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STATE AGRICULTURAL COLLEGE.

The Agricultural Experiment Station.

BULLETIN NO. 14.

PROGRESS BULLETIN ON

SUGAR BEETS

FORT COLLINS, COLORADO.

JANUARY, 1891.

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PROGRESS BULLETIN

ON

SUGAR BEETS

By DAVID O'BRINE, *Chemist*.

Last October, in company with the Director of the Station, we visited the beet sugar manufactory at Grand Island, Nebraska, for the purpose of making ourselves better acquainted with the working details of the manufacture of sugar from beets. The factory is situated about two miles from Grand Island; a street car line makes connection with the city every half hour. As we approached the factory, wagons could be seen coming from every direction, loaded with sugar beets. Henry T. Oxnard, President of the company at Grand Island, Nebraska, has given a description of the plant, and we copy from the *Western Resources*, taken from the *Tribune*, the following facts:

"Past attempts have, in most part, been made by nothing less than adventurers who lacked both capital (they had plenty of capital in Illinois) and experience to go on with the work. Men who knew literally nothing about cultivation of the beet or the process by which sugar is extracted from it, jumped into a big undertaking, and, of course, failed. There has been a wonderful progress in the industry in the last fifty years. In 1829 the sugar beet yielded only $2\frac{1}{2}$ per cent of sugar to the weight of the beet. Ten years ago 9 per cent was the average,

while 14 per cent. was taken (on an average) from the German crop of 1889. Every additional per cent. means an increase of twenty pounds of sugar per ton, or 300 pounds additional to the acre. In Nebraska 315 analyses of different beets gave me an average of 16.10 per cent. In a field of beets, you will find sections which yield more than others, but they won't vary more than 1 per cent., and I may say the average is 14 per cent.

"We have a method by which we are enabled to secure the best results in the beet cultivation, and that is by proper propagation of the plant. We weed out those that we know would produce inferior results, and we keep on watching with great care and allowing nothing to produce seed that will not enhance the valuability of the seed. Producers are ascertained by boring out a quantity of the meat of a beet, after which the hole is plugged and a stake driven into the ground to mark that particular vegetable. If, from an analysis, the beet gives promise of rare quality it is allowed to go to seed. No seed is taken from beets the quality of which is not proven to be of the highest order, and we desire to attain this degree of excellence in the propagation of the beet seed from which to grow our sugar producers."

TO CULTIVATE SUCCESSFULLY.

"The ground being carefully prepared, the seed is drilled in rows at distances from 16 to 18 inches apart, and 1 inch deep, after which the surface is smoothed with a roller. When the plants have grown from 4 to 6 inches they must be separated, leaving a single plant from 6 to 8 inches apart, in rows according to the fertility of the soil. This work is of the greatest importance, and if delayed will result in reducing the yield.

"It requires about twenty pounds of seed to sow an acre, the sowing being done about the same time that

corn is planted. There are 56,000 plants to the acre, and 5 to 10 per cent. of which is said to fail. The contract stipulates that the progress of cultivation must be under the direction of the company, which from time to time will instruct the planters as to the best manner of successful treatment. A machine made especially for this purpose is used, with which the ground is made loose until the plants grow to such a height as to cover the space between rows and plants, when further cultivation is not required. In the fall, the beets are plowed up with an instrument especially adapted to the work. The leaves, in accordance with the contract, are cut off and left on the ground for fertilizing purposes. The beets are then hauled to the factory, where they are paid for in proportion to the saccharine matter contained, which is ascertained by an analysis made from slices of a half dozen beets taken from the load, as follows: \$3 a ton for beets having 12 per cent. sugar, with coefficient purity of eighty, and twenty-five cents for each additional per cent. of sugar. Beet roots having 20 per cent. sugar bring \$5 per ton. Very large beets, or those grown mostly above the ground, are rejected for sugar, as are also those that have been frozen, or diseased. The average yield to the acre is fifteen to twenty tons, and brings the planter about \$45 and \$60 an acre. Considerable expense is incurred in thinning, for which purpose men, women and children are employed during the season.

“ It requires about two and one-half days to take the juice out of a beet and run it into a barrel in the shape of sugar in the grain. The beets are unloaded alongside a hydraulic canal, in which they are rolled about till they are thoroughly cleansed, and are carried by the washing process to an elevator and taken aloft and deposited in a huge weighing machine holding just one ton of beets. This, upon receiving the last ounce, automatically

empties the vegetables into a slicer, in which revolving knives quickly cut the beets into long slices. These, in turn, fall into the diffusion battery, consisting of twelve cells, and there undergo the juice-extracting process, becoming more and more of the character of molasses as each cell is passed. Defecation by lime and heat is then commenced, after which the lime is removed by carbonic acid gas. The mass is then filtered by double process, evaporated to crystallize, and the sugar finally separated from the molasses. The first molasses is evaporated again to furnish a second crop of sugar, and a third and a fourth crop is subsequently obtained. The final molasses is too offensive for food, and is converted into potash. The pulp is disposed of for cattle-fattening purposes."

"With reference to what is being done in California in the way of beet culture for sugar purposes, it was learned that last year in the vicinity of Watsonville the yield was 14,000 tons, bringing to the planter an average of \$5.04 per ton. It costs fifteen cents a ton to plow up, forty cents a ton to top (a woman can top four tons a day), fifteen cents a ton to load and from fifty to seventy-five cents a ton to haul a distance of two and a half miles. It costs about \$29 to harvest an acre, which yields a crop valued at \$110, so that the planter gains \$81 for planting and thinning. One man residing three miles from the factory gives the following as the result of the cultivation of a ten-acre field :

Plowing	\$ 50.00
Thinning	190.00
Topping	153.00
Hauling	150.00
Total	<u>\$543.00</u>
Yield, tons, 154, value	\$972.80
Outlay	<u>543.00</u>
Profit	<u>\$429.80</u>
Profit per acre	\$ 42.90

"Another Watsonville man who lives two miles from the factory and cultivated eleven acres, reports a yield of 170 1-20 tons, which netted him a profit of \$35.08 per acre."

When we were at Grand Island we learned that the plant there cost about \$500,000. About 200 men are employed, 100 on each shift, running night and day. There are six batteries of boilers, two in each battery. We noticed that they made their own lime on the ground. They used up about 250 tons of beets a day. It was about 11 a. m. when we visited the packing rooms, and the workmen told us that they put up 110 sacks (100 pounds in a sack) that morning, or, at that rate, about 400 sacks of sugar a day. The plant runs as long as there are beets to be had—say from three to five months.

It is apparent from the numerous inquiries about sugar beets, that a great many farmers do not understand the terms used by chemists and others in describing the work. This may be due to the fact that the previous bulletins (Nos. 7 and 11) have not fallen into their hands. We find it necessary, even at the cost of repetition, to explain the terms used :

Coefficient of Purity—Is the term used to denote the ratio per cent. of the total sugar (sucrose) in the juice to the total solids. Suppose, for instance, that the juice contained 15 per cent. total solid and 11 per cent. sugar (sucrose), the coefficient of purity would be $11 \div 15 = 73.3$ per cent. It must follow that the higher the coefficient of purity the easier it is for the manufacturer to make the sugar from the juice of the beet.

Marc—Is the name applied to the dried residue or chips that remain after the sugar and juice have been extracted. It is used to some extent as a cattle food, and sold in Grand Island, Nebraska, at twenty-five cents a ton.

Loss on Dressing—Is the loss occasioned by cutting off the part of the beet grown above ground. The per cent. of sugar increases from the top of the beet to the bottom.

The part above ground contains relatively more salts of potash, lime, etc., than the rest of the beet, and these salts increase the specific gravity, lessen the coefficient of purity, and interfere with the extraction of the sugar present. It is for these reasons that it is removed. The sugar in the juice of the sugar beet consists mostly of cane sugar, with a small per cent. (one or two-tenths) of grape sugar. The methods of analysis may be briefly sketched. Average beets are taken, washed, dried and weighed. The part grown above ground (crown) and small rootlets are removed, and again weighed, and the loss carefully noted. The beets are quartered parallel to the axis, and successive slices made lengthwise from each quarter of the different beets selected. These slices are grated on an ordinary tin grater, and the whole well mixed. A weighed quantity is taken, the sugar extracted, the coloring matter precipitated with basic lead acetate, and the amount of sugar determined by a saccharimeter.

The per cent. of sugar in the sugar beets depends upon, (1) the kind of beets, and (2) upon the cultivation.

Many of the beets sent to the Station for analysis were very large, and poor in sugar. They were sent with the mistaken idea that a large, overgrown beet of immense size and weight (11 pounds) was a good sugar beet. The following analyses show that the size of the beet is in inverse ratio to its sugar content. It must follow from this that as the beets increase in size and weight, say above 3 pounds, the per cent. of water increases and the sugar decreases. The following beets

were raised upon the same soil (by the Horticultural Department), had the same cultivation, and were harvested at the same time. They were selected only with reference to their size—large, medium and small:

NAME.	Size.	Weight, in Grams.	Loss on Dressing, Grams.	Cane Sugar.	Grape Sugar.	Total Sugar.
Bulteau Desprez.....	Large	1,245	170	12.7	.13	12.83
Bulteau Desprez.....	Medium	285	20	13.98	.12	14.10
Bulteau Desprez.....	Small	43	3	15.83	.14	15.97
Kleinwanzleben.....	Large	1,015	135	14.03	.09	14.12
Kleinwanzleben.....	Medium	240	20	14.15	.13	14.18
Kleinwanzleben.....	Small	42	2	16.93	.18	17.11
Dippe's Vilmorin.....	Large	860	70	14.25	.12	14.37
Dippe's Vilmorin.....	Medium	280	35	14.67	.17	14.84
Dippe's Vilmorin.....	Small	42	2	16.43	.21	16.66
Bulteau Desprez No. 2.....	Large	980	110	14.13	.13	14.26
Bulteau Desprez No. 2.....	Medium	375	30	15.53	.15	15.68
Bulteau Desprez No. 2.....	Small	89	5	15.96	.13	16.09
Simon Le Grande, Vilmorin.....	Large	1,150	150	11.88	.29	12.17
Simon Le Grande, Vilmorin.....	Medium	150	10	12.73	.15	12.88
Simon Le Grande, Vilmorin.....	Small	43	3	13.30	.22	13.52
Florimond Desprez.....	Large	1,310	170	12.82	.17	12.99
Florimond Desprez.....	Medium	175	10	15.43	.11	15.54
Florimond Desprez.....	Small	30	3	16.92	.13	17.05

The size of the beet can be controlled, at least to an extent, by thick seeding and judicious thinning. Manufacturers think that the per cent. of sugar in the sugar beets should not go below about 13 per cent. It is an important point for the farmers to have their sugar beets run high in sugar, as the price paid for them depends upon it. The seed used by the Horticultural Section was furnished by the Department of Agriculture at Washington, and samples of the beets were sent to Dr. H. W.

Wiley, Government Chemist, for analysis. Prof. Wiley reports to Prof. Crandall, October 2, 1890, the following results:

Name of Kind.	Per Cent. of Sugar.
Kleinwanzleben -----	15.11
Simon Le Grande -----	11.15
Florimond -----	15.39
Bulteau Desprez No. 1 -----	15.20
Bulteau Desprez No. 2 -----	14.75
Vilmorin -----	12.92

Later in the season, November 12, some of the same lot of beets were sent to Grand Island, and their chemist, under date of November 12, 1890, reports the following per cents. of sugar:

Name of Kind.	Per Cent. of Sugar.
Excelsior Sugar -----	7.4
Improved Imperial -----	8.2
Bulteau Desprez -----	14.4
Dippe's Vilmorin -----	14.7
Kleinwanzleben -----	13.5
Florimond -----	13.2
Simon Le Grande -----	13.5

The analysis shows practically the same results when allowance is made for the fact that when sent to Washington they were taken from the soil, and when sent to Grand Island they had been dry some time. In our analyses of the same, taking the average of the medium and small, we have:

Name.	Small.	Medium.	Average.
Bulteau Desprez No. 2 --	16.09	14.10	15.03
Bulteau Desprez No. 1 --	15.97	15.68	15.88
Kleinwanzleben -----	17.11	14.18	15.64
Dippe's Vilmorin -----	16.66	14.84	15.75
Florimond -----	17.05	15.54	16.30

The following additional analyses of sugar beets from different portions of the State were made:

ANALYSES OF SUGAR BEETS.

COLORADO EXPERIMENT STATION.

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NAME.	Grams, weight.	Loss on Dress'g	Cane Sugar.	Grape Sugar.	Total Sugar.	WHERE AND BY WHOM GROWN.
Colorado Imperial	670	70	8.02	.07	8.09	A. R. Black, Lamar, Colorado.
California Sugar Beet	340	50	13.03	.1	13.13	" " " "
Colored Vilmorin Desprez	470	65	11.07	.19	11.26	" " " "
Imported Florimond	415	35	8.45	.24	8.69	" " " "
Kleinwanzleben	550	60	11.04	.17	11.21	" " " "
Vilmorin	837	55	10.38	.13	10.51	Stimson, Nebraska.
Simon LeGrande's White Imperial	278	46	15.59	.17	15.76	San Luis Experiment Station, Del Norte, Colorado.
Bulteau Desprez	270	30	11.82	.09	11.81	" " " " " " "
Vilmorin	320	50	14.14	.28	14.42	" " " " " " "
Vilmorin Desprez	315	40	12.25	.16	12.41	" " " " " " "
Kleinwanzleben	540	80	13.35	.14	13.49	" " " " " " "
Red Top	1482	117	11.84	.10	11.94	Arkansas Valley Exp. Station, Rocky Ford, Colorado.
Simon Le Grande	870	125	13.28	.16	13.44	" " " " " " "
Dippe's Vilmorin	685	55	14.09	.20	14.29	" " " " " " "
Florimond Desprez	825	55	14.72	.23	14.95	" " " " " " "
Bulteau Desprez	760	60	12.89	.10	12.99	" " " " " " "
Kleinwanzleben	750	40	13.66	.11	13.77	" " " " " " "
Name unknown	1830	330	6.72	.12	6.84	Probst, Sterling, Colorado.
" " "	895	195	7.65	.11	7.76	Zetzell, " "
" " "	4360	910	8.18	.15	8.33	Snyder, " "

ANALYSES OF SUGAR BEETS--Continued.

NAME.	Grams. weight.	Loss on Dres'g.	Cane Sugar.	Grape Sugar.	Total Sugar.	WHERE AND BY WHOM GROWN.
Name unknown.....	3320	790	6.55	.22	6.77	Snyder, Sterling, Colorado.
" ".....	1850	280	6.74	.17	6.91	Perkins, " "
" ".....	1500	285	9.16	.14	9.30	J. Silver, " "
" ".....	780	175	11.26	.26	11.52	G. Lee, " "
Improved Imperial.....	2250	445	8.70	.14	8.84	Agricultural College garden, Fort Collins, rich soil.
Imperial.....	1735	315	9.75	.10	9.85	" " " " " " "
Excelsior.....	1940	410	6.95	.11	7.06	" " " " " " "
Kleinwanzleben.....	515	25	12.57	.12	12.69	Agricultural College garden, Fort Collins, Colorado.
Bulteau Desprez.....	205	7	13.37	.14	13.51	" " " " " "
Florimond Desprez.....	415	30	12.90	.19	13.09	" " " " " "
Dippe's Vilmorin.....	415	25	14.20	.09	14.29	" " " " " "
Bulteau Desprez.....	335	20	14.18	.13	14.31	" " " " " "
Simon Le Grande.....	640	55	11.38	.12	11.50	" " " " " "
Kleinwanzleben.....	1085	80	11.11	.09	11.12	" " " " " "
Bulteau Desprez.....	682	52	10.97	.16	11.13	" " " " " "
Florimond.....	755	90	9.82	.21	10.03	" " " " " "
Dippe's Vilmorin.....	970	70	12.74	.08	12.82	" " " " " "
Bulteau Desprez.....	530	30	11.12	.11	11.33	" " " " " "
Simon Le Grande.....	950	60	9.26	.17	9.43	" " " " " "
Imperial.....	500	20	14.08	.12	14.20	Chas. Green, Del Norte, Colorado.
" ".....	335	15	14.76	.13	14.89	A. S. Halsted, " " "
Lane Imperial.....	1520	..	11.30	.22	11.52	Chas. Schielman, La Junta, Colorado.
" ".....	15.68	.09	15.77	

Besides these analyses, twelve others were made with special reference to the specific gravity of the juice as an index of the per cent. of sugar. In all cases 200 grams of the beets were reduced to a pulp, and the washings made up to 750 C C., with the following results :

Name.	Specific Gravity.	Per Cent. of Sugar.
Grown by Probst.....	1.012	6.84
“ “ Snyder, red	1.012	6.77
“ “ Zetsell.....	1.0125	7.76
“ “ Perkins.....	1.015	6.91
Bulteau Desprez, Rocky Ford Station..	1.02	12.99
Imperial.....	1.02	9.85
Kleinwanzleben.....	1.02	12.69
Simon Le Grande, Vilmorin....	1.022	12.17
Bulteau Desprez, College.....	1.022	14.31
Dippe's Vilmorin....	1.025	14.84
Bulteau Desprez, College.....	1.125	14.26
Bulteau Desprez, College.....	1.02	12.83

These results are confirmatory of those of last year. During the past season seventy-three analyses of sugar beets were made. In many cases the yield per acre was not given, nor the kinds of beets raised, which detracts a great deal from the value of the analysis. We would ask, as a favor, those sending anything for analysis to give *all* the facts. For sugar beets, give the name, yield per acre in tons, time sown and time harvested ; also, the method of cultivation, the kind of soil and all other facts that will throw any light upon the subject. The average of the seventy-three analyses gives 11.56 per cent. of sugar, a coefficient of purity of 83.1 per cent. The yield per acre on the College garden was :

Excelsior.....	29	tons
Vilmorin.....	27	“
Imperial.....	22.5	“

An average of over twenty-six tons per acre for the three kinds. Taking into consideration the unfavorable kinds (large) sent for analysis, the per cent. of sugar is very good.

It has been estimated that the per cent. of sugar in the sugar beets in Germany last year averaged 12.55 per cent., and the average yield, according to Mr. Licht, was 14 tons per acre. In this respect Colorado compares favorably, as the average of those raised by the Horticultural Section was over 15 per cent., and the yield per acre over 26 tons. The cost of land in Germany being about ten times what it is in Colorado, gives our State another advantage. With the proposed bill recently introduced in the Legislature, giving a bounty on sugar made from sugar beets of one cent a pound, it must be an inducement to the manufacturer to invest his money in our midst, provided it becomes a law. A correspondent of the *Portland Advertiser* has very truthfully stated that the sugar beet industry conflicts with no other industry: "There is no interest that it would injure, while it would be difficult to find one that would confer so many, so great and so general advantages upon the country."

It must always be a source of gratification to a country to supply, or be able to supply, its own wants. From the official figures it has been estimated that over one million tons of sugar have been imported into our country during the last year. We could raise this surplus and have some to spare, on two million acres of land. It would give profitable employment to nearly one fourth of a million of men, women and children, while the capital required to manufacture it would be counted by the hundred millions.

CONCLUSION.

We believe that it has been established that the soil and climate of Colorado are favorable to the production of sugar beets, and that they can be successfully and profitably raised to the advantage, both of the farmer and manufacturer.

