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UNIVERSITY OF IDAHO AGRICULTURAL EXPERIMENT STATION.

MOSCOW, IDAHO.

DEPARTMENT OF CHEMISTRY.

Sugar Beets in Idaho.

By CHAS. W. McCURDY.

LEWISTON
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1898

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BULLETINS.

The regular bulletins of the Station are sent free to all who request them. Bulletins issued since the close of the fiscal year, June 30, 1897.

11. Smuts and Rusts of Grain in Idaho, and the Most Approved Methods of Dealing With Them.

12. Sugar Beets in Idaho.

THE SUGAR BEET IN IDAHO.

CHAS. W. McCURDY, Ph. D.

The beet (*beta vulgaris*) is a plant of the order of chenspodiaceæ, and has been known for centuries. The plant was found growing wild in Egypt and along the shores of the Mediterranean, and was cultivated long before the Christian era. Many varieties were known to the ancients, of varying degrees in color and quality. Other well known esculent plants belong to this family as well as some of our most common weeds.

Of the beets there are three well marked classes

1. Those used as food for man.
2. Those used as food for animals.
3. Those used for the manufacture of sugar and alcohol.

The red and yellow varieties growing in our gardens are most preferred for salads, and are types of the first class; the many varieties of mangel wurzel, or stock beet, illustrate the second class; while the white Klein Wanzlebeuner and Vilmorin's Improved are representatives of the third class. It is this latter class which is now of most interest to agriculturists and chemists; which was an object of experiment in the time of the emperor Napoleon, and has since commanded the most careful study and culture from the leading nations of Europe and America. Modern cultivation has not only increased the size of the root but has greatly improved the quality as well. A century ago the French and German chemists could extract only about 6 per cent. of saccharine matter from the juice of the beet, but the application of scientific principles in the selection of the seed and the cultivation of the root has increased largely this figure. Idaho has grown sample beets under normal conditions that have contained 21.9 per cent. of sugar in the juice; Washington, 23.6; Oregon, 23.8.

SUGAR BEETS IN IDAHO.

The growing of sugar beets in this state has not yet passed the experimental stage. Only since 1891 has the work been on a systematic basis; even since then the methods practiced have been, at times, quite superficial, the practice being to distribute seed gratuitiously to any and all who might apply. There being no uniformity in the growing of the beets, no data returned beyond the name of grower, the analytical results were necessarily low and often incomparable. The beginning of this industry along definite lines, in other states of the Union that may be said to be in the sugar beet belt, does not date back more than ten years, with one or two exceptions. The real work in Idaho covers four years, and has been in charge of the Agricultural Department of this station. A total of 635 analyses have been made, carrying an average sugar content of 14.56 per cent., with a purity of 80.21 degrees. These experiments have been conducted largely independently but in part co-operatively with stations in other states and, to a limited extent, with the federal government. The purpose of the investigation has been to test the possibilities of the industry for Idaho; also, indirectly, for the government, as a whole. The work this year is in charge of the Chemical Division of this station, and already gives promise of results that will be definite and convincing.

The people of the United States consume in their daily food and through the channels of business about 2,100,000 tons of sugar per annum. Of this enormous quantity of sweetness but little more than one-sixth is produced in the United States. This necessitates the loss of $1,000,000 annually to our people, which might well be retained in this country if only the farmers in the sugar beet area could be aroused to a realization of their opportunities and induced to cultivate this valuable crop. The United States has the climate and soil and capital, and should produce enough sugar to sweeten the civilized world.

These words apply with equal force to Idaho. This young commonwealth possesses all the natural facilities for the growing

and manufacture of beet sugar, and could within ten years produce all that is now consumed within her borders if the farmers, in the distinctly agricultural sections of the state would take hold of the industry with an intelligent, co-operative determination. To illustrate: The state has a population approximating 100,000. The average consumption of sugar in the United States for 1895 was 62.6 pounds per capita, at an average cost to the importer and retailer of 5 cents per pound. These figures represent an annual expenditure of $313,000 for sugar by the people of Idaho—an average of $856 per day. Surely our people have a sugar tooth which ought to be filled by the product of home industry rather than through the channel of importation. It is the province of the State Experiment Station to enroll the farmers in the solution of this problem.

HISTORY OF THE INDUSTRY.

The history of this industry dates back to 1747, when Margroff made some experiments relative to the sugar content of beets, his results being reported to the Berlin Academy of Sciences. He found the beet richer in sugar than any other plant yet examined, and predicted great success for such an industrial enterprise. But his work received no practical recognition until fifty years later when Archard began his investigations of the sugar question. Beets grown by him yielded 6 per cent. in saccharine matter, and it cost 18 cents to make a pound of sugar. Archard's work aroused greater enthusiasm in Germany than in France. In Silicia, in 1805, Baron de Koppy erected on his estate a sugar factory with a capacity of 525 tons per annum. This was followed by the establishment of other factories in Germany.

The continental blockade declared by Napoleon served as a stimulus to the industry. Napoleon decided that 79,004 acres of land should be devoted to the growing of the beet roots; that six experimental schools should be established for giving instruction in the manufacture of beet root sugar, and set aside $200,000 for inaugurating and sustaining the work. Similar schools were established in Germany. By 1835, the industry was firmly established in both countries. Beets were grown at a cost of $3.50

per ton, and commanded from $4.00 to $6.00 per ton at the factories. The next fifty years witnessed a large and constantly growing industry in the production of sugar from the beet, especially in Germany, where the output increased from 13,445 tons of sugar in 1840, to 1,850,000 tons of raw sugar in 1897. Last year 1,092,482acres in the Empire were devoted to the art.

SUGAR BEETS IN THE UNITED STATES.

The first effort at sugar beet growing in this country was made by two Philadelphia gentlemen, about 1830. Mr. D. L. Child at North Hampton, Massachusetts, in 1838, undertook some experiments in the raising of beets and the manufacture of sugar. His method in the latter process consisted in drying the roots, and later extracting the sugar therefrom. The method was not a brilliant success, though about 1,300 pounds were made in this way.

In 1863, two German brothers, by the name of Gannert, began at Chatsworth, Illinois, the manufacture of sugar. The business collapsed after six years. Later they revived the business at Freeport, and were likewise unsuccessful. In 1870, the brothers were located at Blackhawk, Wisconsin, but shortly thereafter sank from sight. Thus the industry during the first forty years of its history in this country was marked by signal failure.

"The first successful undertaking was that by Bonestell and Otto, two Germans, who organized a company with a capital of $12,000, which operated for two years at Fon du Lac, Wisconsin. The works were then abandoned for a flattering offer from the Alvarado Sugar Company of California, where they continued to operate until 1873. Subsequently Mr. Otto went to Santa Cruz county, and continued the operation of a factory till 1876. The Alvarado failed in 1876 owing to the failure of the beet crop."

During these later years, the federal government has fostered the industry, distributing beet seed gratuitously to farmers in every state and territory in the Union. In 1897, the Honorable Secretary of Agriculture, who is a scientific man of high attainments, brought all the power and skill of the Agricultural Department to bear upon the industry, extending special encouragement

to the State Experiment Stations, to induce further experimentation in this line, by the distribution of seed, directions for growing and harvesting the crop, and providing franked shipping tags.

During the present season (1898), the Agricultural Department at Washington, D. C., is giving its support to other lines of sugar manufacture, but is centralizing its plans and working more and more through the State Experiment Stations. The Idaho station is co-operating fully with the federal government in the sugar beet experimentation, and has at the present writing 27.5 acres of sugar beets growing under contract, ranging from one-fourth to one acre in extent, representing sixty-three co-operative experimenters, whose services and land were voluntarily tendered the station.

PRODUCTION OF SUGAR.

That our people may be informed as to the source of the world's sugar supply and the immensity of the crop, some statistics compiled by Mr. Licht, in the Louisiana Planter and Sugar Manufacturer of January 29, 1898, will be of special interest, as they are the latest, reliable estimates that are available:

Cane Sugar Crop.

	Tons.		Tons.
Java	560,000	Puerto Rico	60,000
Louisiana	345,000	Trinidad	50,000
Cuba	200,000	Barbadoes	50,000
Hawaiian Islands	200,000	Guadeloupe	40,000
Phillipine Islands	190,000	Russia	40,000
Brazil	180,000	Jamaica	35,000
Demenara	110,000	Martinique	30,000
Egypt	100,000		
Antilles	95,000	Total Cane Sugar	2,460,000
Peru	65,000		

The latest reliable estimates on the beet sugar crop may be stated thus:

	Tons.
Germany	1,850,000
Austria-Hungary	840,000
France	825,000
Russia	750,000
Belgium	225,000
Holland	125,000
Other countries	190,000
Total beet sugar	4,805,000
Total cane sugar	2,460,000
Grand total	7,265,000

Cuba, in times of peace, has produced about 1,000,000 tons per annum, but war and devastation will greatly reduce this figure for several years, even should independence be accorded the island this year. It is, therefore, an opportune time for pushing the beet sugar industry in the United States.

To make a more concrete showing, I give the production of sugar in the United States during each of the five calendar years, 1893-1897, stated in tons of 2,240 pounds: *

Kinds.	1893	1894	1895	1896	1897
	Tons.	Tons.	Tons.	Tons.	Tons.
Cane	235,886	271,333	324,506	243,220	289,009
Beet	16,000	20,443	30,000	40,000	41,347
Maple	10,500	5,000	7,500	5,000	5,000
Sorghum	500	300	300	300	300
Total	262,886	297,079	362,306	288,520	335,656

* According to Willett & Gray, New York.

CONSUMPTION OF SUGAR.

The following table gives the consumption of sugar by the leading nations of the world, and furnishes much valuable information relative to the growth of the beet sugar industry both in Europe and the United States:

Countries	1895	1896
	Total am't in tons	Pounds per capita
United States	1,960,000	62.60
Great Britain	1,494,000	86.09
Germany	594,000	26.78
France	555,000	30.62
Russia	500,000	10.94
Austria	343,000	19.81
Holland and Belgium	391,000	.....
Canada and Provinces	140,000	.....
Other countries of Europe	813,000	.....
	6,400,000	.....
Unaccounted for	1,157,000	.....
Total	7,647,000	

"The high rate of consumption for Great Britain does not indicate that that amount of sugar is actually eaten as food or confection by the inhabitants of Great Britain, as a considerable part of the sugar, making up to the total consumption of that country, goes into the manufacture of confectionery and preserves for exportation."

The total consumption of sugar in the United States for 1897 is estimated at 2,100,000 tons, or approximating 30 per cent. of all the sugar produced in the world. Of this enormous quantity about 45 per cent. was beet sugar. OF THE TOTAL QUANTITY OF SUGAR OF ALL KINDS CONSUMED IN THE UNITED STATES 84 PER CENT. WAS IMPORTED; AND OF THIS IMPORTATION, ONLY 9.1 PER CENT. WAS HAWAIIAN SUGAR.

GROWTH OF THE BEET SUGAR INDUSTRY.

France		Germany		United States	
Year	Tons of sugar	Year	Tons of sugar	Year	Tons of sugar
1830	4,000	1840	12,000	1887	310
1840	22,000	1850	52,000	1890	4,000
1850	62,000	1860	126,000	1891	6,000
1860	126,000	1865	180,000	1892	6,003
1870	282,000	1870	185,000	1893	16,000
1873	410,000	1880	599,000	1894	20,443
1890	750,000	1890	1200,000	1895	30,000
1896	750,000	1896	1845,000	1896	40,000
1897		1897		1897	45,245

The world's stock of sugar on August 1, 1894, was 1,087,766 tons; on August 1, 1897, it had increased to 1,881,800 tons.

In this connection it will not be unprofitable, not to say uninteresting reading, to note some data pertaining to the factories, yield of beets per acre, yield of sugar, if any, and other data in the principal sugar producing countries of the world, 1895-1896. I quote from Bulletin 49, Illinois Experiment Station :

GERMANY.—The number of factories, 397; quantities of beets used, 10,589,413 tons; number of acres cultivated, 930,245; mean yield per acre, 13.8 tons; mean price of beets, $4.64 per ton; yield of raw sugar, 13.11 per cent. on weight of beets; average output of raw sugar per factory, 3,690 tons.

FRANCE.—Number of factories, 356; quantity of beets used, 4,909,221 tons; yield of refined sugar, 10.97 per cent. on weight of beets; number of acres cultivated, 405,852; yield of beets, 9.5 tons per acre; average output of refined sugar per factory, 1,702 tons.

AUSTRIA-HUNGARY.—Number of factories, 216; quantity of beets used, 5,225,390 tons; yield of raw sugar, 13.5 per cent. on weight of beets; average output of raw sugar from each factoy, 3,323 tons.

RUSSIA.—Number of factories. 273; quantity of beets used, 4,818,869 tons; per cent of raw sugar in beets, 15.71; average output of sugar for each factory, 2,565 tons.

FACTORIES IN OTHER COUNTRIES.—Belgium, 121; Holland, 30; Spain, 15; Sweden, 10; United States, 10; Scotland, 50.

According to the new report of the Department of Chemistry at Washington, it is shown that in the United States during 1897 there were obtained 389,685 tons of sugar beets from 41,272

acres of land, the average yield being 9.5 tons. The total amount of beet sugar made in the country during the year 1897 was 90,491,670 pounds, an average of 232 pounds per ton of 2,000 pounds, or 11.6 per cent. of the weight of the beets. "It is safe to say that at least 80,000 acres will be planted in beets during the season of 1898. The yield of beets may be expected to be 800,000 tons and of sugar 180,000,000 pounds. * * * The percentage of beet sugar produced in the United States during 1897 to the total consumption was only 2.25, but the prospects are that in 1898 it will be nearly 4 per cent of the total consumption, which now amounts to about 2,000,000 tons annually."—The Sugar Beet, June, 1898.

The following beet sugar factories are now in operation in the United States, and were erected in the years indicated:

1870, The Alameda Sugar Co., Alvarado, California.

1888, The Western Beet Sugar Co., Watsonville, California.

1890, The Oxnard Beet Sugar Co., Grand Island, Nebraska.

1891, The Norfolk Beet Sugar Co., Norfolk, Nebraska.

1891, The Chinco Beet Sugar Factory, Chinco Valley, California.

1891, The Utah Sugar Co., Lehi, Utah.

1896, The Eddy Beet Sugar Factory, Eddy, New Mexico.

1897, First N. Y. Beet Sugar Co., Rome, New York.

Building for 1898:

At Salanos City, California; at Ogden, Utah; at LeGrande, Oregon; at Huenerne, California; at Bay City, Michigan; at Santa Maria, California; at Binghampton, New York; at Minneapolis, Minnesota.

For 1899, at Irving, New York.

For 1899, at Essexville, Michigan.

CLIMATIC CONDITIONS FOR SUGAR BEETS.

As a rule, for growing most crops the weather is of more importance than the soil. This is true in raising sugar beets. While an open soil of good depth, well drained and sufficiently supplied with plant food is necessary, unless a reasonable amount of moisture, sunshine, and a certain average temperature prevail

during the growing season, no amount of cultivation can produce a a high grade garden beet. Late frosts in spring and early frosts in autumn, cool nights through the growing season, draughts, or intense heat for a considerable period, high winds, insects, and lack of plenty of sunshine during the period of ripening, all tend to diminish the yield in sugar beets both in tonnage and sugar content.

If the soil has been well prepared, is deep and porous, the beet root can thrive better in dry weather, when once established, than any cereal and many other vegetable crops, as the tap root passes down into the subsoil and draws its supply of water and plant food from these deep recesses. If the surface soil can be made to supply nourishment to the plant until it can tap the subsoil, the sugar beet will thrive in weather that would burn up surface feeding plants.

Our German consul writing from the heart of the sugar beet district, under date of June 3, 1897, says: "A rich, deep soil, with a porous, well drained subsoil, should be selected. If the climatic conditions are such that the beets are assured of abundant moisture for the first three months, then a limited amount of moisture and dry, sunny weather, for the last thirty days, such lands are well adapted for the cuitivation of the sugar beet. It is of great importance that the last thirty days be dry and sunny; wet weather at this period will start a second growth in the beets at the expense of the saccharine contents."—Consular Reports, August, 1897.

Experience has proved, attested by frequent analyses, that dry, sunny weather during the fall is necessary for the perfection of the chemical changes wrought in the beet tissue and juice whereby the sugar is produced. Reports were received last season to the effect that some of the seed sent out by the Station failed to germinate owing to "prolonged dry weather," or "very high winds," or "cold, wet weather," or "insects destroyed the young plants." It is folly to attempt to cultivate the sugar beet with success if the climatic and other conditions in any locality are too precarious. A mean temperature varying from 62 degrees

F. to 72 degrees F. during the months of June, July and August is desirable for this crop.

The following charts prepared from data furnished by Section Director, Mr. D. P. McCallum of Idaho Falls, and Professor J. E. Bonebright, meterologist of this Station, will tell the story as to the adaptability of certain localities for the sugar beet:

MEAN AVERAGE TEMPERATURE AND PRECIPITATION FOR THE YEARS 1894, 1895, 1896, 1897.

STATIONS	DATA	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.
Ft. Sherman	T	46.22	53.21	60.35	67.35	67.55	55.60	47.97
Kootenai Co	P	1.64	2.00	1 62	0.74	0.47	2.18	1.34
Murray	T	43.25	51.12	57.02	62 92	64 32	51.37	45.10
Shoshone Co	P	2.45	3.64	2.42	1.08	0 76	2.93	1.97
Moscow	T	47.60	53.17	58.22	68.10	64.60	52 82	48.27
Latah Co	P	0.91	2.09	1 64	0 51	0.56	1 68	1.49
Lewiston	T	53.40	60.67	66 47	73 57	74.67	59.60	51.75
Nez Perce Co	P	1.13	2.39	1.14	0 49	0 56	1.21	1.29
Grangeville	T	43.90	49.60	56 73	66 90	67.43	53.43	49.00
Idaho Co	P	2 47	4.00	3.53	1.04	1.03	2.61	1.95
Idaho City	T	42.50	53.30	57.85	66.10	68.70	56.10	49 67
Boise Co	P	2.15	3.80	0.75	0.91	0 52	0.67	0 88
Salubria	T	49.25	58.40	63.37	71 60	73.15	58.20	49.87
Washington Co	P	1.73	2.41	0 84	0 24	0.53	0.87	1.00
Boise	T	49.65	57.50	64.15	72 55	72.40	59.22	51.47
Ada Co	P	1.42	2.34	0.49	0 16	0.31	0.45	1.34
Payette	T	51.75	60.10	67.25	73.90	74.55	60.47	52.72
Canyon Co	P	1.15	1.49	0.80	0.40	0.31	0.45	0.61
Paris	T	40.72	50.90	56 80	63.52	65 07	55.12	46.27
Bear Lake Co	P	1.22	1.38	0.59	1 06	0.55	1.23	0.72
Oakley	T	47.00	56.32	63.00	71.27	71.12	58.40	49.83
Cassia Co	P	0.76	0.55	0.55	0.42	0.90	1.10	1.09
American Falls	T	44.90	55.40	61.83	70.37	70.42	56.80	46.57
Oneida Co	P	1.36	1.38	2.27	0.51	0.67	0.70	1.29
Soldiers	T	38.65	49 80	55.62	65.09	64.70	52.82	45.22
Blaine Co	P	0.66	1.09	0.44	0 39	0.25	0.66	0.63
Idaho Falls	T	42.95	52.90	59.27	67.30	67.95	56.57	45.77
Bingham Co	P	1.10	1.69	1.25	0.40	0.44	0.61	0.85
Lake	T	32.87	44.27	51.02	58.02	59.40	51.22	42.72
Fremont Co	P	0.57	1.05	1.25	0.84	0 63	0.31	0.90
Swan Valley	T	40.20	49.87	56.80	63.47	63 50	51.20	42.70
Bannock Co	P	1.07	2.39	1.11	0.83	0.51	1.36	1.41

TEMPERATURE AND PRECIPITATION.

Stations.	Mean Temp. for the Entire Year				Total Precip. for the Entire Year				Altitude.
	1894.	1895.	1896.	1897.	1894.	1895.	1896.	1897.	Feet.
Ft. Sh'mn	*	46.2	46.6	46.8	*	25.62	30.77	33.55	2106
Murray..	43.6	42.6	43.9	43.6	43.19	29.93	42.16	44.07	2750
Moscow..	49.5	48.2	47.1	45.4	23.88	15.81	20.00	22.86	2670
Lewiston	*	*	*	*	*	12.02	*	*	674
Gr'g'ville	44.2	49.6	45.7	*	29.76	21.16	32.00	*	3425
Idaho C'y	*	44.3	44.9	46.0	*	14.32	34.64	13.31	4000
Boise....	50.6	49.4	50.5	50.9	14.89	7.88	22 95	16.56	2880
Payetee..	51.3	49.7	53.6	52.7	11.13	8.20	13.78	14.02	2195
Salubria.	*	46.5	48.4	48.3	*	16.63	29.38	20.47	2750
Paris....	43.1	41.7	41.5	*	15.87	11.07	14.09	*	5946
Oakley..	*	47.7	*	48.5	*	6.66	*	10.41	3091
Am. Falls	46.0	45.4		*	10.79	9.50	*	*	4341
Soldier...	*	*	39.7	41.1	*	*	24.48	12.59	5200
Lake....	55.8	*	*	*	18.84	*	*	*	6000
Idaho F'ls	42.9	41.7	44.4	43.3	14.62	9.20	17.18	15.77	4742
Minidoka	*	*	47.6	*	*	*	14.42	*	4287

* Incomplete.

1896—KILLING FROSTS—1897.

Date of Last in Spring and First in Autumn.

Stations	County	Last in Spring	First in Autumn
Am. Falls	Oneida	May 9 to May 20	Oct. 20 to Nov. 1
Blackfoot	Bingham	May 3, May 11	Sept 9, Oct. 1
Bliss	Lincoln	May 18, May 21	Sept. 8, Oct. 1
Boise	Ada	May 8, May 9	Sept. 30, Oct 14
Burnside	Freemont	May 20, June 17	Sept. 9, Oct. 4
Cœur d'Alene	Kootenai	April 28, April 30	Sept. 16, Sept. 25
Corral	Blaine	May 19, June 18	Sept 3, Sep. 10
Downey	Bannock	June 11, June 17	Sept. 8, Sept. 10
Ft. Sherman	Kootenai	April 28, May 15	Sept. 26 Oct. 14
Idaho City	Boise	June 11, June 16	Sept 4, Sept. 16
Idaho Falls	Bingham	May 8, May 18	Sept 10, Oct. 15
Kootenai	Shoshone	April 20, May 14	Sept. 9, Sept. 17
Lewiston	Nez Perce	April 14, April 28	Sept. 15, Oct. 1
Lost River	Blaine	May 20, June 18	Sept 8. Oct. 15
Martin	Blaine	June 12, July 19	Sept. 8, Oct 1
Marysville	Freemont	June 17, July 1	Sept. 8, Oct. 29
Minidoka	Lincoln	June 11, July 10	Sept 5, Sept. 9
Moscow	Latah	May 17, May 27	Sept 10, Sept 30
Murray	Shoshone	June 10, June 11	Sept. 9, Sept 16
Nampa	Canyon	May 8, May 8	Sept. 26, Oct. 3
Oakley	Cassia	May 8, June 8	Sept 8 Sept. 9
Ola	Boise	May 8, May 15	Sept. 26, Oct. 2
Paris	Bear Lake	June 11, July 18	Sept. 9, Sept. 10
Payette	Canyon	April 20, June 10	Sept. 28, Oct 1
Pollock	Idaho	April 29, May 19	Sept 26, Oct. 3
Roseberg	Boise	June 10, June 22	Sept. 9, Oct. 1
Salubria	Washington	April 30, May 18	Sept. 10, Oct. 3
St Maries	Kootenai	April 27, May 10	Sept. 15, Oct. 3
Soldier	Blaine	June 11, July 4	Aug. 5, Sept. 4.
Swan Valley	Bannock	June 25, July 14	Sept. 9, Sept. 15
Warren	Idaho	July 11, Juiy 19	Aug. 4, Sept. 2
Average dates		May 19, June 6	Sept. 12 Sept 28

NOTE.—Where dates were not stated by observers the date of the last spring and first autumn minimum temperature of 32 degrees or below has been used.

SUGAR BEET SOIL.

A black, sandy or clay loam, on any other soil that will raise a good crop of corn or potatoes, that possesses good depth and is well drained, is typical for sugar beets. The roots require plenty of moisture; it follows, therefore, that the subsoil must be of a porous nature to permit not only of the penetration of the tap root of the beet, but of the absorption and seepage of any unnecessary surface water. Hence a stiff clay having an impenetrable hard-pan as well as muck beds are to be rejected, as they are difficult to manage. An important essential is that the soil should have depth, should be of a friable nature to the depth of a foot or more; another, that there should be no hard-pan near the surface. Other conditions being equal, a calcareous soil has been found to produce the greatest amount of sugar.

The soil of North Idaho, adapted for agricultural purposes, lies in the pluvial region and is typical for this crop. In many of the most desirable sections, however, the soil has been severely cropped with wheat; no system of rotation has been practiced, hence the application of fertilizers in the near future must be resorted to to restore the soil to its normal fertility. The soil is of basaltic origin, finely divided, and, in its virgin state, rich in plant food, possessing just sufficient alkali to produce a large tonnage. The average sugar content of beets grown in Latah county is 15.4 per cent., with a purity of 84 dergees. South Idaho lies in the arid belt and successful farming is achieved only by the application of the principles of irrigation coupled with a system of crop rotation. Soils from several counties in the state analyzed in this laboratory show a sufficiency of plant food with the possible exception of nitrogen and lime. Abundant crops of vegetables and cereals are grown; while several cuttings of alfalfa may be gathered in a single season. There is no questoin as to the adaptability of this volcanic ash for sugar beets, provided the alkali salts are not too abundant. The California Station has this to say regarding the effect of alkali upon sugar beets: "Sugar beets of good and even high grade, both as to

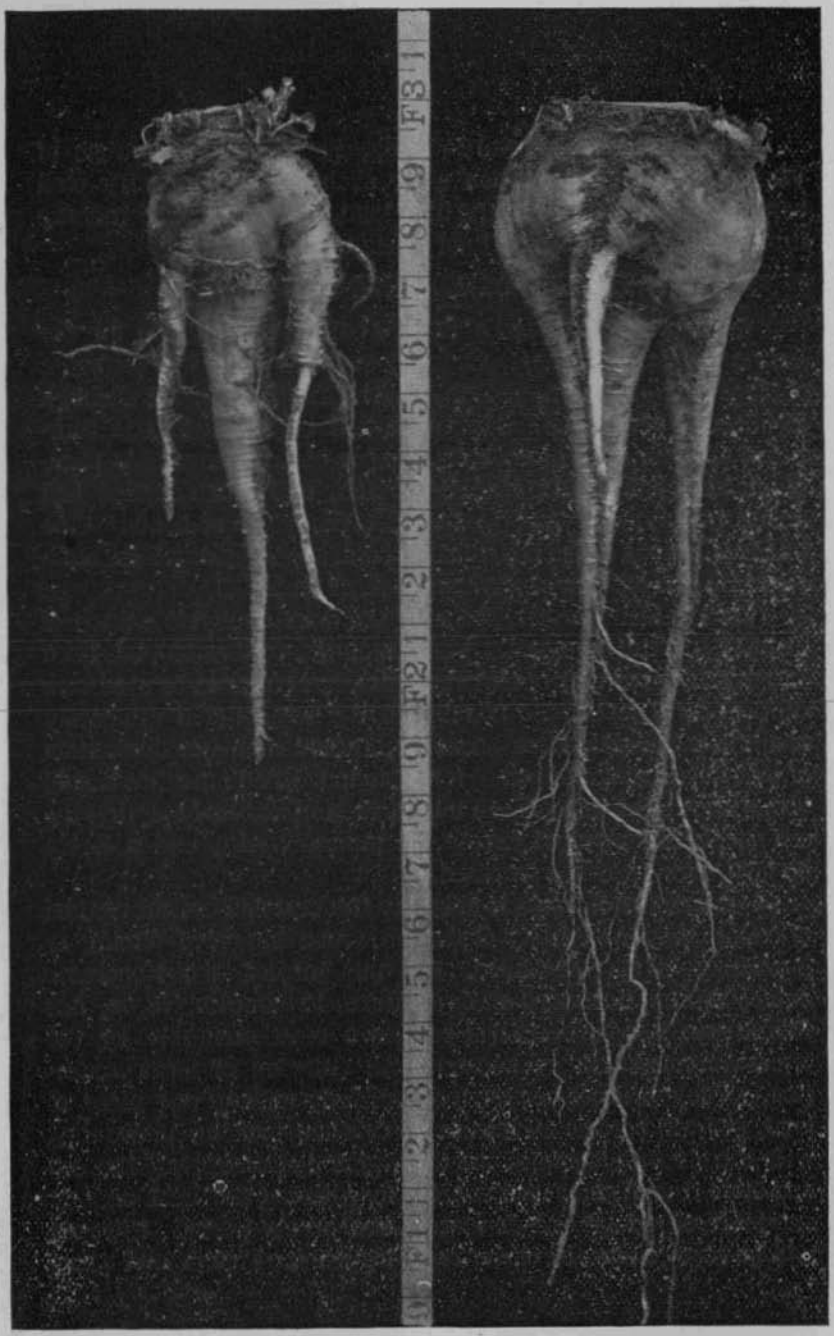

FIG. 1. EFFECT OF SHALLOW PLOWINC AND BAD SUBSOIL.

Experiments conducted in 1897, in the alkali districts of Washington, under irrigation show such soils to be very well adapted to the sugar beet, the high land, or volcanic ash ranking first, the low, sub-irrigated land coming next.

FERTILIZER FOR SUGAR BEETS.

As before stated, most of the soils of Idaho, suitable for the growing of the sugar beet, are fairly supplied with the elements of plant food—nitrogen, phosphoric acid, and potash; but should a fertilizer be needed, the Geneva Station recommends one composed of 4 per cent. of nitrogen, 6.5 per cent. of available phosphoric acid, and 10 per cent. of potash, and when applied just before sowing, will largely increase the yield of beets. One hundred pounds of such fertilizer would supply plant food sufficient to grow one ton of marketable beet roots.

For the Idaho farmer, probably the most available source of plant food is the barnyard. Stable manure, well rotted, has been extensively used with excellent results, but it should be used with caution; for if applied too heavily to the soil, it will ultimately result in a one-sided nitrogenous fertilization with the diminution of phosphoric acid and potash from the soil. Stable manure should be applied in the fall, plowed under, then in the early spring the soil should be harrowed deeply, or plowed again, and a finely divided, firm, seed-bed prepared.

But rotation of crops is probably the best and easiest method of maintaining the fertility of the soil, when intensive forcing or gardening is not demanded. On this subject, the Honorable James Wilson, Secretary of Agriculture, in circular No. 7, has this to say: "Sugar beets will be grown most profitably by the American farmer in connection with dairying or meat production. They will not be grown successfully on any one piece of land, but will become a feature of rotative system, alternating with the grasses, legumes, and the grains that recuperate the soil and store it with plant food suitable for growing the beet on any one piece of ground once in four or five or six years. Nitrogen will be replaced by the clovers and legumes. Potash and phos-

phoric acid will become available in most poor soils while they are resting in grasses."

When the refuse of the factory is restored to the land direct, or through the channel of stock feeding, the fertility of the soil is not impaired by the crop.

The fertilizing constituents of sugar beets may be indicated by the following table taken from Bulletin 135, Geneva, N. Y., Station:

Constituents.	Pounds in 2,000 Pounds of Sugar Beets.	
	Variation.	Average.
Nitrogen	3 to 5 pounds.	4 pounds
Phosphoric acid	1 to 3 "	2 "
Potash	6 to 8 "	7 "
Lime	1 to 1½ "	1¼ "
Magnesia	1 to 1½ "	1¼ "

THE KINDS OF SUGAR BEETS.

During the time this Station has been experimenting with sugar beets, nearly all the varieties known to the grower have

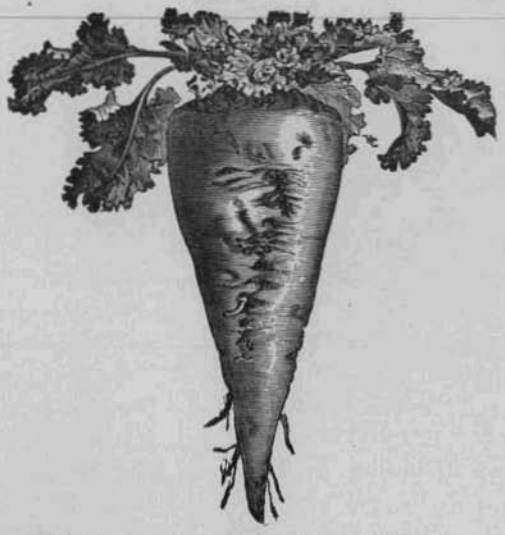

FIG. 2. KLEIN WANZLEBEN IMPROVED.

been tested on the University farm under the direct supervision of a member of the staff. Many of the varieties have been grown continuously the past four years, others for two years; still other varieties were so poorly adapted to our soil, made so poor a stand, and were of such low grade, either for manufacturing or feeding purposes, that they were cast aside. The New Danish, Lane's Imperial, French Red Top and, in some localities, the Vilmorin's Imperial were rejected; while the Klein Wanzleben, Vilmorin's Richest, Metta, and Vilmorin's Improved have proved most desir-

FIG. 3. VILMORIN'S IMPROVED.
(Le plus rich)

able beets for our soil and climate. Three varieties of the Klein Wanzleben—the Original, the Improved, and the Elite have been grown by the Station. A cut kindly furnished by Rolker & Sons of New York, finely represents a typical specimen of one of them. These are the favorite German beet and are well adapted to the soil and climate of Idaho, and have given the highest per centages in sugar content and purity. See page fifty-three.

The Vilmorin Le Plus Rich, figured on this page of bulletin, is a beet that is attracting considerable attention. It has

good form and is a strong grower. It has returned from 18 to 19 per cent. of sugar in the beet. The Michigan Station reports a yield of 18.78 per cent. in 1897.

The Vilmorin's Improved seems well adapted to some soils of South Idaho and in portions of Latah county, and we sent out a good deal of this seed to our co-operative experimenters this season.

The Vilmorins are French beets and have come down through careful training from the White Silician from which Mar-

FIG. 4. DANISH IMPROVED.

groff, one hundred and fifty years ago, obtained from six to seven per cent. of saccharine matter; in fact, the White Silician may be said to be the mother of all the varieties of beets now grown.

There are many so-called sugar beets that cannot be grown profitably for the making of beet sugar. They do not conform to the type in form, color or texture. The real sugar beet is white in color, a slim cone, with a single tap root, covered with fine hair-like roots and sets well in the ground. Beets have been sent

FIG. 5. LANE'S IMPERIAL.

in for analysis that were nearly red, or pink, or orange, and very irregular in form. Even Mangel Wurzels have been delivered to us as sugar beets, supposing that a very large beet would run high in sugar.

The following table has been prepared from analyses made in this laboratory and shows very clearly the relative worth of the different varieties:

Name	Highest in Sugar Content	Lowest in Sugar Content	Average Sugar Content	Purity
	Per Cent.	Per Cent.	Per Cent.	Deg's
Klein Wanzleben	19.60	14.40	14.16	82.80
Metta	18.40	14.60	13.38	82.78
Vilmorin's Imperial	18.20	10.60	14.10	85.42
Vilmorin's Imp'vd	16.60	14.40	11.77	75.55
French Red Top	15.90	10.70	13.65	82.70
Lane's Imperial	15.70	10.60	13.44	81.69
New Danish	15.20	10.80	13.83	81.81

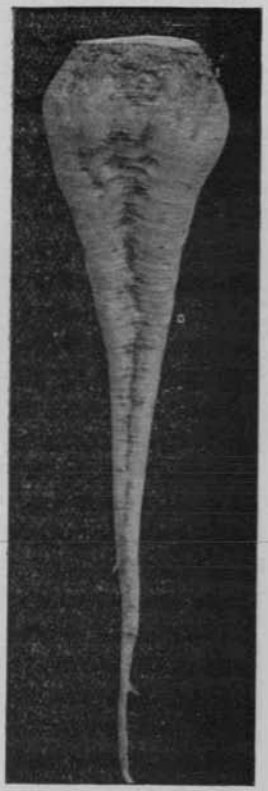

FIG. 6. WELL-FORMED BEET.

In past years, several analyses have been made at this Station for the purpose of determining what bearing, if any, the size and shape of the sample beet had upon the sugar content and purity. Among others, I select four varieties and submit the results without comment:

VILMORIN'S IMPROVED.

Size	Weight Oz.	Sugar in Beet	Purity
Large	21.4	14.02 per cent.	79.95
Medium	15.2	14.31 "	81.26
Small	7.8	14.07 "	78.58

FLORIMOND DEPREZ.

Large	28.7	14.35 per cent.	83.95
Medium	16.5	14.46 "	84.00
Small	17.0	14.10 "	80.25

LANE'S IMPERIAL.

Large	24.1	13.62 per cent.	80.92
Medium	13.3	13.69 "	82.17
Small	8.0	13.38 "	82.07

KLEIN WANZLEBEN.

Large	26.00	14.00 per cent.	84.13
Medium	17.00	14.00 "	84.72
Small	13.00	13.74 "	83 93

INVESTIGATIONS IN PAST YEARS.

In former years, the general trend of sugar beet experiments throughout the state, in vogue at this Station, has been to distribute seed gratuitously and promiscuously to any and all who might apply; in fact, this method has prevailed, as a rule, in nearly all the states and territories and with the government, until this year. The results, so far as they apply to this Station, have been, on the whole, unsatisfactory, as not having furnished data that were at all comprehensive and reliable. While serving to awaken interest in the experiment, still the lack of unity and purpose among the growers in the preparation of the soil, and the cultivation and harvesting of the crop; the failure to return to the laboratory along with the sample beet any data pertaining thereto from which the cost of production, yield, climatic and other conditions affecting the crop could be estimated, necessarily gave results so varied as to be practically worthless. For the season of 1898, therefore, a more concrete, intensive and comprehensive and we hope more reliable procedure has been adopted, as suggested by the Federal government, with whom this Station is co-operating.

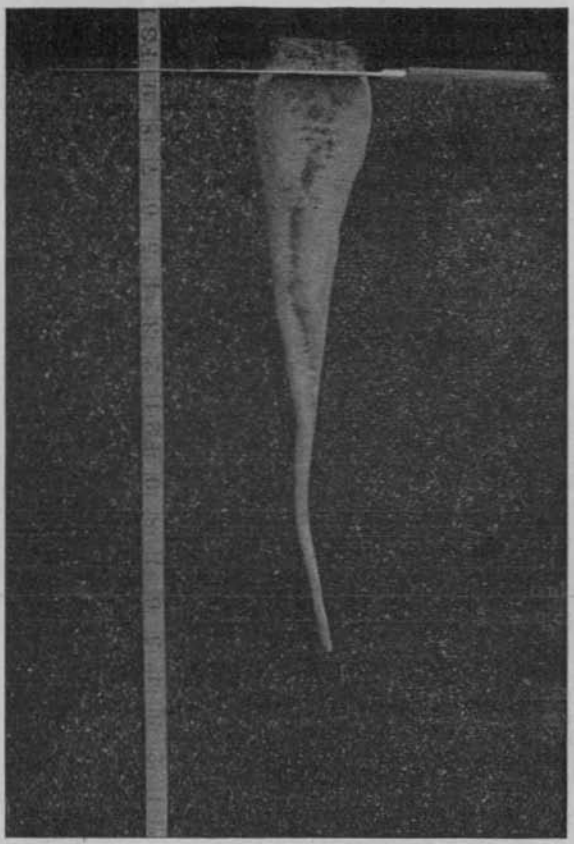

FIG. 7. PLACE FOR CAPPING PROPERLY RAISED BEET.

ANALYSES OF 1894.

Beets of inferior quality, size, shape and partially frozen were received during the fall of 1893, but as the effort of the Station in sugar beet growing for that year was merely incidental; and as the results obtained from the analyses were regarded as worthless, no record of any kind was preserved.

The experiments of 1894 and later, were in charge of the Agricultural Department and considerable interest in the work among the farmers was noted. The results were fairly satisfactory. One hundred ninety-two (192) analyses were made. The average sugar content was 13.7 per cent.; purity,

76.08. Some inferior varieties not adapted to our soil, and badly shaped beets, reduced an otherwise much higher average.

The places represented in the experiment were the University of Idaho, Cœur d'Alene, Sand Point, Moscow, Kendrick, Lenville, Princeton, Cornwall, Genesee, Grangeville, Idaho Falls and Nampa.

ANALYSES OF 1895.

The work of the year was covered by 342 analyses, a majority of the samples being grown by the University. Average sugar content, 15.19 per cent; purity, 79.91. Fifteen samples of red or table beets included, averaged in sugar, 13.75; purity, 75.57. Grangeville, Nampa, Moscow, Weippe, Vollmer, Palouse, Spokane Bridge, West Lake, Starner, Newport, Salmon City, Paris and the University furnished samples.

ANALYSES OF 1896.

The year's experiments were confined very largely to the University campus. An effort was made to grow typical beets, since the analysis of the preceding year proved that a regular, smooth, medium sized beet that had been well cared for, averaged highest in content and purity. Deep and shallow plowing, regular cultivation, use of manure and irrigation were contrasted with usual treatment given the roots by the average grower. The results proved that regular and careful cultivation largely increased the sugar content. Number of analyses, 60; sugar content, 14.18; purity, 77.30; yield per acre, 48,540 pounds.

ANALYSES OF 1897.

The results of the past year were rather disappointing. Only 41 samples were analyzed, including 20 from the Station, though seed was distributed gratuitously to 114 farmers, representing 41 sections; yet only 50 farmers forwarded beets from 13 localities. Late distribution of seed, insect pests, jack rabbits, drought and insufficient care were factors that contributed to failure. Samples analyzed, 41; sugar content, 15.17; purity, 87.55. The 20 samples grown by the Station gave in sugar, 15.28; in purity, 92.55. The 21 samples grown elsewhere gave in sugar, 15.07; in purity, 82.78. The highest rendings were 19.00 and 95.10 in sugar and purity respectively; the lowest, 10.1 and 81.81. Places represented were: Genesee, Moscow, Kendrick, Juliaetta, Rathdrum, American Falls, Payette, Paris, Leduc, Clarkie, Anderson, Newport and Grangeville.

The minimum standard of the factory in purchasing beets is 12.00 per cent. in sugar content and 80 degrees purity. Good soil and culture should put Idaho sugar beets far ahead of this mark. The general average for the state, based on a total of 635 analyses, is in sugar content, 14.56 per cent; in purity, 80.21.

METHODS OF ANALYSIS.

On succeeding pages may be found the details of the analyses of 1897. The method used was that commonly employed in commercial works and the results are comparable with those obtained in the factories.

Briefly, the method was as follows: The beets as they arrived at the laboratory, clean and dry, were weighed; a portion of the crown was then cut away (see cut, p. 59,) to remove the mineral salts which there accumulate; the beets were sliced lengthwise, and put through a large horseradish grater; the pulp was next wrapped in cloth, placed in an iron receptacle and tremendous pressure brought to bear upon the pulp until it felt dry to the touch. The specific gravity was determined by Westphal's balance; a definite quantity of the juice was weighed out, a small quantity of sub-acetate of lead added to clarify it, and the whole made up to 100 c. c., filtered, and the "sugar in juice" determined by the polariscope; 95 per cent. of this reading represents the "sugar in beet".

"Total Solids" consist of the sugar and other solid materials in the beet. To illustrate: The total solids in a beet may be 17.2, of this 13.8 is sugar, the difference, 3.4, solids not sugar. The difference between 100 and 17.2 equals per cent. of water.

By "Purity" is meant the ratio of pure sugar to total solids. A high degree of purity is essential, for the reason that mineral salts and other substances not sugar prevent, at least, an equal weight of sugar from crystalizing during manufacture. The purity is influenced by maturity of beet, size of beet, portion of root used, and the fertilizer applied.

ANALYSES OF 1897.

No.	Grower.	Postoffice.	County.	Variety.	Soil.
594	Uni. of Idaho	Moscow	Latah	Klein wanzleben	Dp blk clay loam
595	" "	"	"	" "	" " " "
596	" "	"	"	" "	" " " "
597	" "	"	"	" "	" " " "
598	" "	"	"	Florim'd Deprez	" " " "
599	" "	"	"	Home Grown	" " " "
600	" "	"	"	Wahanka	" " " "
601	" "	"	"	" extra	" " " "
602	" "	"	"	Danish Impr	" " " "
603	" "	"	"	Red Top	" " " "
604	" "	"	"	Lane's Imp	" " " "
605	" "	"	"	Klein wanzleben	" " " "
606	" "	"	"	Wahanka extra	" " " "
607	" "	"	"	French Yellow	" " " "
608	" "	"	"	Lane's Imper	" " " "
609	" "	"	"	French White	" " " "
610	" "	"	"	Vilmorin's Impr.	" " " "
611	" "	"	"	German Imp wh	" " " "
612	" "	"	"	Klein wanzleben	" " " "
613	" "	"	"	Red Top Sugar	" " " "
614	H. C. Tweedt	Genesee	"	Klein wanzleben	Blk prairie loam
615	W. S. Lancaster	Rathdrum	Kootenai	" "	Blk gravel loam
616	Dilly & Heatley	Am. Falls	Oneida	" "	Light sandy
617	Thos. Weaver	Kendrick	Latah	" "	Rich black loam
618	W. B. Beasley	Moscow	Latah	Vilmorin Impr	Sandy loam
619	F. C. Moss	Payette	Canyon	Red Top Sugar	Clay, sndy loam
620	G. W. Burford	Juliaetta	Latah	Klein wanzleben	Black loam
621	H. A. Russell	Kendrick	Latah	" "	Black loam
622	Jno. Stacker	Paris	BearLake	" "	Black loam
623	W. T. Sheperd	Paris	BearLake	" "	Blk granite loam
624	Michael Fox	Paris	BearLake	" "	Black loam
625	A. K. White	Clarkie	Kootenai	" "	Sandy loam
626	J. L. Freeman	Leduc	Blaine	" "	Black loam
627	J Emmett	Kendrick	Latah	" "	Clayey alkali
628	A. Ifland	Leduc	Blaine	" "	Black loam
629	R. King	Anderson	Latah	" "	Rich drk sandy l.
630	F. E. Howard	Newport	Kootenai	" "	Blck sandy loam
631	J. J. Swartz	Moscow	Latah	" "	Blk prairie loam
632	A. Robinson	Leduc	Blaine	" "	Blk prairie loam
633	C. B. Kuow	Grangeville	Idaho	" "	Blk prairie loam
634	J. Heatley	Am. Falls	Oneida	" "	Blk prairie loam
635	Wm. Heatley	Am. Falls	Oneida	" "	Blk prairie loam

ANALYSES OF 1897—Continued.

Climate.	Last Crop.	Irrigated.	Date of plant'g	Date of thinning.	Date of harvesting.	Av wgt. of beets—oz.	Total solids.	Sugar in juice.	Sugar in beet.	Purity.
Cold & dry spring	Wheat	No	May 1	....	Oct. 23	21	18.09	16.2	15.39	89.77
" " "	"	"	"	....	"	21	18.79	17.0	16.15	90.47
" " "	"	"	"	....	"	15	18.41	15.4	14.63	93 81
" " "	"	"	"	....	"	13	16.47	15.5	14.72	94.11
" " "	"	"	"	....	"	15	18.20	16.1	15.29	88.46
" " "	"	"	"	....	"	16	18.93	17.8	16.91	94.03
" " "	"	"	"	....	"	13	17.77	17.7	16.81	98.39
" " "	"	"	"	....	"	16	17.69	16.8	15.96	94.97
" " "	"	"	"	....	"	12	11.61	10.2	9.69	81.81
" " "	"	"	"	....	"	8	13.47	12.2	11.59	90.57
" " "	"	"	"	....	"	21	15.67	14.5	13.77	90 53
" " "	"	"	"	....	"	17	18.87	17.8	16.19	94.33
" " "	"	"	May 5	...	"	8	19.37	19.0	18.05	95 10
" " "	"	"	"	...	"	18	15.50	14.5	13.77	93.55
" " "	"	"	"	....	"	12	11.97	10.5	9.97	97 72
" " "	"	"	"	....	"	16	16.17	15.0	14.25	92.76
" " "	"	"	"	....	"	8	18.54	16.9	16.05	91.16
" " "	"	"	"	....	"	13	15.50	14 2	13.49	91.61
" " "	"	"	"	....	"	12	15.93	14.0	13.30	87.78
" " "	"	"	"	....	"	14	16.69	14.2	13.49	85.08
Generally dry, hot	Garden tr'k	No	May 18	....	Oct. 30	28	14.56	12.1	11.50	83.10
Av growing seas'n	.....	"	" 10	....	Nov. 2	26	17.13	13.5	12.82	78.70
Hot and dry.....	Vegetables.	Yes	" 2	....	Oct. 4	14	16.23	12.7	12.06	78.40
Av growing seas'n	.....	No	" 17	....	Nov. 2	20	18.80	17.0	16.15	90.40
Cool and dry....	Potatoes....	"	" 16	....	Oct. 23	17	19.00	17.1	16.24	90.00
Wet May, then hot	.....	Yes	" 10	....	Oct. 10	24	16.50	14.2	13.49	83.00
Spr't'g seas'n dry	.....	No	June 18	....	Nov. 4	20	17.20	13.8	13.11	80.20
Good gr'w'g se'sn	Oats	"	" 14	....	Nov. 1	22	19.30	15.8	15.01	81.90
No date kept.....	Garden tr'k	Yes	May 15	....	Oct. 28	18	18.40	15.9	15.10	84.10
" " "	"	Yes	" 15	....	"	22	17.70	14.0	13.30	79.10
" " "	"	Yes	" 18	....	"	20	18.40	15.5	14.72	84.30
Good gr'w'g se'sn	Cabbage...	No	" 10	....	Nov. 6	16	22.35	18.0	17.10	80.50
Spring late, dry.	Beans.....	No	" 24	....	Oct. 24	20	19.65	15.0	14.25	76.30
Backward season	Vegetables.	No	" 15	...	Nov. 10	26	16.90	16 1	15.29	94.20
Very dry.....	.....	Yes	June 23	....	Oct. 30	28	13.10	14.0	13.30	77.80
Season irregular.	Wheat.....	No	May 26	....	Nov. 8	22	15.80	13.5	12.82	85.50
Good gr'w'g se'sn	Potatoes ...	Yes	" 10	....	" 1	20	18.80	16.9	16.05	89.80
Av growing seas'n	Oats	No	" 10	....	" 27	10	19.70	17.2	16.34	87.50
Dry all summer..	.....	No	June 1	....	Oct. 28	18	22.60	16.8	15.96	73.80
Plenty of rainfall	Turnips....	No	" 15	...	Nov. 20	22	15.40	11.9	11.31	77.30
Early part hot, dry	Vegetables.	Yes	May 2	....	Oct. 4	24	18.80	15.5	14.82	82.45
" " " "	Garden tr'k	Yes	" 2	....	" 4	24	18.70	15.4	14.80	82.40

Beets Grown in the State, Analyzed by Division of Chemistry, Department of Agriculture, Washington, D. C.

Serial No.	Name of Grower and Year.	Postoffice.	Variety.	Time of Planti'g.	Time of H'vst 'g
	1890.				
7970	N. F. Kimball	Ada Co			
	1891.				
16060	Geo. Yager	Alturas Co	Bultean Desprez		
	1892.				
17086	H. F. Eames	Alamo, Cassia Co			Oct. 20
	1893.				
161	J. L. Hagemann	Genesee, Latah Co		May 15	Oct. 10
162	Edward Kempf	Genesee, Latah Co		May 9	Oct. 6
	1897.				
714	Oscar Johnson	Idaho Falls, Bing. Co		May 20	Oct. 8
950	Adam Lauer	Coltman, Bing. Co		May 25	Oct. 12
1879	Paul Muchlfeit	Coltman, Bing. Co		May 25	Oct. 30
1984	J. H. Robertson	Idaho Falls, Bing. Co		June 6	Nov. 8
2193	W. S. Jackson	Idaho Falls, Bing. Co	Imperial Elite	June 10	Nov. 4
322	J. T. Dorchens	Lodi, Fremont Co		May 15	Sept 25
1443	J. T. Dorchens	Lodi, Fremont Co	Louis Imperial	May 20	Oct. 12

Beets Grown in the State, Analyzed by Division of Chemistry, Department of Agriculture, Washington, D. C.—Continued

Character of soil.	Date Rec'd.	No. of Beets.	Average Weight		Total Solids.	Sugar in		Purity
			Grams.	Oz.		Juice.	Beet.	
	Oct. 24		100	3.5		8.4	8.0	68.3
	Oct. 31		430	15	17.87	13.4	12.7	74.9
	Nov. 7	2	1020	34	19.50	15.4	14.6	79.1
Bl'k loam		1	1797	63.5	14.7	11.4	10.8	77.5
" "		1	2589	91.5	13.5	10.1	9.6	74.8
Sandy l'm	Oct. 12	2	652	23.0		19.1	18.2	84.5
" "	Oct. 15	2	454	16.0		16.9	16.1	84.5
" "	Nov. 10	2	170	6.0		18.1	17.2	
" "	Nov. 18	14	737	26.0		14.6	13.9	77.6
" "	Nov. 18	2	567	20.0		16.4	15.6	73.2
Bl'k loam	Sept. 30	2	595	21.0		16.9	16.1	80.1
" "	Oct. 15	2	907	32.0		12.3	11.9	74.1

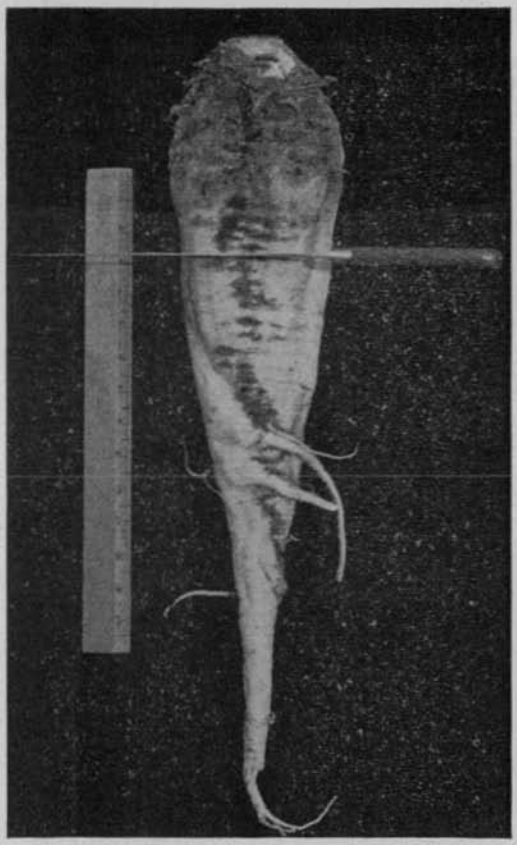

FIG. 8. LOSS IN CAPPING IMPROPERLY RAISED BEET.

That we may fully realize the position which the "Gem Mountain State" sustains in the sugar beet experiments now being vigorously pushed in all the states and territories, and by the government, it will be helpful to refer to results obtained in other states. We predict a still more favorable showing for Idaho this season. Below we give some data, compiled in this laboratory, from published results of 1897, and from letters received direct from the chemists of the stations named:

COMPARATIVE ANALYSES.

States.	Season.	Yield per acre-tons.	No. of analyses averaged.	Sugar in juice.	Co-efficient of purity.	Sugar content of sweetest single beets as analyzed by the stations.
Arizona	1897	15	41	11.80	73.6	17.70
Colorado	1897	16	51	15.50	81.6	23.00
Idaho	1897	15.0	41	15.17	87.55	21.90
Illinois	1897	12 5	314	12.70	76.70	17.50
Indiana	1897	13.0	307	12.80	80.60	22.90
Iowa	1897	22.0	663	13 70	77.40	17.40 [1]
Kansas	1897	....	160	11.88	76.40	.....
Michigan	1897	15.	465	16.40	84.00	22.30
Missouri	1897	15 0	304	11.14	71.00	21.02
Montana	1897	15.0	136	17.10	81.90	20.00
Nebraska	av. 5 y.	13.0	10,000	13.60	81.50	22.90
Nevada	1897	10.0	19	18.63	.....	23.80
New York, Ithaca	1897	16.9	495	16.91	83.50	21.50
New York, Geneva	1897	12.0	140	15.30	82.50	.....
New Mexico	1897	16.0	274	14.46	78.00	22.5
Ohio	1897	10.0	607	14.00	78.7	20.00
Oregon	1897	18.5	206	15.24	84.36	23.80
South Dakota	1897	21.9	951	16.40	85.60	22.90
Utah	1897	17.2	269	14.24	83.10	23.00
Washington [2]	1897	18.0	521	17.06	91.3	23.60
Wyoming	1897	15.0	34	18.00	82.3	25.50

2 The average of ten acre plats. 1 Average of ten samples.

THE VALUE OF THE INDUSTRY TO IDAHO.

The sugar beet problem presents several desirable features which if successfully inaugurated and carried out in this state would greatly augment its wealth. There are several good and essential reasons why this industry should be established in Idaho, and first and foremost is that it would very soon improve the system of agriculture in the state in all its branches. The successful growing of a crop of sugar beets requires the application of skill and intelligent methods of farming, and in time these methods would be extended to the growing of all other farm crops. Director C. F. Curtiss of the Iowa Station in Bulletin 37, page 13, has aptly expressed our ideas, and with a few changes to make his words apply to Idaho, we quote in full. He says:

"Sugar beet culture would bring more thoroughness, more careful methods, more intelligence, and a more rational and balanced system of farming. Every well cultivated field of sugar beets stands as an object lesson in good farming and a protest against superficial and slovenly methods. Sugar beet growing necessitates the intensive system of agriculture, and this system applied to Idaho means better crops, better stock, better farm products, better homes and a better farm life in every way. The introduction of beet culture would be of incalculable value to the live stock industry, independent of its other advantages. The beet pulp and the roots that would be fed directly to the stock would result in higher excellence and greater economy of production. Then, too, there is no crop that could be so advantageously introduced in our plan of rotation as the sugar beet. It is eminently adapted to combining with the grain crops. Chemically considered, pure sugar consists of nothing but carbon dioxide and water, both of which nature has supplied in great abundance. The removal of a crop of sugar takes nothing from the soil that is of any value in fertility. If the pulp is fed and the droppings of the animals applied as manure, beets will exhaust our lands less than any other crop we grow. There are only three agricultural products that can be grown extensively without exhausting the soil, viz.: sugar, cotton and butter. When we sell butter we

sell pure fat, and $1,000 worth of it would not contain $1 worth of material that has any fertilizing value, and if we were to sell sugar we would be selling pure carbohydrates that have no value as fertilizer; but $1,000 worth of wheat or oats at present prices would take from the land over $300 worth of fertility, or at least that which would cost that amount if restored in the form of commercial fertilizers. Commercial fertilizers will never become necessary in Idaho, provided rational policies are pursued, but it will be profitable to conserve fertility by every reasonable and judicious method."

THE BEET SUGAR FACTORY.

Next in importance of determining whether the sugar beet can be grown successfully for manufacturing purposes in Idaho, its richness in sugar and purity fully established, is the question of the beet sugar factory. There are, necessarily, several factors which enter into the solution of this problem. Some of these factors are:

1. The transportation and market facilities of both the raw and finished product.
2. The guarantee of the production of a sufficient quantity of beets for a good campaign.
3. An abundant supply of pure water—about 2,000,000 gallons per day.
4. Cheap fuel; a daily supply of about fifty tons of coal, or its equivalent in wood.
5. Plenty of lime rock; about twenty tons daily.
6. Coke, chemicals, competent labor at a reasonable figure, etc.
7. Profitable disposal of the pulp for feeding purposes.
8. Large capital and favorable state laws.

These several factors are very well elaborated in a letter addressed to me under date of March 17th, by Mr. T. R. Cutler, general manager of the Utah Sugar Company, Lehi, Utah. He says: "I will simply say in a general way that a sugar factory in the West equipped as ours is, with probably forty acres of land

on which the plant would stand, ought to cost about $500,000. Such a plant if properly equipped ought to cut, in a season, about 40,000 tons of beets. The amount of fuel used would be about 14 to 15 per cent. in weight (of coal) to the ton of beets. Of lime rock, it would take about 2,500 tons; coke, about two tons for every 400 tons of beets, and a great many other supplies such as tallow, filter cloth, bags, acids, laboratory supplies, sulphur and very many other things too numerous to mention.

"With good management and effective work such a crop ought to be used up in about 120 days, requiring the labor of 100 men inside the factory, and during the season of receiving beets from twenty-five to fifty men on the outside. Ordinary men get 15 cents an hour; foremen and experts get much higher wages. There is also a small force of men hired by the year. The entire success of the beet sugar industry here in the West as elsewhere, after the provisions I have named have been met, depends on the guarantee of the farmers to furnish the necessary amount of beets containing the proper sugar and purity percentages; and this can only be done by thorough, systematic work.

"If it could be demonstrated in any locality that the farmers can and will raise the necessary amount of acres and tonnage of beets carrying a high per cent. of sugar and purity for a consecutive number of years, at a price the manufacturer could afford to pay, I do not think there would be the least trouble to enlist capital.

"In all localities where a beet sugar plant is desired the farmers should have been experimenting for at least two seasons to get a thorough knowledge and understanding in regard to the requirements of the beet crop."

Our experiments with the sugar beet, for 1898, are well advanced. Sixty-three farmers are co-operating with us, growing the beets under contract, according to specific directions sent out from this office. Sufficient seed to plant twenty-seven acres was distributed. It is a significant fact that nearly all of the seed went to three sections of the state. Any one of these sections could supply beets that would tax the capacity of a

plant of the size of that at Lehi. With a factory located in Bingham or Oneida county; a second in Washington or Canyon county; a third in the Clearwater valley, distributing thousands of dollars annually to the farmers, an era of prosperity would come to such sections of the state, now scarcely imaginable. Land values would advance ; the intelligence and skill required for the successful growing of sugar beets would, in time, be extended to the production of all other form of crops ; and a better and more thrifty class of people would seek homes within our borders. The live stock industry, already an important factor in the growing wealth of the state, would receive a stimulus; the dairy interests would be developed about such centers, for the stockman would find in the discarded pulp of the sugar beet factory a most valuable article of food both for milk and fat production.

Professor Nicholson of Lincoln, Nebraska, has analyzed some pulp with the following results :

Organic matter, 10.78 per cent.
Digestible matter, .37 per cent.
Digestible crude fibre, 1.18 per cent.
Digestible nitrogen free extract, 3.49 per cent.
Digestible fat, .06 per cent.
Nutritive ratio, 1:7.1

What shall be our answer, farmers of Idaho ? Shall this new industry for the Pacific Northwest become one of the most productive sources of wealth of our commonwealth ? We have all the essentials to make it such. There is no better land in the United States, or climate more favorable for the production of the sugar beet than right here in Idaho. Furthermore, we are in the sugar beet belt so-called. What shall be our decision ?

The Experiment Station will furnish the seed and make all analyses, arrange the results, publish and distribute the same. Will the farmers of Idaho organize, inform themselves as to the most modern and scientific methods of producing and handling this crop, so that capital may be convinced that the "Gem of the Mountains" offers exceptional opportunities for profitable investment in this new industry?

In this connection, the writer desires to tender his acknowledgments for the courtesies extended in the preparation of the foregoing matter; to the chemists of many Stations for information furnished by letter direct, and to the Indiana Station and August Rolker & Sons, N. Y., for cuts used. The author has had recourse to much of the literature on the subject, especially Station bulletins at home and abroad, and when possible any credit that was due has been made in the text.

SUMMARY.

1. The beet is a native of Egypt and has been grown for centuries as food for man and beast.

2. Cultivation and careful selection of seed have greatly developed it both in saccharine matter and productiveness.

3. The earliest analyses of the beet showed only six per cent. of saccharine matter; the average now is from fourteen to eighteen per cent.

4. The average of 635 analyses made of Idaho beets, gave 14.56 per cent. in sugar and 84 degrees purity, with a maximum of 21.9 per cent. in sugar.

5. The people of the United States consume 2,100,000 tons of sugar annually, five-sixths of which is imported, a loss to the country of $1,000,000.

6. The average consumption of sugar per capita is 61.6 pounds, which costs the importer and retailer an average of five cents per pound.

7. On this basis, Idaho with a population of 100,000, consumes sugar to the value of $313,000 per annum, or $856.00 per day for the entire state.

8. The state lies in the so-called sugar beet belt and possesses the climate, soil and natural facilities for producing its own sugar; co-operation of the farmer and capitalist only are needed.

9. The first beet sugar factory in the United States was erected in 1863; this fall there will be fifteen factories in operation, with several more building.

10. The United States produced in 1897, in cane, beet, maple and sorghum sugar aggregating 335,356 tons; in beet sugar alone, 41,347 tons. The product of 1898 is estimated at 70,000 tons.

11. The sugar production of the world in 1897, including all kinds, was 7,265,000 tons, of which 4,800,000 tons was beet sugar.

12. A rich, deep soil with a porous and well drained subsoil should be selected for sugar beets; clay and muck lands are worthless for this crop.

13. There should be abundant moisture and good, growing weather the first three months, then a limited amount of moisture and dry, sunny weather the last thirty days, otherwise a second growth may start at the expense of the saccharine matter and purity.

14. The average precipitation during the growing season at Moscow the past four years was 20.88 inches; at Payette, 11.83 inches; at Idaho Falls, 14.19 inches.

15. Soils impregnated strongly with alkali are to be rejected, when growing beets for the factory, the salts corroding the tissues and preventing the crystalization of the sugar and otherwise affecting the market value. In irrigated districts the effect is less marked.

16. At present, Idaho soils require no fertilizer, but should one be needed, barnyard manure is cheapest and best. The use of commercial fertilizers would materially reduce the profit from the crop. A rotative system alternating with the grasses, legumes and the grains, extending over four or five years, will best restore the fertility and prepare the soil for sugar beets.

17. Plant only pure seed, of high grade. For Idaho, the Klein Wanzleben and Vilmorin's Richest have proved the best varieties.

18. The real sugar beet is white, a slim cone, with single tap root covered with fine hair-like roots, and sets well in the ground. Avoid growing large, irregular beets.

19. Factory facilities and the necessary acreage are available in at least three sections—Bingham or Oneida county, Washington or Canyon county, Latah or Nez Perce county.

20. The sugar beet industry should be established in Idaho. The skill and intelligent methods necessary to grow this crop would eventually be extended to the growing of all other farm crops, thus materially improving the system of agriculture throug out the state.