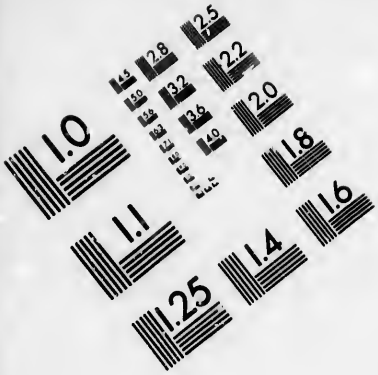

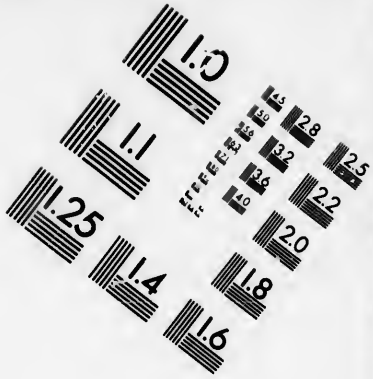

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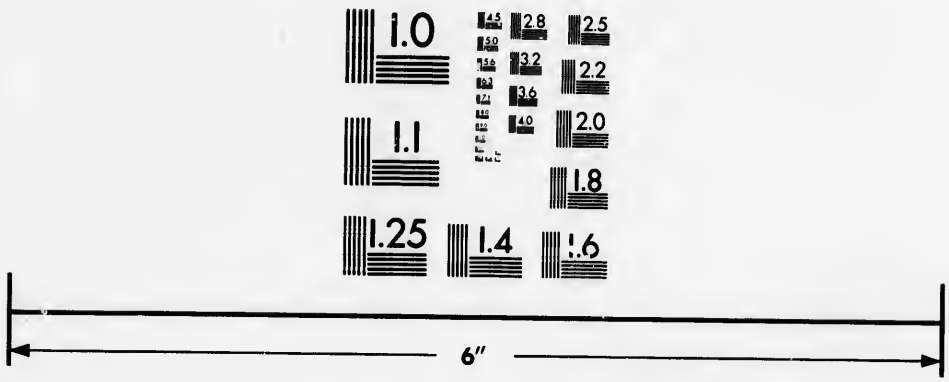

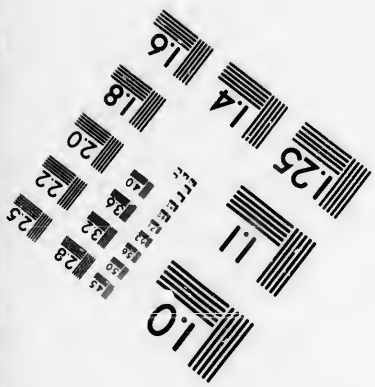

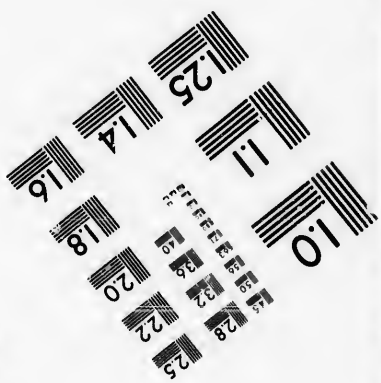

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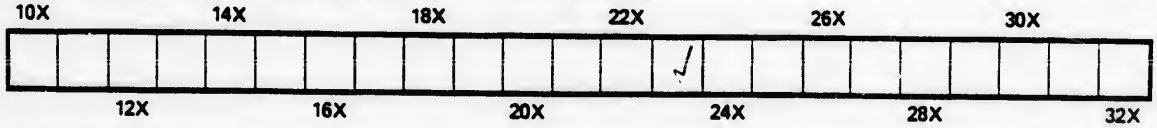

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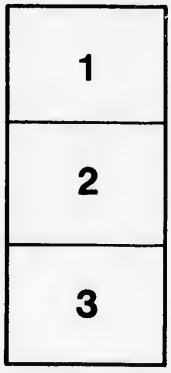

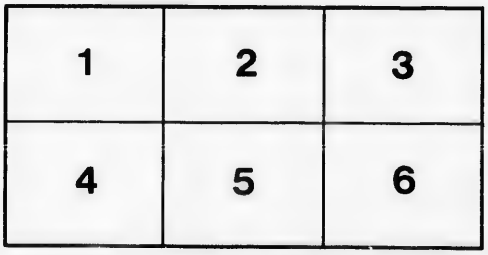

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REPORT

ON THE

PRODUCTION AND MANUFACTURE OF BEET SUGAR

BY

WILLIAM SAUNDERS

DIRECTOR DOMINION EXPERIMENTAL FARMS

OTTAWA:
PRINTED BY S. E. DAWSON, PRINTER TO THE QUEEN'S MOST EXCELLENT MAJESTY
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CONTENTS.

To the Honourable

The Minister of Finance.

SIR,—I have the honour to submit to you herewith a report on the Beet-sugar Industry prepared under your instructions.

In the first part of this report the history of the industry in Europe is briefly traced followed by a sketch of its rise and progress in the United States and Canada. The relative cost of producing cane and beet sugar is discussed, together with the subject of bounties, following with some statistics relating to the sugar interests, and a brief summary.

The subjects treated of in the second part relate to the improvement of the sugar beet, its cultivation, the cost of growing beets, and the value of the beet root and of the waste pulp from the sugar factories for stock feeding, closing with a short account of the process of manufacture of beet sugar.

I have the honour to be, Sir,

Your obedient servant,

WM. SAUNDERS,

Director Dominion Experimental Farms.

OTTAWA, 1st February, 1892.

REPORT

ON THE

PRODUCTION AND MANUFACTURE OF BEET SUGAR

By Wm. Saunders

Director Dominion Experimental Farms.

PART I.

INTRODUCTION.

The rapid growth of the beet sugar industry within the past few years in Germany, Austria, France, Russia and Belgium has awakened in all civilized countries a general interest in this subject. Numerous experiments have been tried with sugar beets for the purpose of ascertaining where they could be successfully grown with a sufficiently high percentage of sugar to permit of their being manufactured with some hope of profit. This experimental testing of sugar beets has become very general of late in the United States and Canada, and sufficient evidence has been accumulated to show that in both countries there are large areas over which this useful plant can be grown to a degree of perfection as to sugar strength and purity equal to any produced in Europe. It is also indisputable that the cultivation of root crops is very beneficial to the soil. The land is necessarily stirred to a greater depth than with other crops; weeds are subdued by the frequent cultivation necessary in root culture, and the soil, after the roots are removed, is left in much better condition for the successful growth of subsequent crops. For these reasons, the growing of root crops deserves encouragement.

In view of these facts the question naturally arises, Why has this industry not been more generally and successfully established in this country? There was paid to foreign countries for 223,841,171 lbs. of sugar imported into Canada for the year ending 1st July, 1890, $5,837,895, and for 174,045,720 lbs. for the year ending 1st July, 1891, $5,186,158. Why could not this article be produced by our own people, and this large sum of money spent in promoting a useful industry in our midst, whereby a portion of the arable land would be improved and employment provided for several months in the year for a number of people.

The beet sugar industry in Europe has been developed under the favouring influences of protection and large bounties, and one of the objects of the present enquiry is to endeavour to present, free from bias or prejudice, the facts bearing on this subject from all sides, so that an intelligent judgment may be formed and such conclusions reached as may best promote the welfare of the Canadian people.

To obtain information, the writer has recently visited the beet sugar factory at West Farnham, Quebec, also the factories at Grand Island and Norfolk, in Nebraska, U. S., and has enquired concerning the valuable tests, both chemical and agricultural, which have been carried on for some years past under the direction of Dr. H. W. Wiley, the talented chemist of the Department of Agriculture at Washington. Visits have also been paid to the experiment station at Lincoln, Nebraska, where the production of beet sugar has been made a special subject of study by the director and well known chemist, Prof. H. H. Nicholson; also to the stations at Ames, Iowa, and Madison, Wisconsin, where further useful information has been obtained. Additional facts have been

gathered by a careful study of the available literature which has appeared on this subject during the past twenty years or more, and by correspondence and interviews with experts who have spent much time in acquiring a knowledge of this industry.

In the preparation of the report free use has been made of the material contained in the reports of the Department of Agriculture of the United States and of the special bulletins on this subject which have been prepared by Dr. H. W. Wiley and published by this department. The past eleven volumes of "The Sugar Beet," published by Lewis S. Ware, of Philadelphia, have been similarly used. The author also desires to acknowledge his personal obligations to Dr. H. W. Wiley for much general information covering the whole subject; also to Prof. H. H. Nicholson, of Lincoln, Nebraska. Further assistance has been given by the loan of a valuable collection of papers and documents on this subject made by Mr. George Johnson, statistician of the Department of Agriculture in Ottawa. For much of the information regarding the manufacture of beet sugar I am indebted to Henry T. Oxnard, Esq., of Grand Island, Nebraska, U. S., and to Alfred Musy, Esq., of Farnham, Quebec.

THE BEET SUGAR INDUSTRY IN EUROPE.

The beet *Beta vulgaris* has long been cultivated. De Candolle, in his "Origin of Cultivated Plants," says that the red and the white beets which botanists generally agree in regarding as varieties of one species were known to the ancients, but their cultivation does not probably date more than three or four centuries before the christian era. The cultivated beet has probably originated from a slender-rooted variety, which grows wild along the coasts of the Mediterranean Sea and in Persia and which has become more fleshy rooted by long cultivation. It is a plant easily improved by selection and careful culture, and the number of varieties has greatly increased in modern times, especially since the beet root has been so largely cultivated for the production of sugar and as food for cattle.

In 1747 a Prussian chemist named Margraaf read a paper before the Academy of Sciences in Berlin on the existence of cane sugar in many home-grown roots. He found most sugar in the white Silesian beet and produced samples which he had made from that root. After describing the process by which he obtained this sugar he gave it as his opinion that the production of sugar on a large scale from the beet could be made remunerative at the high war prices at which sugar was then held. The interest which this discovery at first awakened died out when peace was restored and the price of sugar went down. With the outbreak of another war the subject of making sugar from the beet was again discussed, and under the patronage of Frederick the Great another Prussian chemist, named Achard, began a series of experiments in 1773 to test the practicability of this project, but the death of Frederick put a stop to this work before any satisfactory results were reached. Achard resumed his experiments in 1775 and established a factory which was maintained by the Prussian Government, and in 1779 he presented to the king of Prussia several loaves of beet sugar, accompanied by a report in which he claimed to have obtained 6 per cent of raw sugar from the root and to have manufactured it at a cost of about 6 cents per pound. At the same time he stated that he believed that with further improvements in the process the cost could be materially reduced.

RISE OF THE INDUSTRY IN FRANCE.

This report attracted much attention in France, where a committee of prominent scientific men was appointed to investigate the subject. In their report they stated that Achard did not obtain more than 1 per cent of sugar from the beets, and after this information had been made public further pursuit of the subject in France was for the time abandoned. Meanwhile two new factories were established in Germany, and the results obtained by the three factories working there induced Napoleon I to renew the enquiry by the appointment of a new committee of experts to carry on experiments with the beets. Reports were made in 1810 by Deyeux and in 1811 by Barruel, to the effect

that a yield had been obtained of about 1½ per cent, and that sugar had been made at a cost of about 30 cents per pound. Napoleon offered liberal bounties to further this industry, and at one time $200,000 was placed at the disposal of the Minister of Agriculture to stimulate the production of beet sugar. The overthrow of Napoleon in 1814 cut off the Government bounties and threatened the destruction of the new sugar industry, but a duty of 50 per cent levied by the restored Government enabled one manufacturer, M. Delisse, to continue the business, and he claimed to have obtained 5 per cent. of sugar from his beets, and to have made it at a cost of 7 cents per pound. From 1820 to 1825, under the protection afforded by a heavy duty, the factories multiplied, and from reports published in the latter year we gather that one hundred establishments were in operation, but they must have been very small, as the total output was only 5,000 tons of sugar. By 1836, 436 factories were actively working, producing 49,000 tons of sugar, but in 1837, when a part of the protection was withdrawn by the levying of a duty of 1¼ cents per pound on domestic sugars, 160 of the factories were closed and the production of sugar fell that year to 22,000 tons.

Excise regulations more favourable to the manufacturers soon brought about a revival of the industry, and for some years it made rapid progress, France meanwhile leading all the other nations of Europe in the quantity of sugar produced. By 1872 the production had been worked up to 408,609 tons, but the tax collected was still levied on the sugar produced, and the farmers who grew the beets for the factories, had no special stimulus to produce roots of high quality, but it was rather to their interest to obtain heavy crops. Hence they sought weight per acre rather than a high percentage of sugar. The manufacturers also had but little inducement to improve their processes for making sugar, and under these conditions the industry fluctuated from year to year and made but slow advancement in France. But in 1884 a new law was passed, which provided that the tax should be levied on the beets on the basis of a duty equal to that of 6 per cent of sugar where factories were worked by diffusion and 5 per cent where the juice was extracted by hydraulic pressure. These differences were to be tolerated until 1887, after which all factories regardless of process were to be equally taxed. The manufacturers were to have as bounty all the sugar they could make above these percentages duty free. In 1883 the average sugar production was about 6·60 per cent or 473,671 tons from 7,328,000 tons of beets; in 1884 it was 6.87, the production of beets having dropped to 4,512,000 tons and the total yield of sugar to 308,410 tons, for under the new regulations the bounty obtainable that year by the best-worked factories was reduced to about ¾ of a cent per pound. In 1885 the crop of beets fell to less than half of what it was two years before, having dropped to 3,450,000 tons, with a sugar production of only 290,000 tons; but a great stimulus had been given to improving the quality of the beets as well as the process of manufacture, and the manufacturers offered prices in accordance with the quality of the beets, and the percentage of sugar made that year was 8·40 which brought the bounty up to about 1½ cents per lb. The yield of sugar has been increasing ever since. In 1888 it was said to be 9·63, in 1889, 10·05, and in 1890 it fell off a little being 9.80 per cent. The industry developed rapidly under the stimulus of these increasing bounties. In the meantime, however, the Government gradually raised the standard sugar strength of beets from 6 per cent to 7·50 per cent.

The system at present in force in France, as explained to the writer by Mr. A Musy, manager of the beet sugar factory at Farnham, Quebec, is as follows: There are two methods by which the tax on beet sugar is levied, and manufacturers in that country may elect not later than the 15th of September in each year under which system they prefer to run their factory for the season. One regulation provides that the duty shall be paid on the manufactured sugar, the manufacturer being allowed to take out of bond, without paying duty, 15 per cent of all that he makes. As the duty is about 5½ cents per lb. this is equivalent to a bonus of about 82½ cents on each 100 lbs. By the other method the tax is levied on the beets, which are estimated to yield 7·75 per cent of sugar, and a duty is paid on every 100 lbs. of roots which enter the factory, equal to that on 7¾ lbs. of sugar, and all the sugar which the manufacturer can make over and above the 7·75 per cent he gets duty free up to 10½ per cent. If his beets yield a higher

percentage than 10½ he must pay one-half of the duty on all he makes above that figure. Supposing the production to be 11½ per cent, which many of the best factories are said now to obtain, the owners have 2¾ lbs. of free sugar from every 100 lbs. of beets, equal to a bounty of a fraction over 15 cents, to which the 1 per cent at half duty adds 2¾ cents, making a bonus of 17¼ cents on 11½ lbs. of sugar, a fraction over 1½ cents per pound on all the sugar made. When this sugar is exported a drawback of the full amount of duty is allowed on all that has been made, including that portion which the manufacturer has had free, and by this process the revenues of France are drawn on to furnish cheap sugar to the outside world, for in order to find a market it must compete in price with cane sugar, which costs less to produce. It is stated that refined sugar is sold in France to foreign countries at 3·63 cents per lb., while for home consumption it brings 9·40 cents.

In an official report of the French Secretary of State for 1886 some figures are given of the yearly profits realized by beet sugar factories in France. One factory realized $96,000, and many others had from $52,000 to $54,000. Other cases are cited of $74,000 and $70,000, and one factory is mentioned where the profits in a single campaign were nearly 50 per cent on the capital invested. On 10th November of that year, in a speech by the Director General of the Budget Commission in the French Chamber of Deputies, speaking of the profits of sugar factories the following was stated: "Duty is paid according to a conventional yield, which is this year 6 per cent, but the true yield appears to be nearly 12 per cent. Meanwhile 10 per cent may be taken without exaggeration. The sugar makers obtain a benefit on the yield of 30 to 36 per cent. The actual situation is a loss to the treasury of 72 million francs." During the season of 1889-90 it was estimated that in France about 500,000 acres of land was devoted to the cultivation of sugar beets, and it is said that the factories during the period of active work gave employment to 39,000 men, at an average of 73 cents per day, 4,000 women at 38 cents and 3,000 children at 34 cents.

PROGRESS IN GERMANY.

In Germany, owing to the disastrous effects of devastating wars, but little progress was made in the manufacture of beet sugar until about 1836, when there were 122 factories in operation, which increased to 152 in 1841. During that year a portion of the advantage which the factories had enjoyed was taken from them by the imposition of a light internal revenue tax on the beets used, and 7 of the factories closed. The following year the tax was increased, and 47 more ceased operations, reducing the number working to 98. The industry languished, owing to poorly constructed establishments and severe competition with cane sugar until 1845, when with the number of factories still at 98 a further tax was imposed on the beets, which reduced their number to 96.

By this time marked improvements had been effected in the quality of the beets grown, by which the yield of sugar was increased; improvements also in the process of manufacture were devised which lessened the cost of production, and the growth of the industry was continuous, notwithstanding that the Government doubled the tax on beets in 1851 and again doubled it in 1854, after which no change was introduced until 1859, when another increase was made, and for ten years no further government interference took place.

In the report of the United States Consul-General Edwards, of Berlin, on the beet sugar industry of Germany, submitted in March, 1890, we find that from 1869 to 1886 the duty on sugar beets entering factories was 1·60 marks per 100 kilos, equal to about $3.42 per ton of 2,000 lbs., and from 1886 to 1888 the tax was 1·70 marks, about $3.64 for the same quantity. Another change was made in 1888, which provides for a reduction in the tax on beets from 1·70 to 0·60 marks per 100 kilos, equal to about $1.28 per ton, while an additional tax is put on all the sugar manufactured of 12 marks per 100 kilos, being a fraction over 1¼ cents per lb. The drawback which is allowed under this new law is as follows: For raw sugar polarizing from 90 to 98 per cent, and for refined sugar under 98—8·50 marks per 100 kilos; for white sugars from 98 to 99·50, 10 marks; and for 99·50 and over 10·65 marks.

The object in view in all these changes has been to reduce the bounties which sugar makers have received through the protection which the tariff has afforded and the margin which the internal revenue regulations have allowed them. The last change, while somewhat lessening the production of sugar, has made a favourable showing on the revenue. During the fiscal year 1887-88, before this new law went into force, the taxes collected on beets and sugar amounted to $28,176,106 and the rebates on sugar exported to $25,125,184, leaving a net balance on sugar account of $3,050,922, showing that a very large proportion of the tax paid on the sugar consumed by the German people had been given by the government in indirect bounties to the manufacturers and in drawbacks to enable them to supply cheap sugar, often below the cost of production, to Great Britain, the United States, Canada and other purchasing countries. In 1888-89, while the operation of the new law had lessened the total output of sugar and brought the sum collected in taxes on this article down to $25,869,172, it reduced the amount paid in rebates to $19,058,088, leaving a net balance in the treasury on sugar account of $7,162,310, a gain to the revenue on a reduced production of $4,011,388.

From an early period the system of taxation in Germany was so framed as to prove a stimulus to improvements in the methods of manufacture and to the production of beets containing a high percentage of sugar, as the price paid for them was in proportion to their sugar contents—in short, to extract the largest proportion of sugar possible from every ton of beets used, while the system in operation in France prior to 1884 had a very different effect. In that year, as already stated, a tariff was adopted in France based on the German plan, and the results since obtained show a steady improvement. Nevertheless, Germany still takes the lead, and on account of the relative advantages she has gained continues to make beet-root sugar cheaper than it is yet possible to produce it in France.

The following table shows the relative progress of this industry in the two countries, the number of tons of beets worked, the total sugar extracted and the average percentage of sugar made from the beets from the year 1872 to 1890.*

Years.	Beets Worked. Tons.		Sugar Extracted. Tons.		Approximate Percentage of Yield.	
	Germany.	France.	Germany.	France.	Germany	France.
1872-73	3,181,550	7,168,000	262,551	408,609	8·25	5·70
1873-74	3,528,763	6,722,000	291,040	396,641	8·25	5·90
1874-75	2,756,745	7,963,000	256,412	450,711	9·30	5·66
1875-76	4,161,284	8,889,000	358,043	462,263	8·60	5·20
1876-77	3,550,036	4,863,000	289,422	243,182	8·15	5·00
1877-78	4,090,968	5,526,000	378,009	397,870	9·24	7·20
1878-79	4,628,747	7,952,000	426,155	432,636	9·21	5·44
1879-80	4,805,261	5,099,000	409,415	277,912	8·52	5·45
1880-81	6,322,203	6,934,000	555,915	333,614	8·79	4·77
1881-82	6,271,947	6,362,000	590,722	393,219	9·56	6·18
1882-83	8,747,153	6,937,000	831,995	423,194	9·51	6·10
1883-84	8,918,130	7,328,000	940,109	473,671	10·54	6·60
1884-85	10,402,688	4,512,000	1,123,030	308,410	10·79	6·87
1885-86	7,070,316	3,450,000	838,105	290,000	11·33	9·11
1886-87	9,137,316	5,484,097	1,023,734	506,384	11·87	10·00
1887-88	7,660,456	3,614,642	955,400	405,750	13·08	9·54
1888-89	7,896,183	4,216,850	978,484	474,000	11·96	9·83
1889-90	9,825,000	6,665,801	1,264,607	753,078	12·36	10·05
1890-91	10,628,000	6,473,944	1,335,000	616,888	12·50	9·80

*The following figures are believed to be about correct. They have been compiled partly from official data and partly from "The Sugar Beet" and "Licht's Circulars."

It has often been stated that the farmers in Europe and especially in Germany are fully alive to the importance of cultivating beets on their land, and to the profits of the crop. By the official records of the German government it is shown that for eighteen years ending with 1888, which are the latest records available, more than 60 per cent of the total quantity of beets used in the German empire for the manufacture of sugar was grown by owners of the factories, and less than 40 per cent by the farmers. The average production on the land worked by factories is said to have been 12 tons per acre in 1886, 10 tons in 1887, 11 tons in 1888, 13 tons in 1889, and in 1890, according to the estimate of Mr. Licht, it was 14 tons. The number of factories working during the eighteen years referred to varied from 311 to 401, the number operating in 1888–89 being 396. The average number of days of 12 hours which each of these factories worked during the period named was 78. About 700,000 acres of land are devoted to beet culture, which is said to be about 3½ per cent of the arable land of the empire.

Large profits are made by many of the factories. In 1884 some details were published as to the dividends paid by five of the large establishments, which were said to be as follows: 36, 38, 38, 43 and 50 per cent. In 1889–90 some of the German authorities state that many of the factories had made profits that year varying from 20 to 50 per cent on the capital invested. It does not however appear that the farmers share to any great extent in these large gains. In a report made to the United States government in 1888 by the United States consul at Crefeld we find the following: "The business of farming in Germany has been for some years, and is now, in a depressed and very unsatisfactory condition. This fact is particularly apparent in the prevailing low value of farms as compared with previous years. It is said by those who are in a position to be well informed on the subject that in districts which are remote from large cities, and where the consumption of milk and other perishable farm products is small, that farming properties can be purchased at 50 per cent of their former value."

"The chief reason given for the cause of this depreciation is the universally low prices steadily maintained for grain and cattle, brought on the country, it is said, in consequence of the immense importation from Russia, America and the East Indies of similar articles of food."

"The sugar manufactories are mostly in the hands of companies which control large amounts of capital, and only a few establishments are in possession of agricultural associations. Up to the present date the government has refunded to the manufacturers the entire duties collected on export sugar, and for this reason their dividends have been large; but farmers who produce the beets do not seem to have been benefited by this liberal measure, as the price of sugar beets has been tending steadily downwards."

"Farmers are however growing wise by experience, for they have learnt that the conversion of their sugar beet crops into beef, by feeding them to cattle, is a much more profitable transaction than selling them for sugar purposes at present prices."

"It is noticeable throughout Germany that scientific and modern methods of cultivating the soil are rapidly superseding past usages, and that the business of farming is being conducted upon the basis of higher intelligence and business-like principles."

RUSSIA.

The beet sugar industry in Russia was started in 1803, the first factory being built at Tula, stimulated by a bonus of $80,000. Other factories were soon established and in 1820 there were 38 in operation, in 1850, 362, and in 1862, 407. This latter number gave employment to 58,000 people, including men, women and children. In 1872 the number employed was 88,000. The factories, however, were small, and from this time forward it was found more profitable to lessen their number and increase their capacity.

In 1875–76 there were 254 factories in operation, producing 171,128 tons; in 1885–86 there were 241 working, and the product was 523,212 tons, showing that the factories had greatly increased their capacity within that time. The area of land estimated to be under beets that year was about 687,000 acres, yielding between 8 and 9 tons of beets per acre. This industry afforded employment for two or three months to 78,497 men, 12,000 women and 2,097 children. During that year the production was considerably

in excess of what the country could consume, and as the surplus sugar could not find a market at the cost of production the Russian government gave a direct bounty to sugar exported of a little more than 2 cents per lb., and under this stimulus the excess was disposed of. In July, 1886, the government abolished the bounty on sugar exported to Europe, when the trade was practically extinguished, but a bounty of about $1\frac{3}{4}$ cents per lb. was continued on all the sugar exported to the Asiatic frontier, since which nearly all the export trade has gone in that direction.

The average yield of sugar from beets grown in Russia is said to have been 8·44 per cent in 1884 and about 10 per cent in 1890. The encouragement given to the sugar makers is in connection with the internal revenue. Many of the factories are said to have averaged 25 per cent on their working capital in 1889.

AUSTRIA, BELGIUM, &c.

In Austria the system of taxation is more complicated, the factory being taxed on the juice of the beet, and levied in proportion to the number of presses or diffusors worked, which are estimated as having a certain capacity and are taxed accordingly. In Belgium the system resembles that of France, and in all other beet sugar producing countries in Europe the manufacturers receive indirect bounties on their product in connection with the provisions of the internal revenue laws, and of drawbacks on exports.

THE BEET SUGAR INDUSTRY IN THE UNITED STATES.

The first experiment recorded in the United States respecting the manufacture of beet sugar was by two enterprising Philadelphians in 1830, but as they did not appear to be conversant either with the requirements of the root or the best methods of extraction of sugar their efforts naturally failed.

In 1838 David L. Child, who had spent a year and a-half in Europe studying the methods both of the cultivation of the beet and the manufacture of sugar, established a small factory at Northampton, Mass. He adopted the method of drying and grinding the root, macerating with three times its weight of water and then subjecting it to pressure to extract the juice. He published a small book on this subject, in which he states that the cost of growing beets in the Connecticut valley at that time was $42 per acre, the average yield was from 13 to 15 tons, that the crop yielded 6 per cent of sugar and $2\frac{1}{2}$ per cent of molasses, and the cost of making the sugar was 11 cents per lb. His efforts do not seem to have been long continued, his total product being estimated at 1,300 pounds.

The next attempt to introduce this industry was made by the Gennert Brothers at Chatsworth, Illinois, in 1863. Here 2,000 acres of land was purchased and a factory erected. Subsequently this was sold to an association known as the Germania Beet Sugar Company. This establishment had motive power and machinery of sufficient capacity to work up 50 tons of beets per day. In 1886 this company raised 4,000 tons of sugar beets on 400 acres of land, an average yield of 10 tons per acre, grown at an estimated cost of $4 per ton. In the report of the United States Department of Agriculture for 1867 it is said that the Chatsworth factory had made during that year 1,000,000 lbs. of sugar. The sugar produced was highly spoken of and brought a good price, but it was said that in the earlier efforts the expense of the process overbalanced the market value of the product. This was at first attributed to injudicious management and too rigid an adherence to European ideas. The crop of 1870 covered only 330 acres, of which, owing to severe drought 130 proved an entire failure, while the remaining 200 produced an average crop of 9 tons per acre. The seed used was the White Imperial. About this time a native American western farmer was appointed superintendent, and in a letter to the United States Department of Agriculture in January, 1871, he complained of the necessity of depending "upon foreign labourers, who do not understand our language nor appreciate the necessity of economizing." He also says "the continued lack of water puts us to the most serious disadvantages in the manufacture." One year later the company failed, and such portions of the machinery as were movable were taken to

Freeport, Illinois, and combined with that in another factory which had been started in 1866 and which it was said was giving fair promise of success. The following season proved unfavourable for the growth of the beet; the results were unprofitable and this factory was soon closed. This machinery was subsequently moved again to Black Hawk, Wisconsin, where another failure was made. It is said that the entire loss on this enterprise was not less than $200,000.

In 1867 two Germans, Messrs. Bonesteel and Otto, organized a company at Fond du Lac, Wisconsin, with a capital of $12,000, and machinery having a working capacity of 10 tons of beets per day. Although the capital of the new company was small and their operations limited, these men were so far successful as to attract the attention of capitalists, and they were induced to abandon their factory in Wisconsin and to proceed to California to take charge of the works of the California Beet Sugar Company, which had just been organised at Alvarado, Cal., with a capital of $250,000, and a capacity of 50 tons per day.

The interest awakened by the general discussion of this subject in Canada stimulated the inhabitants of the neighbouring State of Maine and led to the organization of the Maine Beet Sugar Company at Portland. This company at first proceeded cautiously. A number of experimental plots were grown by farmers during 1878 in different parts of the State, and the beets were brought together and manufactured into sugar on the premises of the Forest City Sugar Refining Company, and the results of the experiment were so encouraging as to lead to active and vigorous efforts to establish the industry on a large scale the following year. Contracts were made with 1,700 farmers to grow 1,300 acres of beets, which the company agreed to pay for at $5 per ton delivered at any station on the Maine Central Railway, with whom the company had made arrangements for low rates of freight.

A special agent was sent to Germany to take personal charge of the bringing out of men, and of machinery, previously ordered, with the latest improvements, from the best makers. The entire establishment was said to be complete and perfect in all its appointments, the total cost of machinery having been something over $60,000. The outlay for the plant would have been much larger but for the fact that the company occupied the premises of the Forest City Sugar Refinery, already fitted with steam engine, centrifugals, bone-black filters, &c.

Circulars of instruction and advice were issued to farmers as to the culture and care of beets, and agents were employed to visit the beet fields from time to time during the summer to see that these instructions were carried out. The season, however, proved unfavourable: the spring was late, cold and dry, and the young plants were injured by early frosts, so that the result was an average of only about 9 tons per acre.

The company commenced manufacturing on the 20th of October, and on the 27th was working to the full capacity of 150 tons per day, and continued in operation for a period of about 60 days. The result of the season's work was 1,440,000 pounds of raw sugar, which was sold at 8½ cents per pound, a total of $122,400, while the company also obtained a bounty which had been offered by the State of $7,000. The company paid out during the space of six weeks about $60,000 for beets, and the season was regarded as successful, although it was stated that "the results of another year must be known before its positive success can be assured." What they aimed to do the next season was to secure a sufficient quantity of beets to keep the factory in operation for a period of 100 days, working 200 tons per day. Mr. S. L. Boardman, writing to "The Sugar Beet" in February, 1880, p. 14, says: "It simply remains for the farmers to grow the beets, in order to establish the new industry in New England. And in connection with the deep culture which the crop demands, the high fertilizing and the cleanly care of the land, with the feeding of the pulp to farm animals, it only needs for the enterprise to become fully established to convince all farmers that it will do for the great east in restoring its lost fertility and bringing up its agriculture to a high standard what has been hoped for by its most earnest advocates and supporters. But its success rests more largely with the farmers than the sugar manufacturers. If the farmer will but grow the beets in sufficient quantity the company will guarantee the permanent success of the industry."

In 1879 most of the beets received at the factory were from Maine farmers. In the July, 1880, number of the journal quoted we find the following remarks by the same writer: "The results of the canvass this season show that a much less number of farmers in this State (Maine) have contracted to grow beets than last year, while it has also been necessary to go into Massachusetts, New Hampshire, Vermont, New York, and even Canada, in order to secure a sufficient number of acres to ensure the working of the factory for a profitable season during the coming fall and winter." He further says: "The works of the company will not close, even though Maine farmers should largely stop growing beets. Portland is admirably located in regard to railroad connections with Massachusetts, New Hampshire and Canada. The machinery and works of the company are new, ample, and in every way satisfactory, and the managers of the company are determined men, who do not turn aside for trifles, understand the business thoroughly, and are bound to make it a success."

During this season the factory commenced operations on the 15th of October. The total number of tons of beets worked was reported as 7,000. The average proportion of sugar produced was 6 per cent, corresponding to 420 tons of first grade. Employment was given at the factory to 120 workmen, whose average wages were $1.25 per day, but on the 10th of December, after a run of 56 days, the work ceased for want of further material. In the October number (1880) of "The Sugar Beet," the editor publishes an account of a visit made by him to the Portland factory, in which he says: "The beets are transported great distances and paid for at an enormous price, considering their quality," but he asserts that sugar in Portland is not by any means made at a loss, "as the profits were sufficient, as shown by last year's experience, to justify considerable encouragement." The difficulties of inducing farmers to raise beets, and of being obliged to utilize whatever quality they happen to grow, are without doubt immense obstacles to overcome. But the purchase or the renting of land and its cultivation by the beet sugar company is an easy solution of the difficulty."

Notwithstanding all the efforts made, in the following year, 1881, the farmers could not be induced to grow the beets, even at $5 per ton, and the factory had to be closed and the enterprise abandoned for want of sufficient material.

FRANKLIN, MASS.

A factory was also built in Franklin, Mass., in 1880, after the subject had been well considered and many careful tests made in growing beets. The building is said to have been very complete in all its appointments; the machinery was of the best, and was imported from Germany.

In a letter from E. L. Metcalfe, president of the company, dated 14th December, 1880, published in "The Sugar Beet," he says: "Our factory was started on the 24th November, slicing 95 tons of beets in 24 hours. The factory is now doing splendid work. The cost of our factory and outfit has far exceeded our expectations, having cost us nearly $125,000. Our last sale of sugar (100 hogsheads) was sold at 8 cents; hope to get more for the next." In March, 1881, he writes again, and states that the company was in financial difficulties; that the total cost of the entire property had been $131,000. The quantity of beets worked that season was 3,321 tons, which had cost, delivered at the factory, $20,300, a little over $6 per ton. This was only sufficient to keep the works running for 30 days; the product was 235 hogsheads of sugar and 180 hogsheads of syrup. A portion of this was sold for $21,000, and the balance on hand was estimated to be worth from $15,000 to $16,000. The cost of working the beets, including pitting, was $13,300, over $7,000 having been paid in labour. It was thought there would be a profit of about $3,000 (less than 2½ per cent on the capital invested) when the accounts for the season were finally made up.

The industry here was very short-lived; the experience was so discouraging that in August, 1881, it was announced that the factory was to be sold at auction for what it would bring, and on 15th September, 1881, it was sold for $32,300 and converted to other uses.

WILMINGTON, DELAWARE.

After experiments in growing sugar beets had been carried on for several years in the State of Delaware with satisfactory results as to sugar yield, the Delaware Beet Sugar Company was organized in Wilmington, Del., in 1879. Contracts were made with farmers for beets at $4 per ton, to be grown from seed to be supplied by the company; 600 acres were contracted for, from which it was expected that at least 6,000 tons would be forthcoming. The situation for the enterprise was spoken of as an excellent one with a plentiful supply of water for use of the factory, and cheap railroad and water transportation, and it is said that $80,000 was invested in the undertaking. To stimulate the farmers in the production of beets the State of Delaware offered in 1880 a number of premiums, to the extent of $3,000 in all, for the largest and best paying yield to the acre, the prizes varying from $10 to $50 each.

The factory began working 8th November, 1881, and finished in the early part of December, having worked about 40 tons per day for a period of 30 days, in which time all the beets that could be obtained, about 1,100 tons, were used. The number of hands employed was 42, the wages varying from $1 to $1.25 per day.

The small quantity of beets available was said to be owing to a dry season and the prevalence of a destructive insect. The result was very disappointing, and it was said that the farmers realized but little more than expenses.

In "The Sugar Beet" for May, 1881, the editor says: "One of the greatest difficulties to be contended with in the introduction of the beet sugar industry into the United States is a foolish prejudice of farmers against this crop. There's no money in it, they all cry, and decline to enter into a contract with the manufacturer. The consequence is that the Delaware Beet Sugar Company expect to plant 300 acres this year, and will possibly the coming season grow all that may be required for the campaign." In the same publication, page 38, we find a communication from Mr. K. J. Kribbs, superintendent of the Delaware Beet Sugar Company, in which he says: "The present condition of the industry, it must be confessed, is not very gratifying. It is essential that sugar beets of sufficient richness and at low cost be grown, so as to enable the manufacturer to work them to advantage. A factory once established anywhere would no doubt have a beneficial influence, but it will not in many cases prove a success, as the sums annually sunk are too large not to tire the most open-handed stockholders."

In the August number of the publication referred to the editor gives an account of a visit he had paid to the fields of beets being grown by the Delaware Beet Sugar Company. There were 400 acres in all, and it was estimated at that time that the cost of growing would not exceed $40 per acre, and with a fair crop it was expected that the beets could be delivered at the factory at a cost not exceeding $4 per ton. Subsequently this crop was harvested; the cost of growing was said to be $50 per acre, with an average yield of 10 tons. After these beets had been used at the factory the establishment was closed for want of further material, and the enterprise was abandoned.

ALVARADO, CALIFORNIA.

It has already been mentioned that the two Germans Bonesteel and Otto, who carried on a small beet sugar factory at Fond du Lac, Wisconsin, for two years prior to 1869, where induced in that year to close their factory in Wisconsin and undertake the management of a much larger establishment in Alvarado, Cal.

On arrival there in the spring of 1870 a location was chosen on the farm of E. H. Dyer; the buildings were planned and by November they were ready for occupation. After carrying this industry on for four years it proved a financial failure. The managers contended that the location not being suitable was the cause of the failure, and they succeeded in organizing a new company, which purchased the Alvarado machinery and removed it to Soquel, Santa-Cruz county, where, after operating for several years subjecting the stockholders to a heavy annual loss, the enterprise was finally given up.

Mr. E. H. Dyer, who had bought the buildings and part of the land owned by the old company at Alvarado, was still of opinion that with good management the business

might be made to pay at that place, but found it difficult in the face of so many failures to induce capitalists to invest enough money in it to give the business another trial, and it was not until 1879 that the Standard Sugar Manufacturing Company was incorporated with a capital of $100,000. It was soon found that more capital was needed, and subsequently it was increased to $200,000, and the company re-incorporated under the name of the Standard Sugar Refinery, with E. H. Dyer as general superintendent.

This company has, owing to the capable and economical management of Mr. Dyer, been fairly successful. In a letter addressed to the "Sugar Beet," 16th July, 1880, he says: "I regret that I cannot give a very flattering account of our first campaign, as for various reasons it has not proved financially successful." One of the causes cited was the employment of a foreign sugar maker, who proved to be incompetent; another was the late period at which the factory commenced working, and deterioration of the beets by being too long kept. Mr. Dyer says: "What is needed to start the business and insure its success in the shortest possible time is liberal government aid for a few years; without it the industry will linger along for years. There have been so many failures in the United States in attempting to start this industry that it is very difficult at this time to obtain sufficient capital to made a successful experiment without some encouragement of this kind." During this first season the factory worked 10,329 tons of beets, which yielded about 6 per cent and produced 1,244,502 lbs. of sugar.

In February, 1881, in the same journal, this factory is reported to have made satisfactory returns as to yield and quality. It had worked 70 tons of beets per day, at less expense than the year before, the average yield in sugar and molasses being 8 per cent. It was further stated that the pulp had found no market. During this second season 9,298 tons of beets were worked, yielding 6·54 per cent of sugar, producing in all 1,125,722 lbs. In May, 1881, it was announced that the Standard Sugar Company of Alvarado had paid a dividend to its stockholders, it being the first dividend earned by any beet sugar company in the United States.

In 1882, to encourage the cultivation of the beet, the company offered prizes to the extent of $530—for the best 100 acres of beets $200, and lesser prizes for smaller quantities on the basis of $2 per acre. This year the factory worked 11,230 tons of beets, yielding 6·20 per cent of sugar, the total product being 1,391,688 lbs. At this time the sugar was sold at 10·84 cents per lb., and the profits were claimed to be 30 per cent. The price paid to the farmers for the beets was from $4 to $4.50 per ton of 2,000 lbs. This year the company also grew 100 acres of beets of its own.

In consequence of dry weather in 1883 a small area of beets was planted. The factory received about 7,000 tons, which yielded 7·30 per cent of sugar, or a total product of about 1,027,000 lbs. of white sugar with some of the lower products still unrefined. Mr. Dyer states that the results from the feeding of the waste pulp both to dairy cows and beef cattle on their own premises had been very satisfactory. The net profits on the sugar produced by the factory for the 90 days it was working is said to have been over $21,000. The price realized for the sugar was about 10 cents per lb.

In 1884 the factory worked 217 days, using 16,354 tons of beets, a little over 75 tons per day, which produced 2,167,273 lbs. of sugar, or about 7 per cent. A portion of the sugar was sold for a fraction over 8 cents per lb. The price paid for beets varied from $4 to $4.50 per ton. As this campaign was referred to by Mr. Dyer as an unfortunate one, it may be presumed that the profits, if any, were small. A large part of the sugar of this year's make was held over in hopes of a rise in price.

The seventh campaign, 1885, is said to have been very short and the profits small, owing to the limited capacity of the works—only 80 tons per day—and the low price of sugar. It is also stated that in consequence of the explosion of a boiler towards the close of the campaign a considerable sum would be required for repairs.

In the "Sugar Beet" for February, 1886, it was announced that a new company in California had filed articles of incorporation for the manufacture of beet sugar with a proposed capital of $1,000,000, divided into 10,000 shares of $100 each, of which sufficient for working had already been subscribed. In the same journal for May, 1886, the prospectus of the new company was published, to be known as the Standard Sugar Com-

pany. It is there stated that the new company had purchased the real and personal property of the Standard Sugar Refinery and proposed to continue the business of the former company on a more extensive scale, by erecting an additional factory capable of treating at least 200 tons of beets per day.

In this prospectus it is stated that "during the past five years the present refinery has treated 58,876 tons of beets, making 6,884,336 lbs. of refined sugar, realizing a profit of $97,987.14, of which $44,000 was paid in dividends and $53,987.14 was added to the original capital of $115,000."

From this statement we gather that the average yield of sugar at the Alvarado factory from the commencement had been nearly 6 per cent (5·85 per cent). That out of the profits an average of about 9½ per cent had been devoted annually to improving the works, and that the dividends had averaged about 7¾ per cent per annum on the original capital.

The new company was to pay $150,000 for the buildings and plant, invest about $250,000 in a new factory, having the remainder of the capital in reserve, to be paid up as required for the construction of additional plant when found necessary. The estimate given as to the probable cost of beet sugar manufactured on this larger scale was 4½ cents per lb. and the probable profits 25 per cent annually on the capital invested.

In the November number (1886) the editor of the "Sugar Beet" stated that he had received a confidential letter from Mr. Dyer, informing him that the prospects were most excellent for the starting of the new factory, and that as soon as the total amount was subscribed the machinery would be ordered from Germany.

The necessary repairs to the old factory were not made, and the new project did not seem to be received with favour by investors. In a subsequent letter from Mr. Dyer, in "Sugar Beet," November, 1887, he speaks of another company having been organized (which was on a smaller scale), with a proposed capital of $500,000, known as the Pacific Coast Sugar Company. He says that this company had purchased the property of the Standard Sugar Refinery for $125,000, payable in stock of the Pacific Coast Sugar Company. There were to be 5,000 shares of stock, $100 per share, issued to subscribers, which would be assessed $25 a share, amounting to $125,000. This amount was to be paid in small instalments of about $2 at a time, and extending over nearly a year. The old factory was to be rebuilt, and sufficient new and improved machinery added to make it first-class in every particular, at an estimated cost of $75,000, leaving a cash surplus in the treasury of $50,000 for working capital. It was also said that the foundations of the new factory had been commenced.

In August, 1888, it was stated that "the refining of beet sugar by the Pacific Coast Sugar Refinery will not commence before 1st September. The company has a paid up capital of $250,000. The new refinery will consume 200 tons of sugar beets per day, which will give an output of 20 tons of refined per diem." The factory began work some time in November, but no account was given of the results obtained. In August, 1890, it was stated in the "Sugar Beet" that the stock of this company had been bought up by parties in San Francisco interested in sugar refining, and that Mr. Dyer had sold out his interest in the company. The editor says: "We greatly regret being unable to give complete data respecting the experiences of the past campaign. In Germany and France there is no secrecy respecting methods and results, but in the United States there seems to be a certain reserve and mystery."

We have been unable to find any reliable data regarding the working of this factory either for 1890 or 1891. In the November number of the "Sugar Beet" for 1891 there is published an extract, without date, from the *Tribune*, Oakland, Cal., as follows: "The affairs of the sugar company at Alvarado were considered at a meeting of the stockholders. The books showed a profit for the years 1890-91 of $21,000" (a little over 8 per cent on the paid-up capital of $250,000). "On account of a probable shortage in the sugar beet crop the directors have advanced the price paid for beets from $4.50 to $5 per ton." The president also referred to the probable necessity of removing the company's works from Alvarado, on account of a deficiency in the water supply, the waters forming the source of the Alameda creek having been diverted from their regular course.

The results obtained from the working of this factory, which has been so often cited on account of its success, may be briefly summarized as follows :—

It began the manufacture of sugar in 1879, and the first season it was "not financially successful." For the next five years, from 1880 to 1884, inclusive, the profits enabled the directors to expend 9½ per cent annually on the original capital and to pay dividends to the stockholders, which averaged about 7¾ per cent per annum. In 1885 the campaign is said to have been short and the profits small, and towards the close of the season the factory was injured by the accidental explosion of a boiler. No immediate repairs were undertaken, but early in 1886 efforts were made to form a new company with a capital of $1,000,000 to buy out the old company and increase its capacity. These, however, were not successful. After nearly a year had elapsed another company was organized with $500,000 of capital, of which eventually one-half was paid up. The old factory, with the machinery (the first cost of which was $115,000), in which Mr. Dyer is said to have had a two-thirds interest, was bought by the new company for $125,000, and about $75,000 was spent in enlarging the works and the introduction of new machinery. The factory remained closed from the time of the accident in 1885-86 until November, 1888. No reliable accounts of the results of the campaign for 1888-89 are obtainable, but in August, 1890, another deal was made; another new company buys out the one so recently formed, and Mr. Dyer sells his interest in the concern and severs his connection with it. What proportion of the 8 per cent of profits for 1890-91, referred to by the Oakland *Tribune*, would be available for dividend is unknown, but the contemplated removal of the company's factory would in all likelihood absorb this and necessitate further payments on stock.

It should be borne in mind that during the five-year period when the dividends referred to were made all the sugar manufactured was sold at from 8 to 11 cents per lb., an advantage not likely to occur again. Chinese labour also lessened the sum paid for wages in the factory, and by its employment in the fields a large quantity of beets were annually secured. The *California Rural Press* says: "The system adopted in this country, and which has proved most successful, is for the farmer to prepare the land, sow the seed and do all the work that can be done by teams. When the beet has become quite strong the farmer makes a contract with Chinese, Portugese or Italians to take care of and harvest the crop, delivering the beets on the farmers' waggons, at a cost of $1.50 per ton.

Recent Development of the Industry.

Within the past three years a great impetus has been given to the beet sugar industry, and more especially since the passage by the United States Congress of the McKinley Bill, with its provision to pay a bounty of 2 cents per lb. on all sugar manufactured in the United States for 14 years, the period dating from 1st July, 1891, to 1st July, 1905. Five new factories have been built and equipped with the latest and most improved machinery, making, with the Alvarado factory, six sugar factories now in operation in the United States. These are located as follows: One at Watsonville, California, owned by Mr. Claus Spreckels; one at Alvarado, owned by the Alameda Sugar Company; one at Chino, in the San Gabriel valley, Cal., owned by Oxnard Bros.; one at Lehi, in Utah, managed by Mr. E. H. Dyer; and two in Nebraska, one at Grand Island and one at Norfolk, both owned by the Oxnard Bros.

WATSONVILLE.

In "The Sugar Beet" for February, 1888, a letter is published from Mr. Claus Spreckels, in which he states that all the arrangements have been completed for the erection of the beet sugar factory at Watsonville. Its capacity was to be 350 tons of beets per day, and the machinery was on the way from Germany. Contracts had been made with the farmers for raising beets, the company to furnish the seed and to pay the farmers $4 per ton, and should the roots contain more than 14 per cent of sugar the farmers were to receive 50 cents per ton for each additional per cent.

To stimulate beet production Mr. Spreckels offered a prize of $500 to the farmer cultivating ten acres or more of beets who had the largest return of sugar per acre, and $250 to the farmer cultivating five acres with the largest yield of sugar.

The land on which this factory is located is said to have been a gift of the citizens of Watsonville. The factory was completed in time for the working of the crop of 1888, and from the official returns furnished by Mr. Claus Spreckels to the United States Department of Agriculture at Washington and to the Commissioner of Labour Statistics for the State of California he says that the quantity of beets worked was 14,077 tons, which produced 1,640 tons of sugar (3,280,000 lbs.); 135 men were employed and the time run was 61 days. The average sugar contents of the beets as shown by the polariscope was 14·60; the average of sugar recovered, 11·65; the average price realized for the sugar was 5·64 cents per lb.; average polarization, 95·40; and the average price paid for beets was $5.04 per ton. The number of acres of beets planted was 2,121, which shows an average of a little less than 7 tons to the acre. He also claims a profit on the first season's work of $29,932.48, which, estimating the investment at $400,000, is a return of a little over 7 per cent. In January, 1889, Mr. Spreckels stated before the Senate Committee in Washington that there were delivered at his factory during the previous season 15,000 tons of beets, at an average price of $5.52 per ton; that the crop had averaged 15 tons per acre, with sugar contents 11¾ per cent, as against 10 to 14 per cent in Germany. Mr. Spreckels said the profits of beet sugar making under the protective tariff was $20 per ton, but the tariff reduction would amount to $25 a ton, which would indicate that with free sugar and no bounty there would be a loss of $5 a ton on all the sugar made.

Beet contracts were offered at Watsonville in 1891, either on the old plan of $4 per ton with 50 cents added for each per cent of saccharine matter above 14, or a straight price of $5 per ton, beets not to weigh over 4 lbs. each.

During my recent journey, the establishment of Mr. Spreckels in Philadelphia was visited, when Mr. Augustus Spreckels, who has the management of the Watsonville factory, kindly gave me the following information:

The Watsonville factory is of sufficient capacity to work 375 tons of beets per day. There is no difficulty in getting a sufficient quantity of beets for the factory; most of them are grown by farmers, although a large acreage has been grown by the proprietors of the factory, who have secured an extensive tract of land to carry on this work. The price at present paid for beets is $4.25 per ton containing 14 per cent of sugar, with 25 cents per ton extra for each additional 1 per cent. of sugar.

Mr. Spreckels says that they find the sugar strength of the beets in California is well maintained, and he does not think that an average yield of 9 per cent of first sugars would be too high an estimate for their factory. The Watsonville factory makes raw sugar only; all the product is shipped to San Francisco to be refined. Mr. Spreckels thinks it is doubtful if the manufacture of beet sugar will ever become so far self-sustaining in the United States as to admit of its being carried on successfully without the aid of a bounty.

GRAND ISLAND, NEBRASKA.

During the latter part of 1889 and early in 1890 negotiations were in progress between the city of Grand Island and the Oxnard Brothers in reference to the establishment of a beet sugar factory in that place. A liberal grant of land of some 40 or 50 acres adjoining the city, with freedom from taxes for a term of years and a written guarantee from the leading citizens that there should be raised in that neighbourhood for the use of the factory each year not less than 2,500 acres of beets, induced the Oxnards to locate there and a very extensive and complete factory has been built at a cost for buildings and machinery as given to the writer by Mr. H. T. Oxnard of about $350,000. Prior to the erecting of this factory further encouragement had been given by the passing of an Act by the State of Nebraska providing for a bounty of 1 cent per pound on all sugar produced within the State.

Extensive contracts were made in the spring of 1890 with the farmers for beets at $3.00 per ton of 2,000 lbs. for roots containing not less than 12 per cent of sugar, and a further allowance of 25 cents per ton for every additional per cent the beets contained. They were to be grown from seed of the best varieties imported from Europe by the proprietors of the establishment. The farmers entered into these engagements with the expectation that the crop would give from 15 to 20 tons per acre, but the season was unfortunately a very dry one; every crop suffered from the drought. The yield of beets was very small. Dr. Wiley, chemist of the United States Department of Agriculture, places the average in Nebraska for that season at 3 tons per acre, but Prof. Nicholson, of Lincoln, Neb., who has paid great attention to this subject, thinks this estimate too low and believes the average to have been from 5 to 8 tons. The factory was completed in time for the crop but was only able to work for a short period for lack of material. We have been unable to find any published details of the results of the first season's operations, but from the statement made by the Oxnards to the Inspector for the State of Nebraska when applying for the bounty, it appears that their claim was $7,364, representing a total output of 736,400 lbs. of sugar. Supposing the yield to have averaged 9 per cent, this would indicate that 4,091 tons of beets were used at the factory, a very poor showing for an establishment with so large a capacity.

The discouragement resulting from the disappointing crop, together with the low price paid by the factory for the beets, made it difficult in many instances to induce farmers to undertake beet culture again. A feeling also seems to have been aroused by opponents of the bounty against the manufacturers, and the farmers having the following year a majority in the House of Representatives repealed the Act granting 1 cent per lb. bounty on all sugar made in the State of Nebraska. It being held that since the Federal Government had provided for a bounty of 2 cents per lb. for 14 years from the 1st of July, 1891, it was unfair to further tax the farmers in order to put more money into the pockets of the manufacturers.

On arrival in Grand Island on the 13th of November I found the factory—which is located a short distance outside the town—in full operation. There I met Mr. Henry T. Oxnard, who was exceedingly kind and courteous, and took me through the factory and explained the operations in progress from the time the beets enter the washer until the granulated sugar falls into the bags in which it is shipped to market. Every part of the establishment seemed to be in thorough order, well supplied with every device for the saving of labour and all working smoothly.

The production of first sugars from the roots used was about 9 per cent. and about 2 per cent more was expected to be realized from the second sugars making, 11 per cent in all of crystallized sugar from beets averaging about 14 per cent, by the polariscope test. The proportion of sugar left in the pulp was from $\frac{2}{10}$ to $\frac{3}{10}$ of 1 per cent; the remaining sugar loss occurs in the scums, lime cake, transport water and in the final residue. The pulp is very difficult to dispose of. It is offered to farmers at 25 cents per ton, but there is very little sold even at this low figure. The quantity of beets being used at the time of my visit was about 250 tons every 24 hours, and the output of sugar was about 35,000 lbs. per day; the men employed would average about 75 by day and a similar number at night. The day workers made 11 hours at 15 cents per hour and the night men 13 hours, for which they were paid at the same rate, each gang working day work one week and night work the next week. The consumption of coal was said to be about 50 tons per day and its cost $3 per ton.

The Norfolk factory was visited on the 17th and 18th November. The weather had been very cold for several days, and during the night of the 17th the thermometer dropped to 6 degrees below zero with a brisk wind blowing. The beets, of which there was a large quantity at the factory, were frozen hard, and were being worked up as fast as possible, so as to get them into the diffusors before they should thaw again. Freezing does not appear to injure the beets for sugar making if they can all be worked up while in a frozen condition, but the freezing kills the beets, and as soon as they are thawed again incipient decomposition begins, the proportion of sugar decreases rapidly and the extraction of what remains becomes much more difficult.

This factory, which is situated about a mile from the town, is very complete in all its appointments and is considered superior in equipment to that at Grand Island. To induce the manufacturers to locate in Norfolk $100,000 was given in cash and a large piece of land adjoining the town, the value of which was estimated at about $50,000. The establishment is also free of taxes for a term of years, and a guarantee was given by the people that a specified acreage of beets should be grown annually in the neighbourhood for the use of the factory. Everything is quite new, and this is its first season for working. Operations began on the 14th October, and the stock of beets on hand was probably sufficient to keep the factory going until near the end of November, working about 250 tons per day.

The quantity of sugar which had been made at the Norfolk factory up to the date of my visit was 1,160,000 lbs.

In consequence of the discouraging experience had by the farmers last year in growing beets for the Grand Island factory it was very difficult to induce a sufficient number to enter on their cultivation here. They were also dissatisfied with the price paid by the factory, which was the same as at Grand Island; complaints were also made of cutworms destroying the young beets. After a thorough canvass of the district not more than 1,000 acres were contracted for by farmers and late in the season syndicates were formed of the merchants and business men of Norfolk and 1,300 acres more planted in order that the acreage which the citizens had guaranteed, should be grown for the factory. From parties interested in these syndicates it was learned that the results had not been encouraging, owing to the difficulty in obtaining labour and the late period when operations were begun. One syndicate had undertaken to grow 1,000 acres and two others 300 acres between them. The syndicate with the larger acreage had nearly 100 acres in the ground at the time of my visit, which were frozen so hard that they could not be dug, and a thaw which would take the frost out of the ground would in all likelihood spoil the beets. The most difficult problem to solve in connection with the successful working of this industry in Nebraska is that of obtaining the necessary labour for harvesting the beets and delivering them to the factory, as that demand occurs at a time when all the farmers are very busy in harvesting their corn and other crops and in preparing the land for the next season. From the number of placards seen in prominent places both here and at Grand Island offering 15 cents per hour for men to harvest beets, it was evident that earnest efforts had been made to overcome this difficulty. With the view of inducing the farmers to grow larger quantities the proprietors of the factory have resolved to advance the price next season to $4 per ton.

A third factory was built by the Oxnard Bros. in Chino, California, where it is belived there is a large area of land adapted for raising beets of superior excellence. Mr. R. Gurd, a large land owner in the San Gabriel valley, where the factory is located, has it is said engaged to cultivate sugar beets for the Oxnard factory on a gigantic scale for a period of five years as follows: 2,000 acres in 1891, 4,000 in 1892 and 5,000 in 1893 to 1895. In the "Sugar Beet" for August, 1891, it is stated that the company will pay $3.50 per ton for sugar beets averaging 12 per cent of sugar and 25 cents per ton extra for every additional 1 per cent of sugar. Not much could be learned so early in the season as to the results of the working of that factory, further than this, that it was producing a fair output of sugar.

The other factory at Lehi, Utah, which is under the superintendence of Mr E. H. Dyer, formerly manager of the sugar factory at Alvarado, California, has also been in operation during the past season, but no results have yet been published. In this factory the machinery is entirely of American make, most of it having been manufactured in Cleveland, Ohio. It was stated during the summer that 2,300 acres of beets were being grown for this factory.

While at Washington much information was obtained from Dr. H. W. Wiley, chemist of the Department of Agriculture. Under Dr. Wiley's direction an elaborate and extensive series of tests have been carried on for several years past on sugar beets grown from seed distributed free of cost by the department to parties residing in different portions of the States. He has also visited most of the larger factories and investi-

gated their operations. He is of opinion that all of the best equipped factories extract now about 85 per cent of the sugar in the beet root, about 75 per cent as first sugars and about 10 per cent from the seconds. He finds that the pulp varies in the proportion of sugar it contains, but it will average about $\frac{1}{10}$ of 1 per cent. It is, he says, of low feeding value, about one-fourth that of the beets, and may be fed with some profit if it can be hauled away without expense. For instance, a farmer who brings a load of beets to the factory may find it pay him to haul pulp back, but its value is not sufficient to admit of paying freight on it. He says that pulp should be pressed before it is fed. In this way 25 to 30 per cent of the water it contains can be got rid of.

Under Dr. Wiley's supervision a sugar beet experiment station of 25 acres has been established at Schuyler, Nebraska. The beets are grown there for the purpose of raising seed from them. The best varieties only are planted, and the beets when mature are carefully selected and the average percentage of sugar ascertained before they are pitted. In the spring those which remain soundwillbe tested individually before planting, by scooping out a small portion of the substance from about the middle of the root and submitting it to analysis, and those only which show the highest percentage of sugar will be planted. In this way it is hoped that strains of seed of special value to America will be developed and the average yield of sugar still further increased. The beets grown at this station have cost during the past year $60 per acre to produce, the crop being 22 tons per acre. Dr. Wiley thinks that $40 per acre would be about the average cost to the Nebraska farmer where all the labour has to be paid for. During my stay in Washington opportunity was afforded through the kindness of J. B. T. Tupper, Esq., of the Sugar Bounty Division of the United States Internal Revenue Department, of studying the system under which this bounty is administered. It was expected that the department would be called on to pay from $9,000,000 to $10,000,000 in sugar bounties this year, of which over $8,000,000 would go to the Louisiana planters. There are from 600 to 700 of these operating under the Act. The remainder will be paid in bounties on beet sugar, sorghum sugar and maple sugar.

While in the west visits were paid to the experiment stations at Lincoln, Nebraska, Ames, Iowa, and Madison, Wisconsin, at all of which special work in sugar beets is being carried on. At Lincoln, under the supervision of Prof. Nicholson, a large number of samples are being tested from all parts of Nebraska. Those grown at the experiment station and around Lincoln average this season about 15 per cent of sugar. Preparations have been made at this station also for growing beet seed from selected beets of first quality. A large number of good specimens have been siloed, and those which come out in good condition in the spring will be separately tested for their sugar contents before they are planted. It is in contemplation to establish a sugar school in connection with the State University at Lincoln, where practical instruction will be given in the growing of the beets as well as in the manufacture of sugar from them.

At Ames active operations were in progress in testing sugar beets from different parts of Iowa, under the supervision of Prof. Patrick. Similar work is being conducted at Madison, Wisconsin, under Prof. Babcock. At this latter station experimental plots of beets, covering two acres, have been grown under direction of Prof. Henry, who has devoted much attention to this subject, and beet seed has been sent by him to 1,000 farmers in different parts of the State. Over 400 of these had sent in samples prior to my visit, which averaged in sugar contents about 13 per cent. The beets grown at the station averaged higher, running from 15 to 17 per cent, but on account of the very dry weather which prevailed here the beets are very small and the crop light. On this account they would show a higher percentage of sugar than those grown in localities having an average rainfall.

Satisfactory results are also reported from Colorado, Michigan, Nevada, Oregon, Wyoming and other States, where similar tests have been conducted, all serving to establish the fact that there is a very large area in the United States where sugar beets of good quality can be successfully grown.

THE BEET SUGAR INDUSTRY IN CANADA.

For many years past much interest has been felt in this subject in Canada. Early in 1872 the Department of Agriculture in Ottawa sent a special immigration agent, Mr. Edward Barnard, to Europe with instructions to make enquiries concerning this industry, to procure and forward a quantity of seed sufficient for fifty acres of land and to find out the cost of a cheap factory for manufacturing the sugar. He was to ascertain if it would be possible to send men to Manitoba to grow the beets and to manufacture sugar from them that year, "to enquire as to the number of acres necessary to supply beets sufficient for a factory and to find out the average weight of sugar yielded by a bushel of beets."

Mr. Barnard obtained seed sufficient for 50 acres and forwarded it to Ottawa, and subsequently prepared a report embodying the results of his enquiries. He stated that the machinery and appliances for a factory should be complete and of the best quality, and that the cost for such establishments in Europe for buildings and machinery varied from $60,000 to $80,000, besides which a considerable capital is generally employed by manufacturers in producing a large proportion of the beets required in the manufactory. He submitted particulars as to the number of factories in Europe, the quantity of sugar annually made and the mode of cultivating the beet.

Mr. Barnard, writing from Antwerp on the 29th of March, stated that as the season was already so far advanced he would not advise sending men from Europe to Manitoba to grow sugar beets that year, and suggested that experiments be made in different parts of the Dominion with the seed he had sent, with the view of ascertaining the sugar strength of beets grown in Canada. With regard to the yield per acre, he says that 12 to 15 tons is regarded as a good average crop; that the average number of tons worked per factory in Germany was 3,400 in 1840, but it had increased to 8,000 tons in 1870. He also expressed the opinion that the winter climate of Quebec and New Brunswick was more favourable for the manufacture of beet sugar than that of Germany, France or Belgium; that on this account the working season could be so prolonged that double the quantity of sugar could be made for the capital employed, an advantage which he considered would fully compensate for the difference in wages. He further stated that the quantity of sugar contained in the best beets varied from 12 to 18 per cent, but manufacturers considered they had been quite successful if they obtained an average of 8 per cent; but when the yield of sugar did not exceed 5 per cent of the weight of the beets used they considered their work as unprofitable.

Enquiries were made by Mr. Barnard particularly in Belgium "with relation to the increase in value of lands caused by the introduction of beet sugar factories." He says: "I ascertained that sugar beet producing farms which rented from $3 to $4 only per acre previous to the establishment of beet root sugar factories secure excellent crops of grain and grasses; moreover, the pulp of the pressed beets and the extra fodder produced by the improvement in the culture of the soil enables the farmer to feed with profit double the quantity of stock. In fact, the beet crop requiring proper drainage, clean and deep cultivation, a regular rotation with abundant manuring, forces the farmer to follow out the best teachings of scientific agriculture. In the countries where beet sugar is manufactured the production of wheat has more than doubled since the introduction of this industry. In Germany the cost of the beet root sugar is estimated at from 5 to 6 cents a pound. This allows for the cost of beets per ton, $3.50; excise duty per ton, $3.39. However, the labour necessary in the manufacturing of the sugar is only counted at 36 cents per day for men and 20 cents for boys."

Subsequently the interest in this subject was maintained by the advocacy of the press and by addresses delivered before agricultural societies and other gatherings of farmers. In 1876 Mr. Oct. Cuisset, of Quebec, "Industrial chemist and manufacturer of beet root sugar," wrote a "Popular Treatise on Beet-root Culture and Sugar Fabrication in Canada," in which he says: "It is now by experience incontestably shown that the soil of Canada is favourable to the cultivation of the sugar beet;" "that with a good system of cultivation 15 or 20 tons per acre could be easily raised." Again: There can

be no doubt of the excellence and saccharine richness of the beets raised in various parts of Canada, as well in the Province of Quebec as in Ontario. I will say further, that they have generally been found to be uncommonly rich." After giving a brief summary of the history of the industry in Europe he dwells at some length on the culture of the beet and the manufacture of the sugar.

In 1874 this matter engaged the attention of the Quebec Legislature and a bounty of $25,000 was offered to the first successful manufactory of beet sugar in the province, and in 1875 this offer was increased to $70,000, payable in ten yearly payments of $7,000 each, to the first factory established in a location approved by the government and of a certain capacity. This led to active efforts to form companies for the purpose of establishing factories, and in a letter written by Mr. Cuisset for the 1st volume of "The Sugar Beet," April, 1880, published by Lewis S. Ware, of Philadelphia, he says: "In Canada it appears that the first manufactory will be established at Farnham, in Missisquoi county, where a powerful association of cultivators has been formed." In the same publication for October, 1880, the editor gives an account of a visit he had paid to Canada in connection with a beet sugar project. He says: "A despatch requesting our presence as beet sugar expert in Montreal enabled us to gather some interesting data in regard to the spontaneous sugar beet fever, the main cause of which may be attributed to the organization of a French company with $2,000,000 capital. The plan is to erect not only one but several factories. Nine-tenths of this money has been raised in France and the remaining tenth is being rapidly subscribed in Canada. Under these conditions the French will have the controlling interest, and in many respects it is extremely fortunate that they have, for *experimenting* will thus be obviated, and experienced hands will adhere strictly to foreign methods."

"The company is composed as follows:—President, Mr. Bourgeois, banker and president of the Industrial and Commercial Banks; vice-president, B. Legru, sugar manufacturer at Douaville and Revelon; directors, Mr. Champonnois, president and member of many sugar societies; Mr. Etienne, sugar refiner at Nantes; Mr. Bachoux, sugar manufacturer at Francière, member of the Comité d'escompte of the Bank of France; Mr. M. G. Benoit, Champy, administrator of the 'Credit Industriel et Commercial, Canada'; delegated administrator, Mr. Le Comte G. de Wazières."

"The 'Union Sucrière du Canada' has for its object the starting of the beet sugar manufacture, and refining industries in the provinces of Quebec, Ontario, Nova Scotia, New Brunswick, Manitoba and British Columbia—in other words, throughout all Canada."

"The climate of Canada is considered by the company most favourable for beet sugar manufacture, 'and is in many respects similar to Central Russia and Bohemia, where the roots are extremely pure.' The analyses of Canadian beets had yielded satisfactory results, the average for 81 analyses having shown 13·22 per cent, with a satisfactory degree of purity. It is thought that 30,000 of the inhabitants that emigrate to the United States for employment will remain at home. The protection offered by the Canadian Government is to exempt all beet sugar factories from taxation during a period of five years, and if at the end of that time an internal revenue tax should be imposed it will be considerably lower than the Customs duty upon foreign sugars; consequently, the home production would even then be sufficiently protected to leave a fair margin of profit."

The profits looked for by the company were large. The existing duty upon foreign sugars imported is $7.20 per 220 lbs., or a little over 3 cents per pound; and in an estimate of "the probable cost and return of manufacturing sugar in Canada as compared with France, based upon existing prices," it was calculated that the profits would exceed those made by the manufacturers in France by more than one-third; and "when four factories shall have been built, not less than 11,000,000 pounds of sugar may be manufactured per annum, which would represent a yearly profit of nearly $500,000. If one-half only of this supposed profit be realized it would correspond to 25 per cent on the money invested. It is thought that beet sugar may and will be made in Canada to greater advantage than it has been in France for years past.

"Thus far the 'Union Sucrière du Canada' have decided to erect the following factories:—

"First.—At Longue Pointe, five miles from Montreal, on the bank of the river St. Lawrence. The establishment will be a beet sugar factory and refinery combined, and imported raw sugars will be refined after the beet-root sugar making is over. There the plan is to utilize from 20,000 to 25,000 tons of beets per year, at the rate of 150 tons a day, with a capital say of $150,000. Nova Scotia coal can he delivered at $3.75 per ton, and lime at a mere nominal price, as it is quarried in the immediate vicinity.

"Second.—Charlesbourg, on the St. Charles river, within a mile of the city of Quebec. Here the workings of the factory and refinery will be similar to Longue Pointe.

"Third.—Berthier, a town of 2,000 inhabitants, about 50 miles from Montreal. This will be a smaller factory, working about 100 tons of beets a day.

"Fourth.—Varennes, Verchères county, on the St. Lawrence, also a factory of 100 tons a day. Workings will be similar to the Berthier factory.

"The excitement is great over sugar beet growing. The importance of growing the beet and the possible financial results that may follow are impressed upon the farmers at gatherings and public halls."

Contracts were made with the farmers who would agree to grow a definite quantity of beets each year for twelve years, at the price of $4.00 per ton of 2,000 pounds, delivered at the factory. It was said that companies were being organized at other points, among which Farnham was mentioned, where it was stated that 500 acres of beets had been contracted for. The $70,000 subvention which the Quebec Government had offered for the first factory started proved to be quite a stimulus to prompt action.

In February, 1881, announcement was made that the Pioneer Beet Sugar Company of Coaticook had been organized, with the intention of manufacturing sugar in the fall; that 1,500 tons of beets had been contracted for to be paid for at the rate of $5.00 per ton of 2,240 lbs.

Under date of April 20th, 1881, a letter is published in "The Sugar Beet," from A. J. Lavallée, of the "Union Sucrière Franco-Canadienne," in which he says: "Our company is now organized, and the first beet-root sugar factory is being built at Berthier, Quebec. We have contracted for 1,636 arpents of beets for the Berthier factory, and have offers of contracts for the four factories that the company will build in 1882. The machinery was ordered in January and will be delivered at Berthier about the 15th of June. It will cost about $90,000 and will be first-class in every respect. It will work about 200 tons of beets in 24 hours." In August, 1881, it was said: "The machinery for the factory at Berthier arrived before the end of June; the factories at Coaticook and West Farnham are also ready. The farmers who followed closely the European methods have been very successful and thier beets are looking well."

In the February, 1882, number of "The Sugar Beet" the editor gives an account of a visit paid by him to the Canadian factories, from which the following is taken:—

"The beet sugar factory at Coaticook was organized in Montreal during the winter of 1880 and the final plans matured in 1881. The capital stock then thought necessary was $150,000, but this was found to be inadequate to the requirements; with an increase of $125,000 it is contended they will be able to work 250 tons per 24 hours. The total number of farmers contracting for beets was 2,107, but it has been decided not to deal directly with so many, but to make the contracts with, say, four agents, who will be directly responsible for the same. It is thought that, without counting the hundreds of acres that were destroyed by the frost, the average yield has been 15 tons to the acre, while the maximum yield is 22 tons. The price paid to the farmers was $5 per ton of 2,240 lbs. delivered at the factory or at the nearest railway station. The greatest distance the roots were grown from Coaticook was 120 miles, at Ste. Anne. The total number of arpents contracted for was 1,850, and the freight paid the railway company was not in any case over $1.20 per ton. The company grew only 50 acres, but this area will be increased the coming season. Under present conditions the prospects for the future are most favourable."

A visit was also paid to West Farnham, "a small town, with a population of 2,000, located about 37 miles from Montreal," at the junction of several lines of railway. The history of the starting of this factory is thus given: "Several years ago, when the government of the province of Quebec voted the subvention of $7,000 a year—with the proviso that the site should be officially selected—an official made his report as to the advantage that West Farnham possessed—being at the junction of many railroads—the competition resulting therefrom would have a tendency to permit a minimum rate for transportation of its crude and manufactured products.

"Being near Montreal the sugars, if made, could be sold at advantageous prices. The surrounding land that had been in use for 30 years would give but little trouble from an excess of alkaline or other objectionable elements—so much to be avoided in beet cultivation. The neighbouring population was English and French; the rivalry between the two might have a beneficial agricultural effect. The arguments were so convincing that there remained no longer a doubt but that the best locality had been determined upon. The town subsequently subscribed $35,000; the agitation continued during 1879, and in the spring of 1880 the company was organized. The then proposed capital was $500,000. The final plans, with a capital of over $200,000, were matured in November, 1880; but a few months elapsed before the entire amount was paid in cash." Contracts were made with 500 farmers for ten years to grow annually 1,437 arpents, the company agreeing to pay $5 per ton of 2,240 lbs. delivered at the factory; the company also decided to undertake the planting of a certain area. The designs for buildings, etc., were made in Germany; the boiler, piping, etc., to be made from them in this country, while the machinery proper was to be imported. The price of the latter according to estimate was $85,000. The farmers did not like this long binding contract, and the period was afterwards reduced to five years, while many of the farmers are said to have grown beets for one year only. They were also dissatisfied with the price, and thought they should receive $5 for a ton of 2,000 lbs. During 1881 the company had planted 300 acres of beets and were contemplating growing a much larger area the next season. The crop on the whole is said to have been very satisfactory and the roots of excellent quality. What yield was obtained from this large plantation is not stated, but we learn that the crop of beets was much smaller than was expected, and that all of the factories had but a short run that year.

BERTHIER.

The new factory at Berthier was also visited. The town is located about 50 miles from Montreal, and is said at that time to have had a population of 2,300. The factory here was the outcome of the organization of the "Union Sucrière Franco-Canadienne." It is said that on 1st July, 1881, $140,000 was paid in cash by the French shareholders, while the Canadians were represented by $60,000. The order for the machinery had been sent to France in February, and the delivery was made in July, August and September, at a total cost of $85,000. The capacity of the factory was 200 tons per 24 hours.

There was an unfortunate failure in the beet crop the first year. All the roots obtainable were gathered up and brought to the factory, some being carried by rail as far as 71 miles. It is stated that "on 8 arpents only was there an average of 15 tons; on 300 arpents the beets did not come up at all, and on 500 arpents they yielded an average of only 6 tons. The total quantity received was said to be about 2,600 tons, and of these several hundred tons were frozen, and a proportion of them rotted before they could be used. During the few days which the factory worked it consumed about 150 tons of beets per day, and the beets tested before working showed an average of 11 per cent of sugar.

The returns for the manufactured product fell so far short of what was expected that the close of the first season found the company in financial difficulties, and as the original shareholders were not willing to subscribe the money required to continue the enterprise the factory was sold in the latter part of 1882 at a nominal sum. At first it was expected that operations would soon be resumed under new management. With

regard to its future prospects, a Montreal firm, largely interested in its success, writes thus to the editor of "The Sugar Beet" (August, 1883, p. 34): "All depends on the supply of the beets, which are next to impossible to have from the farmers. The only way to obtain them is for the company to buy 3,000 acres of land and cultivate 1,000 acres every year, and take of the farmers such quantities as they will condescend to furnish."

During 1883 an effort was made to resuscitate this factory. About 800 tons of beets were secured in October and November, and for some reason unexplained they were said to have been kept over-exposed to the frosts of winter for several months "and on being worked up in April, 1884, were found to be in an excellent state of preservation, having lost only 1 per cent of sugar." After that the factory remained closed, and, with machinery complete, was offered for sale at a low figure. In a letter from A. Musy, published in "The Sugar Beet" for November, 1889, he says: "The Berthier factory worked this year; beets were purchased at $4 per ton. Unfortunately, however, only 30 tons of roots have been worked per diem, while the capacity is for 200 tons." This factory has not been worked during the past year.

COATICOOK.

After the unfavourable experience had in 1881 "the entire foreign *personel* returned to Germany." Efforts were made to increase the capital stock of the Pioneer Beet Sugar Company $129,000, but these do not appear to have been successful. In August, 1882, it was announced that "through most worthy effort of the directors, etc., of the beet sugar company at Coaticook, the government has granted to it a subsidy of $35,000. This amount, added to the amount elsewhere obtained, will permit, it is thought, the manufacture of beet sugar under more favouring circumstances than last year." The company proposed to offer prizes for the best field of beets of from 1 to 5 acres, and every effort was made to stimulate the farmers to grow beets. The greater number of contracts for the roots had been made on the island of Montreal, and the prospects of a good crop at that date were said to be most encouraging. About 250 farmers had contracted to furnish beets; the total number of acres contracted for was 1,000, the largest with any one farmer being 60 acres. The season was favourable, and the average yield per acre 10½ tons, with a percentage of sugar varying from 11 to 12 per cent. The company planted 150 acres of beets, which were said to have shown an average of 14·20 per cent of sugar.

The factory commenced its second campaign in October, having added a distillery to its plant, with the view of converting the refuse molasses into alcohol. It continued working for sixty days, using about 100 tons of beets per day, and the weather continued favourable during the working period. The product was 180 tons of white sugar and 2,500 gallons of molasses. The molasses was being converted into alcohol in the annexed distillery; about 100 hands in all were employed, and the average pay was $1 per day.

The greatest trouble was said to be "a financial one; the enterprise was not sufficiently backed by capitalists." In August, 1883, it was announced that the factory was closed, that most of the movable machinery had been sold and the enterprise abandoned.

FARNHAM.

The short crop of 1881 had its effect also on the Farnham Beet Sugar Company, and in 1882 an effort was made to add to the capital by the issue of preference stock to the extent of $150,000 "in order to increase the facilities of the company." Of this $100,000 was disposed of. The superintendent of the past year was replaced by a sugar maker from France. The machinery was in good order and was said to be the best and most improved known, and everything seemed to promise well: 1,000 acres of beets had been contracted for, 500 acres of which it was said had been taken by four syndicates, the balance in smaller areas by farmers. The price to be paid to the farmers was $5 per ton of 2,000 lbs., delivered at the factory, or $4.50 F. O. B. cars, but to syndicates who contracted to raise 50 acres and upwards, $5.50 delivered at the factory and $5 F. O. B. cars. In 1882 insects injured the crop to a considerable extent. There was no difficulty from frost, but fall rains caused a second growth of leaves, which

increased the labour of harvesting and cleaning and the supply was not as large as was anticipated. The crop averaged about 8 tons to the acre, and it is said that many of the farmers used their roots as food for their cattle. Very few acres were grown by the company and only 3,500 tons were received at the factory. These, however, tested 12 per cent of sugar. These beets were "as good if not better than those generally grown in France."

Work began on the 9th of October and continued for 29 days, about 120 tons of roots being used per day. The first sugars obtained amounted to 6·50 per cent, or 500,500 lbs., and it was expected that the second sugars would give 150,000 lbs. more. Eighty-five men were employed, who received wages amounting in all to $101 per day. The pressed pulp was said to be sold freely at the factory at $2 per ton, and the farmers who had tried it were well satisfied with the results they had obtained.

Preparations were made for the next season's work, and it was claimed that contracts had been made for 600 acres of roots up to May 18, 1883. In an article published in the *Courier de St. Hyacinthe* of 9th November, 1883, it is stated that "the directors of the Farnham company have this year introduced a system of economy in the administration of the sugar factory. There were 30 men employed at the works and the saving effected was about $300 per week over previous years."

In 1884 the factory was closed. It was stated that the company had lost $250,000, and that the whole of the buildings and plant were offered for sale and that the price asked was $60,000.

This factory remained closed until 1890, when it was rented by the present company, of which Mr. A. Musy is the manager. "The company distributed gratuitously $4,000 worth of seed, paid premiums for the finest crops of beets, and $4.50 per ton of 2,000 lbs. for beets delivered at any railway station within 100 miles of the factory."

The total quantity of beets used was about 6,000 tons; the price received for the raw sugar was 5 cents per pound and for the refined 6 cents in Montreal.

"The industrial campaign was pronounced a success, the factory being worked without stoppage to the last beet, and the percentage of sugar extracted was as large as it would have been in Europe from beets of the same richness."

In 1891 the work began at this factory on the 9th of October, and it was in full operation at the date of my visit, 28th October. The manager, Mr. A. Musy, who was very courteous and obliging, afforded me every facility for seeing all parts of the factory and freely gave me all the information sought. About 110 tons of beets were then being worked per day of 24 hours, and large quantities were being delivered both by waggon and by rail. The beets appeared to be quite sound; they were fairly even in size, most of them running from 3 to 4 inches in diameter. I was informed by Mr. Musy that up to the time of my visit the tests had shown that they contained an average of from 12 to 13 per cent of sugar. The factory continued working until the 6th of December, using in all about 10,500 tons of beets.

The company pays the farmers $4.50 per ton of 2,000 lbs. for the beets delivered at the factory, to which is added a bonus of 50 cents per ton, given to the farmers by the Quebec Government in accordance with the provisions of the Act passed in December, 1890, making in all $5 per ton. The company usually advances money to the farmer on his beet crop where three acres or more grown, the custom being to advance $10 per acre in June when the beets are up and $10 more per acre in July after they are thinned.

The population of Farnham is now given as 2,822, and the principal industries of the place are the workshops of the Canadian Pacific Railway and the beet sugar factory. The factory was said to furnish employment for from 150 to 200 men in all, one-half working during the day, the other half during the night, and this continues until all the beets are worked up, after which only a small number are needed to extract the second sugars. The machinery appeared to be complete and in fair order; the engines are of 500 horse-power. Coal dust is used as fuel, brought from Springhill, Nova Scotia, and costs laid down at the factory $3.31 per ton of 2,000 lbs. The consumption was said to be 40 tons per day. Bone charcoal is used in this factory for the

final decolourising of the sap, for the making of which a roasting oven has been provided. The bones are bought in Montreal and Quebec at from $17 to $20 per ton. At the time of my visit the output of raw sugar was from 27,000 to 28,000 lbs. per day. This raw sugar was further treated in another part of the factory, the finished product being pure white sugar of excellent quality, which the manufacturers were then selling in large lots at 4¼ cents per pound.

CANE VERSUS BEET SUGAR.

The contest which the war in prices, resulting partly from overproduction, has brought about between the cane sugar and beet sugar producers has been very fierce and protracted. On the one hand the cane sugar makers have the great advantage of being able to place their product in the markets of the world, in spite of export duties, at a less cost than beet sugar factories can produce sugar from the beet. On the other hand, the beet sugar makers are aided by liberal bounties by their respective governments, without which, the industry could not be carried on with profit.

From an editorial in the *Sucrière Indigène* of 28th December, 1886, we quote the following: "We have seen that the Austrian sugar manufacturers have, at a meeting held lately, raised the question of closing their works for a year, in the hope of putting an end to the ruinous prices which characterize the present crisis. Not even this heroic expedient would save the beet-root sugar industry of the future, because the colonial production asks nothing better than a chance of developing itself, and if it is not restrained by surtaxes from entering European countries it will end by crushing the whole of the continental production."

"The struggle between the cane and the beet has assumed an alarming aspect, since the creation of powerful associations has rendered practicable the application to the cane of the whole of the progress which the working of the beets has enjoyed, through the advances made in machinery and chemistry. It is our own mechanics and our own men of science who are furnishing the improved weapons to our rivals who are able to crush us."

In vol. 19 of "The Sugar Cane" the following is quoted from a statement made by Mr. G. Gorz, the eminent Berlin engineer and sugar specialist. Speaking of sugars in general, he says: "We find a tolerably large amount of over-production, in consequence of which prices have sunk to a level which keeps only a little above the cost of production. This assertion is applicable to all sugar-producing countries and colonies. The competition in the world's markets is now extraordinarily great; this is carried on and still maintained by cane sugar against beet-root sugar, in spite of the fact that the former is to a considerable extent hampered by export duties, while the latter is under the support of more or less high premiums. In the face of this fact we are justified in asking: How would the beet sugar have stood the competition during the past few years if, on the one hand, the export duties on cane sugar had been reduced, and on the other hand the premiums on the export of beet sugar had been abolished?"

A well-known French authority, Mr. George Dureau, of the *Journal des Fabricants de Sucre*, writing on the subject of premiums on sugar, is thus quoted in the same volume:—

"Beet root sugar may be considered as the sugar which, *par excellence*, is favoured by premiums, whilst cane sugar is that which is produced under natural conditions, without other advantages than those with which nature has endowed it, which we hasten to add, are considerable."

"In the present state of things, what is the object of the premiums granted to beet root sugar? The premium enables the producer to sell below prime cost, and consequently, if we admit that the cost of production is equal for the two kinds of sugar, the producer of beet sugar will be able to sell with profit at a price which is ruinous for the producer of cane sugar. The more the system of premiums is exaggerated the lower will prices fall, and the more reduced become the number of those who are placed under natural conditions and who are selling at a loss."

"To what extent does the premium granted to beet sugar confer an advantage on

it—or, in other terms, if the premium were to be abolished, what would be the difference between the natural prime cost of beet root and cane sugar? Whatever be the solution, there is one certain and indisputable fact, viz., that the abolition of the premium granted to beet root sugar would at once result in a general advance in prices, by which the producers of cane sugar would immediately profit."

The contest would then be carried on on conditions equal as regards artificial advantages. In however small a degree certain colonies, as, for example, Cuba and Java, pursue their course on the path of improvement and progress on which they have entered, the equilibrium between beet and cane sugar would very soon be destroyed in favour of the latter. The question is exceedingly complex. It requires a profound study of the resources of the colonies, natural resources, fertility of the soil, the supply of labour, social conditions, facility of transport, of obtaining supplies, abundance of capital, etc. This study will probably have in store more than one surprise for those who may undertake it."

"Does not an examination of the situation of the British colonies specially show that according to the last statistics their total export, which was in 1864 300,764 tons, attained in 1885 the figure of 505,000 tons, an increase of 68 per cent in 21 years; and as one of our English contemporaries has justly remarked, it was during that period of 21 years that the beet root sugar was enjoying those premiums which are being denounced as ruinous to the colonies. During the eight months of the present year have not the imports of raw cane sugar into the United Kingdom reached 325,000 tons, whilst those of raw beet sugar were only 253,660 tons?"

"We lately read in an English consular report on the state of the sugar industry in the island of Réunion that on the plantations of the Credit Foncier they had been able to reduce the cost price of cane sugar from 46 francs 90 centimes (37s. 8d.) the 100 kilos (220 lbs.) in 1878 to 34 francs 3 centimes (27s. 3d.) in 1886, and that by the aid of new improvements they hoped to be able from the year 1887 to produce sugar at 31 francs (24s. 10d.), making a reduction of 34 per cent in less than ten years."

"A plantation in Réunion is instanced on which, in 1886-7, the 100 kilos of sugar have been produced at only 24 francs (19s. 3d.), and this estate reckons on being able still further to reduce the prime cost by adopting cultivation by implements—the plough, etc.—in a word, by substituting mechanical for hand labour. The cost price of the cane delivered at the mill, which in 1883 was 26 francs 94 centimes (21s. 8d.) per ton, was only 10 francs 65 centimes (8s. 6d.) in 1885. The cost of manufacture can be reduced by 5 to 6 francs. At the present yield of 9 per cent the cost price of 100 kilos of sugar can thus be reduced to less than 20 francs (16s. less than 1d. per lb.) Now this yield of 9 per cent is a very moderate one in proportion to the saccharine contents of the cane, and we have not heard all that can be said with regard to the improvement of the quality of the plant and in the extraction of the juice. Under the conditions indicated above, a yield of 10 per cent would bring down the cost price per 100 kilos of sugar to 16 or 17 francs (12s. 10d. to 13s. 7½d.) Undoubtedly, it is not every plantation that is in a position to realize this progress; but the mere fact that such progress belongs to the domain of possibility is surely somewhat disquieting."

In "The Sugar Beet" for 1889, p. 30, a well known German writer who advocates continuation of the bounty system is quoted as follows: "Respecting the competition that will exist between cane and beet sugar manufacturers, there is greater margin for improvement in the cane than in the beet processes; the former need only to imitate the progress already achieved by the European industries in cultivation and technical treatment. Such quantities of cane sugar will come into the world's markets as to render competition on the part of beet sugar very difficult."

In the same journal for 1888, p. 54, the editor, when speaking of the cane sugar industry in Brazil, says: "Canes raised in the province of Rio Janerio tested from 13 to 19 per cent of sugar." Again, on page 55 of the same year, he says: "In Martinique the sugar-makers extracted 7·93 per cent of sugar in 1885, 7·36 in 1886 and 8·40 in 1887. From data sent by Mr. Ehrman, the cost of manufacture is $3 per 100 kilos, about $1\frac{1}{3}$ cents per pound.

On page 62 of the same publication ex-Governor Warmouth, of Louisiana, is reported as making the following statement: "Ten years ago 1,500 lbs. of sugar was the average yield of an acre of cane. This has been increased to an average of 2,000 lbs., and our best places with best machinery get as much as 4,000 lbs. per acre." Again, in the May number for 1889 we find the following: "From the 'Louisiana Planter and Sugar Manufacturer' we learn that the cost of manufacturing cane sugar on four important plantations in that State varied from 1·58 to 1·80 cents per pound.

In "The Sugar Beet" for 1887, p. 43, the editor, speaking of Egyptian sugar, says: "During the latter part of 1886, 18,500,000 lbs. of first grade was sold at 2·65 to 2·75 cents per lb., and 10,000,000 lbs. second grade at 1·60 cents per lb." From the same journal, for 1888, we make the following extracts: "Cuban sugar-makers seem of late to have diminished the cost of making sugar, and the product may be sold at less than 2 cents per lb. and leave ample margin of profit. The cost of making sugar in Java is said to be $2\frac{1}{2}$ cents per lb. In Trinidad the average price of Muscovado sugar in April, 1888, was $1.80 to $2.00 per 100 lbs.; profits were said to be small." In "Barbadoes land has much lowered in price with the fall of sugars. That formerly worth £100 per acre can now be bought for £50. On the other hand, those who have bought land at moderate prices can manufacture Muscovado sugar at £5 per ton, about $1\frac{1}{4}$ cents per lb., and sell it at £10—$2\frac{1}{2}$ cents.

"At Santa Cruz labourers secure 20 cents a day and feed themselves, are furnished with a room in which to lodge and a piece of land large enough for their household. I see no reason why the sugar production of this important British colony should not be greatly improved. Limited capital prevents any change, at least for the present. If a system of taxation and drawback similar to that existing in beet sugar producing countries were adopted, money would be forthcoming and beet sugar would have a battle to fight of a very different character from any in the past."

In "A Handbook of Industrial Organic Chemistry," by Prof. S. P. Sadtler, published in August, 1891, the author, speaking of the sugar cane, says, p. 113: "It has a wide range, succeeding in almost all tropical and sub-tropical countries, and requires a warm, moist climate, developing most luxuriantly on islands and sea coasts in the tropics. It is the richest in sugar of all the plants cultivated for this purpose. Under ordinary favourable conditions it yields about 90 per cent of juice, which contains 18 to 20 per cent of crystallizable cane sugar." The following proportions of sugar in cane grown in different localities are given from analyses by well known chemists: "Martinique, 17·80 to 18 per cent; Guadeloupe, 17·8; Mauritius, 20 per cent; Middle Egypt, 16·00; Upper Egypt, 18·10; Cuba, from crystalline cane, 19·2 to 20·5; from red ribbon cane, 18·5 to 20; black Java cane, 20·6 to 21·3. In Louisiana the yield is much less, and is given as 13·05 in 1884, 12·11 in 1885, 13·50 in 1886 and 13·69 in 1887." It will be seen that leaving out Louisiana these figures show a much higher percentage in the cane than has been given for the beet.

Dr. H. W Wiley, of Washington, is of opinion that the average sugar cane grown in Louisiana is not equal to the best beets in the proportion of sugar it contains, and says that it varies from 10 to 12 per cent to 13 to 14 per cent, depending on the care with which the cane has been grown.

In the United States agricultural report for 1872 R. T. Brown, chemist, says: "When sugar is produced in the above-ground organs of a plant it is found to be in the ratio of light and heat to which a plant is exposed. Under the operations of this law, as we recede from the tropics the cultivation of cane becomes less and less profitable till we reach a point where it is no longer remunerative. Cane sugar in Louisiana is an uncertain industry from degeneration of the cane and partial failure of the crop in unfavourable seasons. In 1834 it was 100,000 hogsheads; in 1835 it fell to 30,000; in 1853 it reached 439,976; in 1856 only 73,000 hogsheads were produced." In the report for 1878 the Commissioner of Agriculture, Hon. Wm. G. Le Due, says, speaking of the sugar cane: "The plant itself belongs to a tropical country, and refused to ripen its seed in Louisiana, never even maturing the whole extent of stalk grown. All these considerations combined to make a discouraging outlook for the home production of sugar from tropical cane."

In the report for 1888 the Commissioner, the Hon. Norman J. Coleman, remarks: "In the United States the area which can possibly be devoted to the production of sugar cane is a limited one. Small proportions of Florida, Louisiana and Texas only can hope to compete with the tropics in the production of cane sugar." It would appear from these quotations that comparisons drawn from the yield of the cane as produced in Louisiana and the beet as grown in the western States are scarcely fair to the cane, when looked at from the standpoint of the world's production.

It is difficult to ascertain the cost of producing beet sugar in European countries owing to the hidden bounties the manufacturers receive. The lowest price at which it is stated to have been made in Alvarado, Calafornia, is a trifle over 4 cents per lb. "The Sugar Beet" for February, 1886, says: "The cost of making beet sugar at Alvarado in a factory of capacity of 80 tons is 4·9 cents per lb. Mr. Dyer says that with a factory of 200 tons capacity he could make beet sugar at a cost of 4 cents per lb."

A large convention of those interested in beet sugar was held at Lincoln, Nebraska, on the 17th and 18th of December, 1891, at which it is said that 300 delegates were present. That the two factories in Nebraska had demonstrated that sugar could be made in that State. The first season, 1890, was dry, and the beets were small; the second, 1891, was cold and wet, and the crop was damaged by early frosts. "In spite of the bounty, neither one of the factories have been making money; one of the great difficulties has been to educate the farmers to successful beet growing. The Nebraska factories themselves will hereafter cultivate about 1,000 acres each to supply any deficiency and enable them to run at full capacity." The bounty on sugar was discussed at length. A few of the delegates were in favour of removing all encouragements of this kind and letting the industry perish if it is not self-sustaining. The sense of the convention, however, was for sustaining the national bounty and restoring the State bounty. It was proposed that the State bounty law should be reenacted, and the bounty divided between the farmers and the manufacturers. The following figures were given as to the cost of making beet sugar and the profits obtained: "A ton of beets produces an average of 150 lbs. of sugar; the manufacturer receives 6 cents a pound for his sugar, including the bounty (2 cents) received from the government, thus making his receipts $9 per ton. He pays the farmer $4 per ton, and it costs him $3 per ton for the manufacture, leaving him a profit of $2 per ton." In other words, the sugar, on the basis of $4 per ton paid to the farmer for beets, is said to have cost the manufacturers who have worked with all the most recent improvements and labour-saving appliances $4\frac{2}{3}$ cents per pound to manufacture, while the usual market price is about 4 cents per lb. Hence, if the government bounty were withdrawn the sugar on this calculation would have been manufactured in Nebraska this year at a loss of $\frac{2}{3}$ of a cent per lb. By the bounty of 2 cents per lb. paid by the national government the manufacturers have been repaid the loss and have made a profit of $1\frac{1}{3}$ cents per lb. Presuming the yield in the two factories in Nebraska to have been 4,000,000 lbs., this would give the manufacturer a net profit of $53,333 on a working capital of $500,000, which added to the bonus and land grant given by the people is probably about the sum which the owners have invested. This would be equal to a dividend of a little over $10\frac{1}{2}$ per cent.

A yield of 150 lbs. of sugar per ton is only $7\frac{1}{2}$ per cent from beets, which are said to have shown by the polariscope an average of about 14 per cent of sugar contents. This would be a very small yield, and it seems probable that there is some error in this statement of yield as given in the Omaha *Bee*. In similar factories in Germany and France, and in California also, the proportion of sugar extracted is about 80 per cent of what the beets contain, which would be equal to 11·20 per cent of the manufactured article from roots containing 14 per cent of sugar. A yield of 11 per cent would correspond with the figures given to the writer by Mr. Oxnard at the time of his visit to the factories, which would bring the yield up to 220 lbs. for each ton of beets used, increasing the receipts from $9 to $13.20 per ton, lowering the net cost of the sugar to a fraction under $3\frac{2}{10}$ cents per lb. and increasing the profits of the manufacturer from $2 to $6.50 on each ton of beets worked; or, estimating the sugar production at 4,000,000 lbs., the total profits at $2\frac{8}{10}$ cents per lb. would be $112,000, a little more than 22 per cent on a capital of $500,000. If this latter calculation be correct, it would appear that during the past

year the beet sugar industry might have been carried on without a bounty and have realized the manufacturers a return of about 6 per cent on the capital invested. If the production has not exceeded 3,000,000 lbs., the profits would be reduced to $84,000.

BOUNTIES.

An international conference was held in London, England, in 1887–88, on invitation of Her Majesty's government, at which nearly all the sugar-producing powers were represented, the object of the conference being to discuss proposals for the abolition of all bounties on sugar, direct or indirect. The representative from Germany stated that the German government was quite ready to abolish the bounties if the same should be done in other countries. The Austrian representative made a similar declaration. The representative from France admitted that the sugar manufacturers in his country received high bounties, but said that France did not set the example, but only took up the policy in self-defence. He further added that he was "not authorized to indicate the means for putting an end to this regrettable state of things." Belgium was anxious to frame her laws so as to abolish bounties as soon as possible. Russia was in favour of abolishing bounties, and the representatives of other governments expressed themselves in similar terms. There appeared to be a unanimous sentiment among all present as to the desirability of abolishing bounties.

After holding several sessions at intervals from November, 1887, to August, 1888, it was found impracticable to harmonize the conflicting interests, and the object for which the conference was convened was not attained.

In a preliminary memorandum compiled by Sir George Baden-Powell, and published by order of the English House of Commons in 1884, he says: "The amount paid in bounties is provided by the tax-payers in general. In addition to this, additional taxation has to be resorted to, because the amounts so paid are deductions from the yield of the sugar taxes. All the money is paid to the sugar manufacturers, and the public generally is thus deprived of moneys it might invest or spend in other ways, which would undoubtedly promote production, exchange and general prosperity." Again: "The consumer in England pays less than cost price for his beet sugar, because the German tax-payers pay to German manufacturers sufficient not only to cover the actual loss, but also a margin of profit. But sugar can be obtained cheaper from cane than beet-root, and thus the English consumer is compelled to use that kind of sugar which it costs most to produce;" and "the gain of the English consumer is a deduction from German wealth."

"The recent proposal to assist English agriculture by introducing into England the manufacture of sugar from beet-root is thoroughly impracticable, so long as continental manufacturers can obtain a bounty on all produce they put into the English market. The amount paid in bounties is provided by the tax payers in general. In the French government both sides are anxious to see the bounty system put an end to. In Germany the notorious results of the excessive bounty, in forcing into existence a very large industry, are having an effect in favour of now reducing the heavy charge the nation has hitherto borne."

In Holland the pressure of the system on the State revenues has driven the government to fix a minimum of net receipts from sugar duties.

In "The Sugar Beet" for 1887, p. 54, it was said that the bounty system in European countries entails the following losses to the revenue: France, $13,120,000; Germany, $9,420,000; Austro-Hungary, $5,000,000; Belgium and Holland, $5,200,000. With the enormous increase which has since taken place in the export trade the loss is probably much greater now. There seems to be no doubt that all the European sugar-producing countries desire to abolish the bounty system if they could find any way of doing so without crippling the industry.

The Congress of the United States removed the duty on sugar from the 31st March, 1891. This, basing the estimate on the sugar duties collected in 1890, was a loss to the revenue of about fifty-four million dollars. The results of this change would, it is said, have been ruinous to the planters of Louisiana, Texas and Florida, whose annual output of sugar was about 465,000,000 lbs., and to compensate the sugar-makers and encourage the industry an Act was passed on the 1st of October, 1890, which pro-

vides for the payment of a bounty of 2 cents per lb. on all sugar of a purity of 90 per cent and over made within the United States, whether from cane, beets, sorghum or maple, for a period of fourteen years, from the 1st of July, 1891, to the 1st of July, 1905. It is expected that $10,000,000 will be required to pay the bounty this year. In the annual report of the United States Commissioner of Internal Revenue, recently issued, we find that the quantity of sugar imported into the United States during the fiscal year ending 30th June, 1891, was 3,483,477,222 lbs., and that the quantity produced in the country was 512,261,530 lbs. If the sugar industry should develop under the stimulus of this bounty, as its advocates expect it to do, until the whole supply of the United States is produced within its own borders, it will involve, on the basis of the present consumption, the annual payment to the sugar manufacturers of nearly eighty millions of dollars, which must be provided for by tax on other goods. It is further argued by some of those who favour this industry that the United States should not only aim to supply its own consumption of sugar but also to become an exporting country, which would entail a loss of $20,000 on every million pounds exported.

State bounties have also been given in some instances. Kansas, which formerly offered a bounty of 2 cents per lb. on sugar made from beets, sorghum, etc., reduced that bounty by Act of 4th March, 1891, to ¾ of a cent. In Utah, by Act of 12th March, 1890, a bounty of 1 cent per lb. on similar sugars is offered for the years 1890 and 1891. The State of Nebraska also passed an Act, 19th March, 1889, providing for a bounty of 1 cent per lb. on all sugar produced within the State, but this law was repealed by the legislature of 1891.

In December, 1890, the Legislature of the Province of Quebec passed an Act which provided for the payment to the growers of a bonus of 50 cents per ton for one year on all sugar beets grown within the province and delivered at the factories to be made into sugar.

During the session of 1891 the House of Commons in Canada also abolished the duty on sugar, which lessened the revenue to the extent of nearly three million dollars. The Customs Act also made the following provision for a bounty on beet sugar: "Under such regulations and restrictions as may be provided by Order in Council there may be paid to the producers of any raw beet sugar produced in Canada, wholly from beets grown therein, between the first day of July, one thousand eight hundred and ninety-one, and the first day of July, one thousand eight hundred and ninety-three, a bounty equal to one dollar per one hundred pounds, and in addition thereto three and one-third cents per one hundred pounds for each degree or fraction of a degree of test by polariscope over seventy degrees."

This bounty, which is practically the same as that of the United States, is offered for two years only. If this be continued, and the production of sugar stimulated in Canada to the point of supplying all that is now purchased abroad, it would, on the basis of the imports of 1890, of 174,045,720 lbs., involve, the annual payment in cash to the sugar manufacturers of $3,480,914, which would have to be provided for by taxes on other commodities.

The number of acres of beets which would be required to produce the annual supply of sugar for Canada would be about 75,000, which, at 12 tons per acre, yielding 10 per cent of manufactured sugar, would supply 40 large factories with 22,500 tons each, which would yield about 180,000,000 lbs. of sugar. There seems to be no doubt that the sugar beet can be produced over a very large area in Canada under as favourable conditions as in any country in the world. The beets worked at the Farnham factory, in Quebec, during the past year, are said to have contained an average of about 13 per cent of sugar. From a report by Robert H. Lawder on "The Cultivation of the Sugar Beet in Ontario," published by order of the Legislative Assembly of Ontario in 1890, we find that in a large number of analyses made by Wilfred Skaife, Esq., of Montreal, an average of 13·75 per cent of sugar was found, while in another series, grown in Ontario, made by Prof. C. C. James, of the Ontario Agricultural College at Guelph, the average was 13·63. In a large series of samples from Ontario, analyzed in 1890 at the laboratory of the Central Experimental Farm, Ottawa, by Mr. F. T. Shutt, chemist of the Dominion

Experimental Farms, 60 per cent of the samples averaged 12 per cent of sugar and 38 per cent 13 per cent. During the past season the result of 42 analyses by Mr. Shutt of beets grown at the experimental farm and in other parts of Ontario have given an average of 13·37 per cent. Two varieties grown at the experimental farm at Nappan, N.S., have given 14·70 per cent; the same varieties at the experimental farm at Indian Head, N.W.T., 11·45, and at the experimental farm at Agassiz, B.C., 13·2 per cent. The seed sent to the experimental farm at Brandon, Man., was lost in transit, and for this reason we have no report from that institution.

SUGAR STATISTICS.

WORLD'S PRODUCTION OF CANE SUGAR.

The world's production of raw sugar from the sugar cane for the years 1885–86 to 1889–90 is thus estimated by Willet and Gray (*Louisiana Planter and Manufacturer*, 5th April, 1890): —

Countries.	1885–86.	1886–87.	1887–88.	1888–89.	1889–90.
	Tons	Tons.	Tons.	Tons.	Tons.
Cuba	705,400	608,900	610,000	530,000	600,000
Porto Rico	64,000	86,000	50,000	55,000	70,000
Trinidad	49,200	69,000	60,000	60,000	60,000
Barbadoes	44,000	65,000	60,000	50,000	60,000
Jamaica	17,000	21,000	30,000	28,000	30,000
Antigua and St. Kitts	25,000	25,000	26,000	25,000	28,000
Martinique	33,000	41,000	39,000	38,000	40,000
Guadeloupe	37,000	55,000	50,000	45,000	50,000
Demerara	111,800	135,000	110,000	108,000	125,000
Réunion	35,000	32,000	32,000	25,000	30,000
Mauritius	114,200	101,800	120,000	132,000	125,000
Java	365,950	363,950	396,000	364,000	310,000
British India	50,000	50,000	55,000	60,000	60,000
Brazil	186,000	260,000	320,000	220,000	150,000
Manilla, Cebu and Hsilo	186,000	180,000	174,000	210,000	180,000
Louisiana	127,900	80,900	158,000	145,000	125,000
Peru	27,000	26,000	30,000	30,000	30,000
Egypt	65,000	50,000	35,000	35,000	35,000
Sandwich Islands	96,500	95,000	100,000	120,000	120,000
	2,339,950	2,345,550	2,465,000	2,254,000	2,228,000

WORLD'S PRODUCTION OF BEET-ROOT SUGAR.

The total production of beet-root sugar for the years 1885–86 to 1889–90, as given by the best German authorities, is as follows: —

Countries.	1885–86.	1886–87.	1887–88.	1888–89.	1889–90.
	Tons.	Tons.	Tons.	Tons.	Tons.
Germany	838,105	1,023,734	955,400	978,484	1,264,607
Austro-Hungary	369,000	555,300	408,000	525,000	787,989
France	298,407	506,384	405,759	474,000	753,078
Russia	526,200	480,854	435,361	500,000	456,711
Belgium	48,420	118,455	121,643	124,400	221,430
Holland and other countries	37,500	69,552	70,538	68,746	135,813
	2,117,632	2,754,299	2,396,692	2,670,630	3,619,678

On comparing these figures it will be seen that the quantity of beet sugar made during the last two years in the series given was much greater than that made from the cane, and that while the production of cane sugar has remained about the same during the five years named the quantity of beet sugar manufactured has increased during the same period over 70 per cent.

The imports of sugar entered for consumption in Canada in 1889-90 were 223,841,171 lbs.—111,921 tons of 2,000 lbs., and valued at $5,837,895. The duty collected on the same was $3,675,724.

These sugars came from the following countries:

Countries.	Entered for Home Consumption.		
	Quantity.	Value.	Duty Collected.
	Lbs.	$	$
Great Britain	1,804,591	53,615	47,973
United States	6,954,452	249,355	151,634
Austria	76,438	4,732	3,013
British Africa	664,252	14,149	9,962
British Guiana	3,359,968	109,487	61,914
Brazil	45,622,267	1,073,638	687,078
British West Indies	13,458,910	394,547	234,312
French West Indies	186,210	6,137	2,723
Spanish West Indies	66,767,633	1,910,808	1,158,829
Dutch East Indies	4,396,568	82,405	61,740
France	736	160	55
Germany	35,507,471	1,037,333	633,357
*Spanish possessions in Pacific Ocean	45,013,110	900,591	622,464
China	28,565	878	667

The imports of sugar entered for home consumption in 1890-91 were 174,045,720 lbs.—87,023 tons of 2,000 lbs., and valued at $5,186,158. The duty collected on the same was $2,851,547.

These sugars came from the following countries:—

Countries.	Entered for Home Consumption.		
	Quantity.	Value.	Duty Collected.
	Lbs.	$	$
Great Britain	8,581,873	207,678	142,065
United States	20,520,285	637,058	351,562
British Guiana	3,112,637	111,428	56,038
British West Indies	7,257,913	245,998	125,598
China	46,726	1,540	1,158
France	2,022	289	109
Japan	1,377	68	44
Spanish West Indies	40,522,778	1,480,031	712,746
St. Pierre	340	23	14
Dutch West Indies	897	30	18
Spanish possessions, other	29,006,851	639,510	411,344
Brazil	25,837,684	687,095	373,754
Germany	26,777,510	863,474	475,193
Mauritius	2,507,984	54,810	37,501
Danish West Indies	173,591	7,150	1,729
French West Indies	285,620	9,653	4,575
Dutch East Indies	9,429,632	240,323	158,098

* Phillipine Islands, Sooloo Islands, Caroline Islands.

SUMMARY.

From the evidence submitted it would appear that the great stimulus given to the beet sugar industry in Europe by the liberal bounties which have been paid has resulted in an increase in production beyond what is required for consumption, and for this reason mainly the price obtained for this commodity has been but little more than the cost of cane sugar, while the beet sugar is sold at less than cost.

Notwithstanding the low wages paid to operatives, the great improvements which have of late years been made in the quality of the beets, and the almost perfect condition to which the process of manufacture has been brought, it is not yet practicable to make beet sugar anywhere at such a price as will enable the operator without a bounty to compete with cane sugar, and in view of the improvements taking place in the quality of the cane and in the process of manufacture of cane sugar there seems to be no prospect of the beet sugar industry ever becoming self-sustaining.

From the facts presented relating to the history of this industry in the United States and Canada, it appears that many carefully-constructed factories have been established in different parts of the country backed by a liberal supply of capital, managed by men thoroughly trained in the business, having at their command the most approved machinery and labour-saving appliances, but, leaving out of consideration the factories recently built, it may be said that in no instance has the industry prospered sufficiently to give a fair return for the capital invested, and in almost every instance the effort has resulted in financial failure.

The main cause of these frequently-repeated failures seems to have been the want of sufficient beets to work with. In the older European countries, where labour is abundant and cheap, farmers cannot be induced to grow the quantities which the factories require at the prices they are willing to give; hence, more than half of the beets used in Germany and a large proportion of those consumed in France and other European countries are grown by the companies who own and work the factories.

In America, where labour is dearer than in Europe, this difficulty presents itself in a much more forceful way and has been the cause of many disappointments. In beet culture a large part of the labour is required during the time of harvesting and drawing the beets to the factory, and this demand occurs at a time when every farmer is busy in preparing his land for the following year, in bringing in his late crops, or in threshing or marketing his grain. It is very doubtful if farmers in Canada could afford, with a large area of land to look after, to grow sugar beets as they should be grown, of small size in rows 18 inches apart, and give to them the hand labour and the general care and cultivation they require and deliver them to the factories at the prices offered. It may be shown on paper that the business of growing beets is a profitable one for the farmer, and occasionally it may prove to be so; but there have been so many drawbacks in the high price of labour and the difficulty of procuring it at that period when it is most needed, in the unfavourable character of the seasons, and the occurrence of injurious insects, that farmers in most instances have refused to continue to grow the beets, even when $5 a ton of 2,000 lbs. have been offered for them.

Farmers may generally be trusted to find out for themselves when a crop is profitable, and such a crop they are not likely to hastily abandon, and when we find so many instances where large numbers of them have made contracts to grow sugar beets, and after one or two years of trial have refused to continue to produce them, it is self-evident that the returns cannot have been so very profitable.

It is quite true that the cultivation of sugar beets, in common with all other root crops, greatly improves the soil in which they are grown and increases the yield of subsequent crops; but these results can be produced equally by growing the larger sorts of sugar beets at a greater distance between the rows, or by growing in a similar way the coarser sorts of roots for stock feeding. Such roots can be raised at much less cost for

hand labour, and in feeding them to cattle for the production of butter, cheese or beef, the profits to the farmer are likely to be quite as satisfactory as the growing of sugar beets for a factory and less exhaustive to the soil.

The forty large factories which would be needed to produce the sugar required for home consumption would each employ probably from 200 to 220 hands, or 8,000 to 8,800 in all. Most of these would find employment in the factories during the busy season only, which would begin in the early part of October and continue probably until near the end of December.

The effect the establishment of this industry would have on other industries is a feature too important to be overlooked. The building of forty sugar factories in Canada would for a time give employment to many mechanics engaged in their construction; the increased consumption of coal would give employment to miners. It would add to the earnings of railways engaged in transporting the coal and in carrying the beets to the factories, give employment to machinists, who would manufacture more or less of the machinery, to the makers of barrels and bags to be used as containers for the sugar, and also, find employment for a large amount of capital.

The relative usefulness of the refuse pulp as cattle food will be discussed in the second part of this report. It is not, in the opinion of the writer, of that value in this country which has been claimed for it.

It is probable that the strongest objection to the encouragement of this industry, on the only basis on which it is claimed it could be established, will be found in the fact that it would require, when fully developed, an annual subsidy of about $4,000,000, for the raising of which, as long as we have free sugar, other industries must be taxed. This subsidy might in the course of time be lessened, but in view of all the facts presented, of the greater richness of the sugar cane when grown in the tropics and the probabilities of further improvements in the quality of the cane and in the process of manufacture, it is not likely that the bounty could ever be much reduced without crippling the industry.

PART II.

IMPROVEMENT OF SUGAR BEETS.

Systematic efforts have been continued during the past forty years in France and Germany to increase the proportion of sugar in sugar beets, a work which has been attended with much success. It has been found that the beet is very susceptible to improvement when a proper selection of roots is made of good form and especially rich in sugar from which to grow the seed. The beets which it is intended to use for seed purposes are selected with much care as to size, form and weight. They are then preserved in suitable pits until the time for planting arrives, when by means of a small scoop, similar to that used for testing cheese, a piece is cut from the centre and the juice expressed from it and analysed. Only those beets showing a high percentage of sugar are chosen; all others are rejected. The cavity made by the removal of the piece for testing is filled with charcoal to prevent decay before the root is planted.

The improved Vilmorin sugar beet is one of the most important results of many years of patient labour by Mr. H. Vilmorin, of the well known seed firm in Paris. It is a variety very largely cultivated both in France and Germany, and is very rich in sugar. Its general type is shown in figure 1, and it is said to hold its sugar contents under varying conditions and in unfavourable circumstances more persistently than most sorts. It does not grow to a large size, and produces only a medium crop.

Fig. 1.

The Klein Wanzleben is a cross between the Vilmorin and some other varieties, and at the present time is perhaps more extensively grown than any other sort of sugar beet. This is shown in figure 2. It is large at the head and tapers rapidly, and is distinguished from the Vilmorin by its lighter-coloured leaves, which have scalloped edges. This sort gives a heavier crop than the Vilmorin.

Fig. 2.

The Brabant sugar beet, (figure 3*), is a still more productive variety, and is readily distinguished by the form of the crown, which rises well above the level of the soil and has vigorous upright-growing foliage. Its heavy yield with a fair percentage of sugar makes it profitable to the grower, especially where it is intended to use the crop as food for stock.

Among other esteemed sorts are the French Rich Sugar beet, Improved White Imperial, Simon le Grand, Florimond, Bulteau Desprez, Electoral, Improved Elite, Imperator and Excelsior.

Fig. 3.

CULTIVATION OF THE SUGAR BEET.

Selection and Preparation of the Soil.

Probably the best soil for a crop of sugar beets is a moderately rich sandy loam. There will be no objection to it if it be more or less mixed with clay, provided the proportion be not sufficient to interfere with its porous and open character. A stiff clay soil, which packs under the influence of a hard rain or bakes under a hot sun, is an unfavourable soil for this purpose, while peaty or marshy land is still less suitable for this crop. It is also necessary that the sub-soil should be porous and open, as the sugar beet cannot be satisfactorily grown where the sub-soil is wet. In such case tile draining is necessary to remove the superfluous water.

The land should be ploughed in the fall as deep as is practicable, so as to expose the under layers of the soil to the beneficial action of frost and winter weather. In the spring it should be ploughed again, increasing the depth of the furrow, and it will be

*Figures 1, 2, 3 have been kindly supplied by order of the Secretary of Agriculture at Washington rom Bulletin 27, Division of Chemistry, by H. W. Wiley.

much improved if a sub-soil plough be made to follow in the furrow of the ordinary plough, so as to thoroughly loosen the soil to a depth of from 12 to 15 inches, after which it should be well harrowed, when it will be ready for sowing.

Manuring.

Where sugar beets are being grown for a sugar factory stable manure should not be applied to the land about to be used for a beet crop, but should be put on the land for the crop preceding—for the reason that sugar beets grown on freshly-manured land absorb too much nitrogenous and alkaline material to produce the best results in a sugar factory. When the beets are grown for feeding stock barn yard manure may be liberally applied in the autumn or the spring and ploughed under as soon as possible after spreading.

Of artificial fertilizers, a liberal dressing of superphosphate of lime is highly recommended, either alone or associated with potash, and a small proportion of nitrogen in the form of dried blood or nitrate of soda. As to the proportion in which these ingredients should be returned to the soil, it is generally held that to keep the land in good condition an amount of nitrogen at least equal to what has been used by the crop should be returned, with one and a-quarter to one and a-half times as much potash and two and a-half times as much phosphoric acid.

The quantities of these fertilizing constituents which a crop of sugar beets will take from the soil is estimated as follows, giving the proportions extracted by the root and leaves separately: In a crop of sugar beets of first quality, in which the size of the roots would be relatively small, the leaves will weigh about half as much as the roots, and estimating the crop at 12 tons per acre, with 6 tons of leaves, there will be taken from each acre the following:—

	Roots—12 tons.	Leaves—6 tons.
	Lbs.	Lbs.
Potash	79	78
Phosphoric acid	19	15½
Nitrogen	38	46½
Magnesia	12	36

Since most soils contain a sufficient quantity of magnesia to serve for an indefinite period, we need only consider the other three ingredients, and if the leaves are left on the ground and ploughed under and thus returned to the soil, as it is highly important they should be, the proportion only of fertilizing ingredients removed by the roots remains to be dealt with.

In an application of 20 tons to the acre of barn yard manure, composed of one part of horse and two parts of cow manure, the solid and liquid portions being mixed in fair proportions, there would, according to the best authorities, be supplied to the land the following quantities of the ingredients referred to:—

From 110 to 130 lbs. phosphoric acid.
140 to 160 lbs. alkalies, chiefly potash.
160 to 175 lbs. nitrogen.

sufficient to replace what is taken by the beet crop and provide fairly well for the other crops to be mentioned under "rotation."

If artificial fertilizers are to be used to replace what the crop has taken from the soil it will be well to bear in mind that every pound of phosphoric acid to be supplied will require from 6 to 12 lbs. of super-phosphate, depending on the quality, 2 lbs. of muriate of potash, 6 or 7 lbs. of kainit, or from 16 to 20 lbs. of wood ashes contain 1 lb. of potash, and 5 lbs. of commercial sulphate of ammonia, or 6½ lbs. of nitrate of soda furnish 1 lb. of nitrogen. Having these facts in memory, the intelligent farmer can regulate his application of artificial fertilizers to suit the crop he wishes to grow.

SEED AND SOWING.

The next thing to consider is the seed, of which there are many varieties which have been brought to a high degree of perfection by judicious cross-fertilizing, and carefully selecting for seed only those beets which are shown by individual analysis to contain a high percentage of sugar. The names of the sorts most esteemed are already given under "Improvement of Sugar Beets."

Having secured the variety desired, the sowing should be done as soon as possible after the land is prepared. Fine weather should be chosen for this work and the land rolled soon after the sowing is finished, to induce that condition of moisture at the surface necessary for the prompt germination of the seed. The sowing should be done on the flat, in drills about 18 inches apart and at the rate of 16 lbs. of seed to the acre. This may appear to many to be a very large quanity, but long experience in Europe has shown that this close planting gives surer and better results than where lesser quantities of seed are used.

Several forms of implements have been devised for sowing the seed. The most expeditious of these, where a large area is to be covered, is the Moline Beet Seeder, specially devised for sowing beet seed, and recently brought out by the Moline Plough Company, of Moline, Illinois. This instrument, which sows four rows at a time at 16, 18 or 20 inches apart, is shown in figure 4.

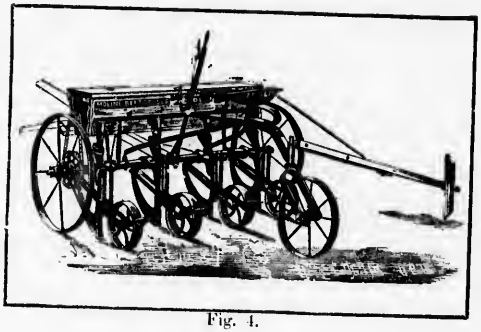

Fig. 4.

AFTER TREATMENT.

In the course of 10 or 15 days, if the atmospheric conditions are favourable, the plants will show themselves above ground, and as soon as they are well up they should be weeded, and for this purpose the hand cultivator, known as the Planet Junior (Fig. 5), will be found very convenient. When the young plants have grown to be about as thick as a slate pencil they should be thinned, so as to leave one plant by itself every 6

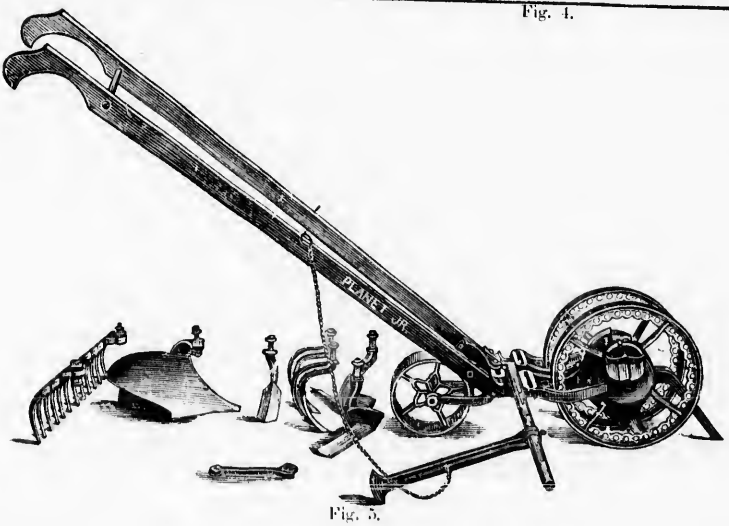

Fig. 5.

to 8 inches. This work should be preceded by the use of the cultivator between the rows, so as to kill all the weeds which may have started. Vigorous plants only should be selected, even if the regularity of the intervals is not exactly preserved, but no space should be left more than 12 inches. Much of the thinning can be done with a narrow hoe, and the hand work thus limited to the pulling of the plants immediately around the one to be preserved, which, when the others are removed, should have the earth pressed firmly around it. After the young plants have recovered from the effects of the thinning a cultivator should be again passed through between the rows, so as to loosen the ground and kill the weeds, and this stirring of the soil and killing of weeds should be repeated at intervals of ten days or a fortnight during the growing season, so as to keep the ground clean and the surface loose and friable, the earth being worked towards the roots, so as to cover them up to the collar. In figures 6 and 7 the method

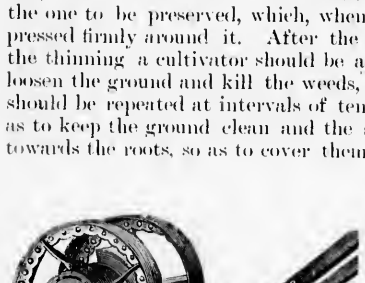

Fig. 6.

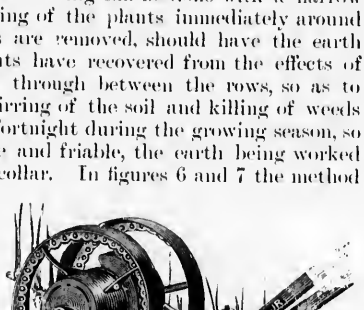

Fig. 7.

of cleaning the ground between the rows by the Planet Junior cultivator is shown: in figure 8, the same implement, of stronger build, for use with a single horse, is represented.

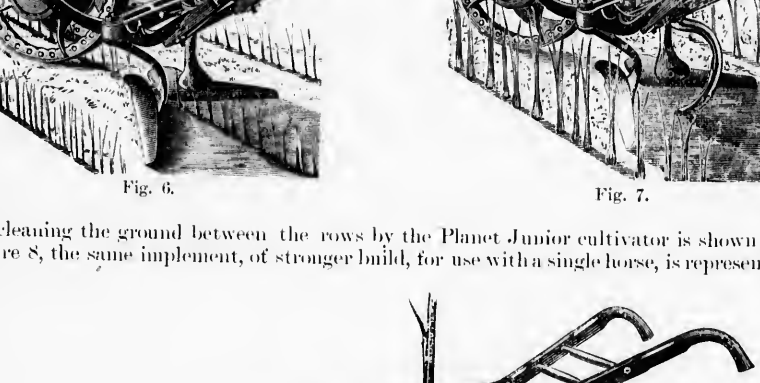

Fig. 8.

This latter will be found useful where the rows are sown wide enough apart to admit of the use of a horse.*

This covering of the upper part of the root with earth is required, for the reason that any portion exposed above the surface will contain a very much smaller proportion of sugar than those parts below the ground. In a series of twelve analyses recently

* Figures 5 to 8, inclusive, have been kindly supplied by S. L. Allen & Co., of Philadelphia, who manufacture these implements.

made by Mr. F. T. Shutt, chemist of the experimental farms, of the same varieties of beets earthed and unearthed, it was found that while the former averaged 13.2 per cent of sugar the latter averaged only 11 per cent. In figure 9 another form of cultivator is shown specially devised for beet culture which cultivates four rows at a time and is worked by one horse. This is made by the Moline Plough Company, Moline, Ill.

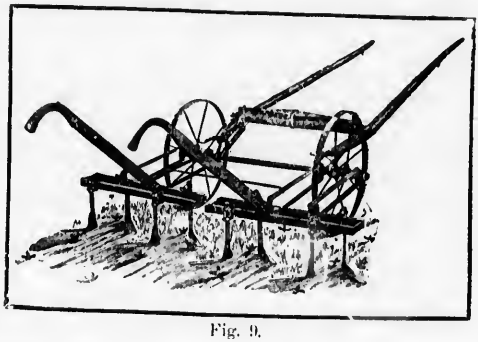

Fig. 9.

When the leaves have grown so as to cover the ground the plants may be left without further treatment until harvest time. As the beet ripens the outside leaves lose their bright green colour and change to a yellowish green; they also droop, and lie close to the ground, some of them dying. It is most important that the beets be left in the ground until they are fully matured, as the formation of sugar in them takes place very rapidly during the last few days of their growth.

HARVESTING.

Beets planted during the first week in May will usually be ready for harvesting about the middle of October. At the Central Experimental Farm at Ottawa sugar beets were sown in 1889 on the 20th May and harvested on the 14th October; in 1890 sown on the 13th of May and harvested 18th October; and in 1891 they were sown on the 9th of May and pulled on the 19th of October. The harvesting is usually accomplished by first loosening the beets in the ground, which may be done by ploughing a furrow alongside of the row and lifting the beets by hand. A new form of beet harvester which is highly spoken of is shown in figure 10. This also is manufactured by the Moline Plough Co. *The next operation is the removal of the leaves and neck of the root, which is that part to which the stems of the leaves have been attached. This latter is cut off with a short hook or heavy knife and left on the ground to decay and be ploughed under with the leaves, because this part of the root contains a large proportion of the mineral salts which the plant during its growth has extracted from the soil, the carrying off of which would unnecessarily exhaust the land. Further, the presence of these mineral salts in the juices of the beet when worked in the factory interferes with the crystallization of the sugar, and increases the trouble and expense of manufacturing it.

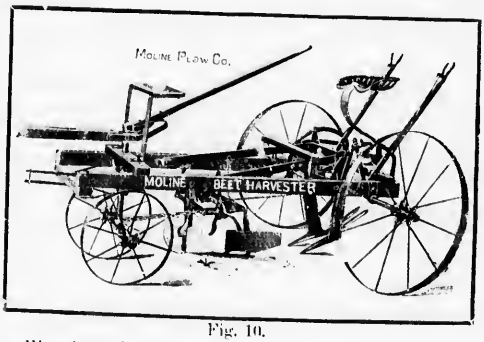

Fig. 10.

When the beets are topped they are thrown into heaps, and covered with the tops and leaves, to protect them from the sun and frost until they can be delivered to the factory.

ROTATION OF CROPS.

A proper rotation of crops is always desirable, and beets seem to do best after wheat or some other cereal. Rich soils on which beets have not been previously grown may

* Figures 4, 9 and 10 have kindly been furnished by the Moline Plough Co., Moline, Ill.

produce several good crops in succession without much injury to the land. The following is a good system of rotation: First, wheat, on land well manured; then beets, followed by barley, and at the same time seeding down with timothy and clover, which is cut for hay the following summer and the second crop ploughed under in the autumn, to be followed the next season with potatoes or oats, which completes the rotation.

COST OF GROWING SUGAR BEETS.

The cost of growing a sugar beet crop is so varied under the modifying circumstances which prevail in different countries that no general estimate can be given which would correctly apply to all. The price of labour and the value of land are the principal factors which influence the cost.

In Germany the cost of raising sugar beets is estimated in the statistical report of the government for 1888-89 to average $40 per acre, while the average yield for that year was 12 tons.

The average cost in France is given by Mr. E. Du Fay, of Chevy, Cossignac, at about $80 per acre, but this estimate seems to be excessive.

In "The Sugar Beet" for 1883 it is stated on the authority of Mr. D. Doff that the cost of cultivating the beet in Saxony is $4.76 per long ton of 2,240 lbs., delivered at the factory, and that the growers realized from $5.71 to $6.19.

In "The Sugar Beet" for 1882, p. 60, it is stated that the average cost of raising this crop throughout the northern States may be put at $45 per acre.

Dr. H. W. Wiley, of the Department of Agriculture, Washington, in his bulletin on "The Culture of Sugar Beets" (1891) says: "It is probable that the actual cost to our farmers for the first few years of the beet industry will not exceed $45 to $50 per acre, and it is believed that, accidents of season aside, a net profit of from $8 to $15 per acre may be expected from the proper culture of the sugar beet in localities near a factory."

Mr. Henry T. Oxnard, of the Grand Island factory, Nebraska, estimates the cost of raising beets in that State at about $40 per acre, where all the labour is paid for.

Prof. H. H. Nicholson, of the State University, Lincoln, Nebraska, is of opinion that sugar beets may be grown in Nebraska and delivered at the factories at a cost of $30 per acre. The yield of the plots at the experiment station at Lincoln, of which Prof. Nicholson is director, was 16 tons per acre in 1891.

Mr. J. Thomnsen, of Hall county, Nebraska, found the actual cost of growing 5 acres in 1890 to be $34.30 per acre, but in his estimate nothing is allowed for rent of land, fertilizers or hauling the beets to the factory.

Mr. J. B. Henderson, of Alameda, California, gives the cost of raising this crop at $51.48 per acre, while Mr. A. F. Richardson, of the same place, reports that 11 acres cost him on an average $48.64 per acre.

Mr. Oct. Cuisset, of Quebec, in his pamphlet on "Beet Root Culture," estimates the cost of growing an acre of beets in the Province of Quebec, including rent of land and proportion of cost of manure, at $34 per acre.

In a report to the Minister of Agriculture of Ontario on the cultivation of the sugar beet in Ontario, by Robert H. Lawder, in 1890, the estimated cost of production is given as varying from $15 up to about $35. From a careful estimate prepared by Mr. John Fixter, farm foreman at the Central Experimental Farm, the cost of raising sugar beets at that institution during the past year (1891) was nearly $40 an acre ($39.79). This estimate is based on labour at $1.25 per day; single horse and man, $2; team and man, $3 per day. Beets sown in rows 18 inches apart, and the use of 16 lbs. of seed per acre, at 18 cents per pound.

The estimate includes also $4 for fertilizers, being one-fourth the cost of 20 tons of barn yard manure per acre used in the rotation, and $3 for rent of land, equal to 6 per cent on $50 per acre.

VALUE OF BEETS FOR FEEDING STOCK.

It is very difficult to arrive at the exact value of roots as food for stock, since there are advantages in feeding them apart from their chemical constituents. The use of a cer-

tain proportion of such succulent food mixed with the drier rations commonly used in winter promotes the health of the animals, and makes the other food more palatable and more easily digested. It is however generally estimated by farmers in Ontario that a ton of well-grown roots, turnips or mangels is worth about $4, while carrots are usually valued somewhat higher. In Europe, where labour is cheaper and more easily procured, these roots would probably be rated a little lower in value.

ANALYSES OF ROOTS.

The following table shows the results of recent analyses of turnips, mangels, sugar beets and the waste pulp from the sugar beets obtained at the beet sugar factory at Farnham, Quebec. These analyses have been made Mr. F. T. Shutt, chemist of the Dominion Experimental Farms.

	Percentage of Water.	Percentage of Dry Matter.	Digestible Matter per Ton.
			Lbs.
Turnips	90·34	9·66	179
Mangels	91·29	8·71	145
Carrots	90·47	9·53	173
Sugar beets	84·25	15·76	296
Sugar beet pulp	95·72	4·28	83

These figures indicate that the probable value of a ton of sugar beets in feeding stock is equal to about 1½ tons of either turnips, mangels or carrots, and if this be so the relative feeding value of sugar beets should be about $6 per ton.

PRICES PAID FOR BEETS BY SUGAR FACTORIES.

In 1888–89 the prices paid at the factories for sugar beets in France varied from $4.40 to $5 per ton, while the yield per acre was from 11 to 13 tons. In Germany the prices paid for the roots varied from $4 to $6 per ton, with an average yield of 11 tons. It is said that in Austria some cultivators asked $6 per ton with a right to claim 60 per cent of the pulp, but that manufacturers of sugar refused to pay such prices. From a statement in "The Sugar Beet" for the year 1890, page 30, it appears that at Watsonville factory in California in 1889 the beets brought an average of $5 per ton with a yield of about 6¾ tons per acre. At the Alameda factory in the same State the price varied from $4.50 to $5 per ton. In Nebraska the price paid at the factory at Grand Island in 1890 was $3 per ton delivered at the factory for beets not having less than 12 per cent of sugar, and 25 cents per ton for each additional percentage of sugar. Owing to the very dry season the yield was light, and was estimated by some at about 3 tons per acre, by others at from 5 to 8 tons. The roots were very small, and on this account contained an exceptionally high percentage of sugar; hence they probably brought about $4 per ton. In 1891 the same prices prevailed at both the Grand Island and Norfolk factories, and as the crop has been larger the sugar percentage has averaged less, about 14 per cent, which would make the price paid for the beets $3.50 per ton.

At Farnham, in Quebec, $4.50 per ton has been paid, delivered at the factory, added to which a bounty has been given for one year by the Quebec Government of 50 cents per ton, increasing the receipts of the farmers to $5 per ton. It is said that the factories cannot afford to pay a higher price than $4.50, and if that be correct it would appear to be more profitable for farmers to raise sugar beets for feeding stock than for the sugar factories. It would also seem to offer a partial explanation of the reason why in Ger-

many, after the farmers have had an experience of about fifty years in the cultivation of beets, the owners of the factories are still obliged to grow an average of more than one-half of all the beets they consume.

VALUE OF BEET PULP FOR FEEDING.

Concerning the value of this material as food for stock there are many conflicting statements. It must, however, be borne in mind that when beet pulp is spoken of in Europe it is generally understood to be pulp which has been pressed, by which process a large proportion of the water is got rid of and the proportion of solid matter increased to about 20 to 22 per cent, thus adding very much to its value. In Canada and the United States the pulp has hitherto been offered just as it comes from the diffusors. From the analysis of Mr. Shutt of the sample sent from the Farnham factory it appears that in this condition the pulp contains nearly 96 per cent of water, and less than one-third of the nutritive matter contained in the sugar beets before treatment. On comparing the proportion of digestible matter with that contained in ordinary mangels or turnips it would appear that the pulp would average about half the value of these roots. But the relative cost of handling material so weighty with water and containing so low a feeding value would detract from its actual worth when comparing it with mangels or turnips, while the difficulty of preserving from decomposition a substance so succulent and watery would prove another objection to its use. Taking all these points into consideration, it would appear that the estimate formed of this substance by Dr. H. W. Wiley, of Washington, as given on page 21, is about correct, where he considers the feeding value of the pulp as about one-fourth of that of the beets.

PROCESS OF MANUFACTURE OF BEET SUGAR.

When the farmer delivers his beets at the factory they are weighed, and a receipt is given him for them. Samples are taken to the laboratory, where the proportion of sugar contained in them is ascertained and the price fixed accordingly. The beets are unloaded in a suitable shed, from one end of which proceeds a shallow underground sluiceway, with a smooth bottom, through which a shallow but rapid stream of water floats the beets to the washing machine. This machine is a long iron trough resting on a slightly inclined plane and partly filled with water. Revolving arms gradually carry the beets to the lower end of the vessel, by which time they are thoroughly cleaned. They are then thrown out automatically into an elevator, which carries them to the upper story of the building, where they are emptied on an inclined platform made of slats between which the water drips away from the beets. As the roots are gradually forced down the inclined platform they fall into an iron weighing chest, with a capacity of 500 kilos, equal to 1,102 lbs. As soon as this weight is reached the falling of the beam lifts a shutter, which prevents any more beets falling in until the chest is emptied, which is done by means of a movable bottom worked by a lever. The dropping of the beam also sets some internal machinery in motion, which automatically records the weighings.

From the weighing chest the beets drop into the cutter, where small ribbed knives on a revolving cylinder reduce them rapidly to shreds, almost like vermicelli. These shreds, which are commonly called cossettes, pass down as they are cut, and by means of a movable wooden carrier are transferred to the diffusors below.

The diffusors are arranged in a circular series or battery, and are connected by pipes which supply hot water for the exhaustion of the beets, and form outlets through which the sap may be forced when it is sufficiently concentrated to be removed to the treating vessels. The diffusor is a long cylindrical wrought-iron vessel, capable of holding about 2 tons of the cut beets, having a man-hole on the top with a swinging cover, and the bottom arranged so that it can be readily opened, so that the cossettes may drop out when exhausted. When the diffusor is filled the closely-fitting cover is tightly fastened and hot water introduced into the vessel from below, and gradually forced upwards

through the mass of loosely-packed shreds of beet root. The loose cellular structure of the root is rapidly permeated by the hot water, and the denser saccharine juice in the beet cells passes rapidly through the walls of the cells, being replaced by the water When the water which entered the bottom reaches the top of the vessel it passes down by means of a pipe and enters the lower end of the adjoining diffusor, where it passes through another mass of cut beets, and so on until the water has become sufficiently charged with sugar, when it is transferred to the vessel where the saccharine fluid is decolourised and purified. By this process the cossettes which are continually exposed to the action of fresh portions of water are rapidly exhausted, and so completely is the sugar taken from them that when emptied they seldom contain more than from two to three-tenths of 1 per cent of this substance.

The next process is the purification of the sap, which leaves the diffusor as a dark sugary liquid with a rather disagreeable odour and taste, and passes into the carbonatation tank. When the latter is about half full of sap, lime freshly slacked and mixed with water is passed into it, steam being turned on to raise the temperature of the fluid. The proportion of lime used in this first treatment is usually equal to about 2 per cent of dry lime. The temperature of the juice is gradually raised by the steam introduced until it reaches 190 to 200 Fahr., which coagulates the albuminous matter. The caustic lime forms a soluble compound with a portion of the sugar known as sucrate of lime, which is decomposed by passing carbonic acid gas into the fluid forming an insoluble carbonate of lime, which on settling carries down with it a large portion of the colouring substances. After treatment the milky mixture of sap and carbonate of lime is pumped into the filter presses, where all the sedimentary matter is separated and the transparent liquid flows out of a light yellow colour.

In most factories the saccharine fluid after filtration undergoes a second treatment with lime added in much smaller proportion, followed by carbonic acid gas and another filtration, after which the last trace of colour is removed by treatment with sulphurous acid gas. In other factories filtering the sap through bone black takes the place of the second treatment with lime and the after treatment with sulphurous acid. This also decolourizes the solution effectually. The clarified liquid is next concentrated by boiling in large cylindrical evaporators, in a partial vacuum, by which the boiling point is much lowered, the vacuum being created by the action of powerful air pumps, while the steam escaping from the first evaporator is used to raise the temperature in the next.

When sufficiently concentrated the fluid is transferred to another vacuum pan, where it is boiled until it is so far thickened that it granulates on cooling. When this point is reached the sugar is dropped from the bottom of the vacuum pan into another vessel below, where it forms a dark-coloured pasty mass, consisting of sugar crystals enveloped in about one-fourth their weight of molasses, and when cooled it is transferred in successive portions to the centrifugal machines, which, when set in motion, make about 1,200 revolutions a minute. The rapid motion to which the sugar is subjected has the effect of throwing the mass evenly against the sides of the centrifugal and also of throwing off the molasses, which, passing through the wire backing with which the centrifugal machines are furnished, escapes through a tube below into a suitable receptacle, the sugar in the course of 10 or 15 minutes becoming either a light-coloured raw sugar or a white refined sugar, depending to some extent on the method of treatment as well as on the perfection of the apparatus.

If refined directly from the first crystallization the last trace of colour is removed by using a jet of steam associated with compressed air on the revolving sugar in the centrifugal, by means of which the last portions of the adhering molasses are removed from the crystals, leaving them pure and white. The refined white sugar, still damp, is elevated to an upper chamber, where it enters a long cylindrical iron vessel fixed on an inclined plane which revolves around a coil of steam pipes within. By the revolutions of the cylinder the sugar is frequently thrown on the warmed surface of the pipes, and in this way by the time it reaches the lower end it is thoroughly dried. It is then passed through sieves by means of which a uniform grade of finely granulated white sugar is produced.