United States. [2] 896,000 pounds damaged. [3] Included in "rice bran, etc."

Table 8 presents imports of rice and its by-products, by countries, for the year ending June 30, 1900.

TABLE 8.—IMPORTS, BY COUNTRIES, RICE, AND RICE FLOUR, RICE MEAL, AND BROKEN RICE, YEAR ENDING JUNE 30, 1900.

COUNTRIES.	TOTAL.		RICE.		RICE FLOUR, RICE MEAL, AND BROKEN RICE.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Total	116,679,891	$2,279,036	93,648,451	$1,904,915	23,031,440	$374,121
France	66,584	1,205	380	29	66,204	1,176
Germany	39,173,448	683,186	18,603,285	353,112	20,570,163	330,074
Italy	1,527,061	48,550	1,527,061	48,550	.....	.....
Netherlands	1,940,600	50,725	1,940,600	50,725	.....	.....
United Kingdom	18,378,015	370,004	16,470,735	335,937	1,907,280	34,067
Dominion of Canada:						
Nova Scotia, New Brunswick, etc	448	17	448	17	.....	.....
Quebec, Ontario, Manitoba, etc	5,018	84	5,018	84	.....	.....
British Columbia	4,865	649	4,865	649	.....	.....
Mexico	728,556	20,141	728,556	20,141	.....	.....
West Indies:						
British	1,200	60	1,200	60	.....	.....
Cuba	1,785	46	1,785	46	.....	.....
Brazil	180	3	180	3	.....	.....
Colombia	150	6	150	6	.....	.....
Chinese Empire	24,604,713	489,809	24,354,306	485,347	250,407	4,462
East Indies—British	123,375	1,034	123,375	1,034	.....	.....
Hongkong	4,813,633	92,725	4,720,708	91,238	92,925	1,487
Japan	24,713,735	491,471	24,569,699	488,631	144,036	2,840
Turkey in Asia	425	15	.....	.....	425	15
Hawaii	596,100	29,306	596,100	29,306	.....	.....

Table 9 presents imports of rice and its by-products, by countries, for the years ending June 30, 1891 to 1900.

TABLE 9.—IMPORTS, BY COUNTRIES, RICE AND ITS BY-PRODUCTS, IN POUNDS, YEARS ENDING JUNE 30, 1891 TO 1900.[1]

COUNTRIES.	1900	1899	1898	1897	1896	1895	1894	1893	1892	1891
Total	116,679,891	204,177,293	190,285,315	197,816,134	146,724,607	219,564,320	142,161,817	147,483,828	148,103,688	214,363,582
Hawaii ... free	596,100	2,595,600	4,414,300	5,881,600	4,354,500	5,144,087	9,115,483	8,473,800	7,489,700	7,840,900
Hawaii ... dutiable				46			22,890			
Austria-Hungary ... do				220						
Belgium ... do			3,358	840	613				112,260	200,000
Denmark ... do			110,236						448,000	2,240,000
France ... do	66,584	1,455		490	2,536	244	121	716	2,206	396
Germany ... do	39,173,448	68,876,114	101,329,151	93,130,979	76,681,164	109,091,207	57,592,434	63,911,049	59,046,542	92,775,543
Italy ... do	1,527,061	1,295,549	985,872	935,864	901,592	894,056	648,906	725,949	478,627	373,943
Netherlands ... do	1,940,600	3,283,467	9,366,562	7,321,861	698,419	10,733,022	2,068,497	22,400	143,936	621,540
Portugal ... do					4,000			2,729		
Spain ... do			2,205						1,102	1,217
Sweden and Norway ... do							313			
United Kingdom ... do	18,378,015	19,799,935	19,154,899	21,641,430	7,290,095	8,829,497	12,281,985	14,516,868	11,760,456	20,952,347
British Honduras ... do					6,400					
Dominion of Canada:										
Nova Scotia, New Brunswick, etc ... do	448	1,922	10			244		55	100	224
Quebec, Ontario, Manitoba, etc ... do	5,018	115,012	980	36,456	321	1,413	344	2,266	622	261
British Columbia ... do	4,865	21,751	7,324	100	158,015	367,201	554,500	556,438	519,500	1,248,610
Central American States:										
Costa Rica ... do		295								
Guatemala ... do				5,850				50		
Honduras ... do									5,100	5,635
Salvador ... do	728,556	575,354	224,386	800		1,848				
Mexico ... do	1,200		89,140	92,439	19,500	348,124	1,302	15,652	1,159	35,943
West Indies:										
British ... do	1,785	163,384	663						300	5
Cuba ... do			218	1,780	24,365	50	1,190	2,683	56,836	57,015
Porto Rico ... do	180									
Brazil ... do	150									26,455
Colombia ... do									351	
Guiana—British ... do	24,604,713	34,484,841	32,098,874	192						
Chinese Empire ... do	123,375	10,387,439	1,267,524	29,753,135	27,219,663	40,473,266	33,727,366	32,603,476	30,870,205	39,601,761
East Indies:										
British ... do					2,129,724	5,131,923	1,684,921	3,813,480	5,926,060	13,500,019
Dutch ... do	4,813,633	5,166,408	3,679,174	413,733	197,057	56,000	16,522	27,547		
Hongkong ... do	24,718,735	57,408,717	17,550,439	3,813,207	2,603,734	4,240,319	2,906,193	4,513,347	5,078,163	2,597,547
Japan ... do	425			34,785,112	24,482,909	34,251,824	21,538,650	18,293,273	26,162,463	32,184,221
Turkey in Asia ... do										
All other Asia ... do		50					200			
Turkey in Africa—Egypt ... do								2,050		

[1] Commerce and Navigation of the United States.

Table 10 presents the quantity and value of rice, and rice bran, rice meal, and polish exported, by countries, for the year ending June 30, 1900.

TABLE 10.—EXPORTS, BY COUNTRIES, QUANTITY AND VALUE OF RICE, AND RICE BRAN, RICE MEAL, AND POLISH; YEAR ENDING JUNE 30, 1900.[1]

COUNTRIES TO WHICH EXPORTED.	TOTAL.		RICE.		RICE BRAN, RICE MEAL, AND POLISH.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Total	41,066,417	$667,387	12,947,009	$500,364	28,119,408	$167,023
EUROPE.						
France	23,096	1,559	23,096	1,559		
Germany	21,694,171	126,878	4,607	261	21,689,564	126,617
Greenland, Iceland, etc	589	38	589	38		
Netherlands	4,058,200	28,261			4,058,200	28,261
United Kingdom	2,773,065	32,332	428,821	20,334	2,344,244	11,998
NORTH AMERICA.						
Bermuda	1,082	80	1,082	80		
British Honduras	25,400	402	10,000	321	15,400	81
Quebec, Ontario, Manitoba, etc	7,424	389	7,424	389		
British Columbia	24,272	1,263	24,272	1,263		
Central American States:						
Costa Rica	2,500	16			2,500	16
Guatemala	14,723	442	14,723	442		
Honduras	79,842	2,577	79,842	2,577		
Nicaragua	507,375	17,735	497,875	17,685	9,500	50
Mexico	150,663	5,178	150,663	5,178		
West Indies:						
British	100	4	100	4		
Cuba	155,486	3,145	155,486	3,145		
Haiti	700	36	700	36		
Porto Rico	4,852,008	153,882	4,852,008	153,882		
Santo Domingo	325	20	325	20		
SOUTH AMERICA.						
Colombia	23,111	991	23,111	991		
OCEANIA.						
French Oceania	2,697	94	2,697	94		
Guam	40,200	1,193	40,200	1,193		
Hawaii	6,619,188	290,575	6,619,188	290,575		
Tongo, Samoa, etc	10,200	297	10,200	297		

[1] Commerce and Navigation of the United States.

Table 11 presents exports of domestic rice and its by-products, by countries, for the years ending June 30, 1891 to 1900.

TABLE 11.—EXPORTS OF DOMESTIC RICE AND ITS BY-PRODUCTS, BY COUNTRIES, YEARS ENDING JUNE 30, 1891 TO 1900.[1]

COUNTRIES TO WHICH EXPORTED.	1900 (pounds).	1899 (pounds).	1898 (pounds).	1897 (pounds).	1896 (pounds).	1895 (pounds).	1894 (pounds).	1893 (pounds).	1892 (pounds).	1891 (pounds).
Total	41,066,417	15,334,689	6,200,987	8,905,754	15,031,554	1,623,336	10,766,249	[2]13,711,798	[2]10,256,796	[3]3,490,895
Belgium										450
France	23,096	45,709	35,812	19,952			30,765			31,450
Germany	21,694,171	13,029,985	5,547,922	3,493,542	10,350,557	809,203	9,677,859			2,620
Greenland, Iceland, etc	589									
Netherlands	4,058,200	728,000		27,000	56,000		154,560			
Russia, Baltic and White seas		800								
Sweden and Norway		350								
United Kingdom	2,773,065	1,052,719	400,596	118,390	2,606,346	54,759	179,365			240,444
Bermuda	1,082	681	948	500	777					
British Honduras	25,400	8,083	31,886	4,020	620	2,540	7,725			675
Dominion of Canada:										
Nova Scotia, New Brunswick, etc					50					
Quebec, Ontario, Manitoba, etc	7,424	22,116	38,688			30,650				1,630
British Columbia	24,272	565	985		8,030	5,600	630			
Newfoundland and Labrador			340	448						442
Central American States:										
Costa Rica	2,500		2,015		22,825	500	251,575			11,979
Guatemala	14,723	28,565	37,513	49,226	20,425	4,641	34,096			
Honduras	79,842	31,450	32,746	39,989	15,784	7,418	80,955			710
Nicaragua	507,375	31,234	6,000	106,524	135,184	18,344	122,545			62,487
Mexico	150,663	125,443	23,660	23,924	29,565	6,695	29,330			39,263
Miquelon, Langley, etc			318							1,010
West Indies:										
British	100	1,674	2,559	3,159	3,551					2,111
Cuba	155,486	209,239	4,009		1,693,478	655,950	122,000			17,433
Dutch		200	1,293	2,055	1,305					85
French		310								
Haiti	700	126	15,490	3,332	3,667	3,283				25,290
Porto Rico	4,852,008	2,754			9,700					200
Santo Domingo	325	691	400		516					3,026
Brazil										75,735
Colombia	23,111	10,471	16,484	12,158	71,075	23,750	74,844			2,775
Peru										3,990
Venezuela		416	723	1,535	662					10,565
British Australasia		2,908			1,437					1,250
French Oceania	2,697									
Guam	40,200									
Hawaii	6,619,188									
Tonga, Samoa, etc	10,200									
Liberia		100								5,009
Portuguese Africa		100	600							895

[1] Commerce and Navigation of the United States.
[2] Rice, etc., not enumerated by countries, 1892 to 1893, inclusive.
[3] Includes an item of 2,950,275 pounds of rice polish exported; destination of same not given.

Tables 7, 9, and 11 show the foreign trade in rice and the distribution of exports during each year of the decade ending June 30, 1900, while Tables 7, 8, and 10 show the distribution of the foreign trade in rice for the census year 1900. Although the foreign rice trade has fluctuated very much from year to year, there has been a general decrease in imports and a corresponding increase in exports. The imports of rice and its by-products decreased from 214,363,582 pounds in 1891 to 116,679,891 pounds in 1900, while the exports for the same period increased from 3,490,895 to 41,066,417 pounds. Exports prior to 1900 were on the average less than one-half of 1 per cent of the production, except in 1896, when a large proportion of damaged rice was exported. More than one-half of the exports of rice and its by-products, during the year ending June 30, 1900, went to Germany, the remainder being sent principally to the West Indies and Central America. The imports of whole rice have varied greatly from year to year, but the amount of by-products imported, beginning with 81,259,519 pounds in 1891, has steadily decreased to 23,031,440 pounds in 1900. The amount of whole rice imported has been in inverse ratio to production, except in 1899 when a substantial increase in production failed to produce a reduction in imports. Importations of rice are chiefly for food and come principally from Japan, China, and Germany. There was a marked change in the foreign rice trade of the United States during the census year. The exportation of domestic whole rice was 12,947,009 pounds, or 5.2 per cent of the production of 1899. Of this quantity 6,619,188 pounds went to Hawaii, and 4,852,008 pounds to Porto Rico. The large increase in exports to these countries has been occasioned by the change of political relationship between them and the United States.

Table 12 presents the exports of domestic clean rice, by customs districts, for the years ending June 30, 1891 to 1900.

TABLE 12.—EXPORTS OF DOMESTIC CLEAN RICE, BY CUSTOM DISTRICTS, YEARS ENDING JUNE 30, 1891 TO 1900.[1]

DISTRICTS FROM WHICH EXPORTED.	1900		1899		1898		1897		1896	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Total	12,947,009	$500,364	852,704	$38,511	637,146	$27,501	387,288	$14,617	1,346,876	$14,117
Baltimore, Md	28,425	1,063								
Bangor, Me	589	38								
Bath, Me	6,000	300								
Belfast, Me										
Boston and Charlestown, Mass							9,160	458		
Charleston, S. C	2,700	145	1,190	79	2,831	159			750	50
New Bedford, Mass					600	28				
New York, N. Y	5,100,633	168,148	306,499	19,604	352,620	18,518	91,122	4,851	83,867	4,307
Philadelphia, Pa			5,249	196						
Providence, R. I									50	4
St. Johns, Fla									200	10
St. Augustine, Fla										
Savannah, Ga	14,534	760	13,808	813	14,965	852	10,745	586		
Brazos de Santiago, Tex	76,787	2,015					21,484	427	28,446	601
Corpus Christi, Tex	1,165	46	76,962	1,912						
Galveston, Tex	155,200	3,134			1,100	28	665	31	69,400	1,888
Key West, Fla	236	9	72,736	2,110	1,580	57	220	8		
Mobile, Ala	5,382	192	6,715	289	10,913	427				
New Orleans, La	662,406	24,662	246,393	8,563	190,354	4,988	251,702	8,193	1,155,774	7,827
Paso del Norte, Tex	26,642	2,108			20,020	1,001				
Pearl River, Miss										
Saluria, Tex	42,529	898	47,776	1,507	140	6			146	8
Tampa, Fla			72,000	3,284						
Alaska	8,722	777	565	36	985	54				
Arizona			450	15	485	30	2,190	63	763	51
Puget Sound, Wash	15,550	486								
San Diego, Cal			95	4	565	29			200	7
San Francisco, Cal	6,792,085	295,199	150	7	1,300	160				
Champlain, N. Y	2,616	130	1,721	69						
Huron, Mich	1,860	93	100	4	38,588	1,158				
Minnesota, Minn			295	19	100	6				
Montana and Idaho									7,280	364
Oswegatchie, N. Y	280	10								
Vermont, Vt	2,668	156								

DISTRICTS FROM WHICH EXPORTED.	1895		1894		1893		1892[2]		1891	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Total	124,296	$4,687	763,425	$19,884	756,992	$25,126	[2]10,256,796	[2]$89,340	540,620	$33,012
Baltimore, Md	16,895	676			52,429	2,555			6,908	346
Bangor, Me										
Bath, Me										
Belfast, Me					990	59				
Boston and Charlestown, Mass					134,564	5,976			1,120	39
Charleston, S. C										
New Bedford, Mass										
New York, N. Y	3,283	141							444,045	29,217
Philadelphia, Pa									200	9
Providence, R. I										
St. Johns, Fla										
St. Augustine, Fla					40	4				
Savannah, Ga										
Brazos de Santiago, Tex			5,578	141					1,900	102
Corpus Christi, Tex									4,435	228
Galveston, Tex										
Key West, Fla	212	11	122,580	2,068						
Mobile, Ala										
New Orleans, La	97,288	3,516	611,087	16,986	568,969	16,532			41,601	1,068
Paso del Norte, Tex										
Pearl River, Miss	1,063	38								
Saluria, Tex	665	48	23,550	658						
Tampa, Fla										
Alaska										
Arizona										
Puget Sound, Wash			630	31						
San Diego, Cal									2,904	181
San Francisco, Cal									35,877	1,714
Champlain, N. Y										
Huron, Mich										
Minnesota, Minn									1,630	108
Montana and Idaho	4,240	212								
Oswegatchie, N. Y	650	45								
Vermont, Vt										

[1] Commerce and Navigation of the United States.

[2] Not enumerated by districts; total for year includes values for bran, meal flour, etc.

This table shows a decided increase in the exports of rice at nearly all the customs districts and especially at San Francisco, where the exports increased from practically nothing in 1899 to 6,792,085 pounds in 1900. The leading customs districts in the exportation of rice in 1900 were San Francisco, New York, and New Orleans.

HISTORICAL AND DESCRIPTIVE.

If its importance as a food product is to be measured by the number of persons who consume it, rice must, without doubt, be considered the greatest cereal. The countries in which rice forms the principal and, very often, the only food, have a population variously estimated to be from 825,000,000 to 900,000,000 of the world's population of nearly a billion and a half. There is no authentic record of its origin, though frequent mention is made of it in ancient literature. Nearly all authorities agree, however, that the Chinese were its first cultivators.

It was introduced, for cultivation, into the United States in 1647, when Sir William Berkeley, then governor of Virginia, received a half bushel of the grain from England. He caused this to be planted and from it a yield of 16 bushels was obtained. But with this the industry appears to have rested until 1694. In that year a ship bound from Madagascar was obliged to seek refuge in the harbor at Charleston, S. C., owing to a violent storm at sea. The captain of the vessel finding an old friend, Thomas Smith, governor of the province, presented him with a sack of the grain. Experiments in its cultivation were begun, resulting in making South Carolina, for more than a century, the leading rice producing state of this country.

Up to 1860 the industry was confined chiefly to the Carolinas and Georgia, these states producing practically the entire commercial crop. But the revolution in the system of labor, and the almost complete annihilation of the capital of the planters by the Civil War resulted in a new beginning for this industry, which brought radical changes in farming methods and in milling processes.

The effect of the change in labor conditions, resulting from the war, has been instrumental in keeping rice production practically at a standstill in the two Carolinas and Georgia, and to increase its culture on the prairie lands of Louisiana, where improved machinery can be more advantageously employed. For example, the combined production of the Carolinas and Georgia decreased from 56,641,486 pounds in 1869 to 50,741,787 pounds in 1889, while that of Louisiana increased from 15,854,012 to 75,645,433 pounds during the same period. The Twelfth Census, reporting for the crop of 1899, gives the Carolinas and Georgia 66,427,270 and Louisiana 172,732,430 pounds. The remarkable increase in rice culture in Louisiana and Texas during the past decade is due to the discovery that the lands of this region are both suitable to rice culture and capable of satisfactory irrigation. The farmers no longer raise "Providence rice," a localism for a crop dependent upon rainfall, but the rivers and bayous have been utilized and canal companies have grown rich furnishing water to rice planters. When the flooding season is over, these lands are so readily and thoroughly drained as to permit of the employment of modern harvesting machines.

With the opening up of these vast prairies to rice culture have come the gang plow, the horse drill, the twine binder, and the steam thresher. One harvesting machine, operated by one man and five mules, does in one day what formerly required a whole family and hired help to do in a season. Nowhere else in the rice-growing belt has it been possible to introduce such implements, owing to the inability of the growers to properly drain their rice lands.

The problem of a fuel supply has been removed by the recent discovery of natural oil in Texas. Beaumont, the famous oil center, is in the midst of this rice belt. Oil tanks already dot this section, and rice farmers and rice millers alike are using the oil for fuel. There has thus been made available for rice culture in southwest Louisiana and southeast Texas a vast territory which will guarantee a steady increase of the rice crop, unaffected by drought and so cheapened by the utilization of machinery as to encourage the hope that the United States may at no distant time not only supply its own consumption requirements but successfully compete with the East in the markets of the world.

Although rice is one of the oldest cereals and constitutes the principal food of over half the people of the world, the methods of cleaning it have until recently been of very crude design. The great advancement in the methods of recent years is largely the result of greatly increased production and consumption among the civilized countries and the technical requirements of a fanciful trade.

The primitive method of milling rice in the United States, and at present in vogue in China and other foreign countries, is to place a small quantity of the grain in a hollow stone or block of wood and pound it with a stone pestle. The blow cracks the hull, and the friction created by the sliding motion of the rice under the pestle removes the hull from the cuticle. The hulls and bran are gotten rid of by winnowing. The first advance from this process was the use of a mortar made of a short section of a hollowed log, the pestle being a heavy pounder attached to a horizontal beam 6 to 8 feet long, which rested upon a fulcrum, 4 to 5 feet from the mortar. The pounder was raised and dropped by quickly stepping on and off the shorter end of the beam. This simple process and the fanning mill are in use in oriental countries at this time. Such a mill cleans about 11 bushels of paddy a day. The next advance was the use of the water wheel as a motive power, geared to a horizontal shaft. The pounder was a vertical beam, about 10 feet long and 6 inches square. As the horizontal shaft revolved, a rounded arm projecting from it caught

a pointed pin in the vertical shaft, raised the pounder, and slipping past dropped it into the mortar of rice. This was repeated until the hulls and bran were separated from the grain.

The usual process of milling the rice of commerce is more complicated. The paddy is first screened to remove trash and other foreign particles. The hulls are then removed by rapidly-revolving mill stones, and separated from the whole and broken rice by means of screens and blowers. This process does not remove the thin cuticle of the grain; to do this it is passed through a huller or subjected to heavy pounding. The huller is a short, horizontal tube of cast iron, with interior ribs and a funnel at one end to admit the rice. Within this tube revolves a shaft, with ribs so adjusted that the revolution of the shaft creates sufficient friction to remove the cuticle. The rice passes out of the huller at the end opposite the funnel, to be separated from the by-products and polished. In other mills the cuticle is removed by pounding in mortars, with pestles weighing from 380 to 400 pounds. Strange to say, this heavy weight breaks comparatively few grains. When it is sufficiently cleaned, the flour and bran are separated, and the grain sent to cooling pans, where it remains for eight or nine hours. After passing through the huller or the mortar, the rice is ready for the finishing process, polishing, which gives it a pearly luster. This finish is secured by passing the whole grains through a rapidly revolving screen with brushes, or with wire gauze and sheepskin.

This process gives to the rice grain its fine, glossy surface, and adds to its commercial value, but detracts from its value as a food. The outer surface of the clean, unpolished rice contains almost all the fats of the grain, and its removal materially lessens both the flavor and nutritive value. The fashion of highly polishing the grain for the general trade does not tend to popularize it as a food. In its preparation for local consumption rice is seldom or never polished. This may explain the reason why travelers remark upon the excellent quality of oriental rice compared with that of commerce.

The grading of clean rice is not according to quality. From one kind of paddy may be obtained several grades according to the size of the grain, whole or broken, its susceptibility to polish, and general appearance. The average price for the crop of 1899 varied from 2½ cents per pound for common, to 6 cents for fancy grades. No. 2 rice, consisting of broken grains and fragments, and worth about 1⅝ cents per pound, is mostly used by breweries, and therefore called "brewers' rice." This arbitrary grading of rice according to size and luster, without regard to quality, makes breakage in milling a serious problem for both producer and miller. When a grain breaks it loses a large percentage of its commercial value, though its food value is unchanged. Rice worth 6½ cents as extra fancy, when broken so as to pass through a No. 12 sieve, is worth only 1½ cents.

The proportion of whole rice obtained by milling varies greatly, dependent largely upon the quality of the paddy. The selection of seed, cultivation, and curing all decidedly affect the friability of the grain. Careful attention on the part of the planter goes further to decrease the percentage of broken rice than that of the miller himself. The annual loss in the commercial value of the rice crop, on account of the difference in price between whole and broken rice, has been estimated by the United States Department of Agriculture (Bulletin No. 22, 1899) at about $2,000,000. The most productive is not usually the best milling rice.

TABLE 13.—RICE, CLEANING AND POLISHING, BY STATES: 1900.

	United States.	Alabama.	Florida.	Georgia.	Louisiana.	North Carolina.	South Carolina.	All other states.[1]
Number of establishments	80	4	4	4	37	4	18	9
Capital:								
Total	$2,601,352	$2,995	$4,510	$113,155	$1,818,144	$51,325	$293,385	$317,838
Land	$202,927	$95	$550	$30,085	$119,109	$5,425	$46,012	$1,651
Buildings	$610,808	$400	$800	$40,075	$450,260	$13,600	$97,958	$7,715
Machinery, tools, and implements	$764,125	$2,100	$2,960	$20,775	$522,250	$19,300	$51,090	$145,650
Cash and sundries	$1,023,492	$400	$200	$22,220	$726,525	$13,000	$98,325	$162,822
Proprietors and firm members	71	5	5	4	26	2	22	7
Salaried officials, clerks, etc.:								
Total number	169	.....	.....	5	126	9	18	11
Total salaries	$182,033	.....	.....	$4,800	$141,122	$8,825	$15,762	$12,024
Officers of corporations—								
Number	27	.....	.....	.....	20	4	2	1
Salaries	$50,570	.....	.....	.....	$42,450	$4,400	$2,720	$1,000
General superintendents, managers, clerks, etc—								
Total number	142	.....	.....	5	106	5	16	10
Total salaries	$131,463	.....	.....	$4,800	$98,672	$3,925	$13,042	$11,024
Men—								
Number	138	.....	.....	5	104	4	16	9
Salaries	$129,744	.....	.....	$4,800	$97,802	$3,700	$13,042	$10,400
Women—								
Number	4	.....	.....	.....	2	1	.....	1
Salaries	$1,719	.....	.....	.....	$870	$225	.....	$624
Wage-earners, including pieceworkers and total wages:								
Greatest number employed at any one time during the year	1,188	7	8	19	797	41	155	111
Least number employed at any one time during the year	591	7	8	12	414	7	78	65
Average number	651	3	3	14	412	30	112	77

[1] Includes establishments distributed as follows: Washington, 2; Texas, 1; Oregon, 1; New York, 2; Mississippi, 2; California, 1.

TABLE 13.—RICE, CLEANING AND POLISHING, BY STATES: 1900—Continued.

	United States.	Alabama.	Florida.	Georgia.	Louisiana.	North Carolina.	South Carolina.	All other States.[1]
Wage-earners, including pieceworkers and total wages—Continued.								
Wages	$265,585	$360	$976	$8,250	$180,523	$7,675	$25,243	$42,558
Men, 16 years and over—								
Average number	639	3	3	14	400	30	112	77
Wages	$262,042	$360	$976	$8,250	$176,980	$7,675	$25,243	$42,558
Children, under 16 years—								
Average number	12				12			
Wages	$3,543				$3,543			
Average number of wage-earners, including pieceworkers, employed during each month:								
Men, 16 years and over—								
January	872	6	4	19	574	39	132	98
February	785	6	4	19	513	39	120	84
March	711	6	1	17	446	39	113	89
April	578	4		12	320	39	113	90
May	435	4		15	182	39	109	86
June	285	4		13	90	12	104	62
July	204		3	2	92	9	39	59
August	316		3	2	208	9	42	52
September	575		5	16	355	12	134	53
October	914	1	7	19	633	37	144	73
November	1,012	3	7	19	702	41	146	94
December	994	2	7	18	684	41	144	98
Children, under 16 years—								
January	14				14			
February	14				14			
March	12				12			
April	8				8			
May	7				7			
June	3				3			
July	2				2			
August	7				7			
September	18				18			
October	22				22			
November	18				18			
December	14				14			
Miscellaneous expenses:								
Total	$230,203	$29	$109	$2,690	$162,104	$3,782	$9,862	$51,627
Rent of works	$19,556		$36	$100	$4,410	$500	$235	$14,275
Taxes, not including internal revenue	$24,769	$6	$36	$1,306	$17,394	$157	$4,785	$1,085
Rent of offices, interest, etc	$165,784	$23	$37	$1,284	$131,503	$3,125	$4,842	$24,970
Contract work	$20,094				$8,797			$11,297
Materials used:								
Aggregate cost	$7,575,522	$3,615	$10,855	$161,070	$4,954,135	$200,465	$856,790	$1,388,592
Principal materials—								
Total cost	$7,382,132	$3,442	$10,530	$158,703	$4,819,645	$187,020	$842,497	$1,360,295
Purchased in raw state	$7,169,294	$3,435	$10,505	$154,433	$4,644,838	$175,700	$821,698	$1,358,685
Purchased in partially manufactured form	$212,838	$7	$25	$4,270	$174,807	$11,320	$20,799	$1,610
Fuel	$89,307	$100	$235	$1,535	$72,233	$2,435	$6,367	$6,402
Rent of power and heat	$8,560				$300			$8,260
Mill supplies	$44,929	$48	$80	$782	$31,999	$760	$7,625	$3,635
Freight	$50,594	$25	$10	$50	$29,958	$10,250	$301	$10,000
Products:								
Value	$8,723,726	$4,816	$13,995	$184,804	$5,736,451	$238,520	$973,132	$1,572,008
Comparison of products:								
Number of establishments reporting for both years	47	3	2	3	23		9	7
Value for census year	$5,296,141	$4,200	$6,773	$182,494	$3,561,956		$184,960	$1,355,758
Value for preceding business year	$4,370,897	$4,150	$3,500	$76,754	$2,905,962		$160,320	$1,220,211
Power:								
Number of establishments reporting power	78	4	3	4	37	3	18	9
Total horsepower	7,578	28	60	216	5,106	140	913	1,110
Owned—								
Engines—								
Steam—								
Number	90	2	3	3	50	3	24	5
Horsepower	7,002	18	42	210	5,069	125	898	640
Water wheels—								
Number	9	2	1	1		1	1	3
Horsepower	264	10	18	6		15	15	200
Electric motors—								
Number	2				2			
Horsepower	27				27			
Rented—								
Electric horsepower	280				10			270
Establishments classified by number of persons employed, not including proprietors and firm members:								
Total number of establishments	80	4	4	4	37	4	18	9
No employees	6			1		1	3	1
Under 5	38	4	4	2	13	1	12	2
5 to 20	15			1	9	1		4
21 to 50	14				9	1	2	2
51 to 100	6				5		1	
101 to 250	1				1			

[1] Includes establishments distributed as follows: Washington, 2; Texas, 1; Oregon, 1; New York, 2; Mississippi, 2; California, 1