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OREGON AGRICULTURAL EXPERIMENT STATION.

CHEMICAL DEPARTMENT.

A REVIEW OF

OREGON SUGAR BEETS.

By G. W. SHAW.

"Respect me, for I enrich the soil; I fertilize the land, which without me would remain uncultivated; I employ the hands, which without me would be idle. Finally, I solve one of the greatest problems of modern society, I organize and increase labor." *PRINCE NAPOLEON in Analyse de la Question des Sucre.*

The Bulletins of this Station are sent free to all residents of Oregon who request them.

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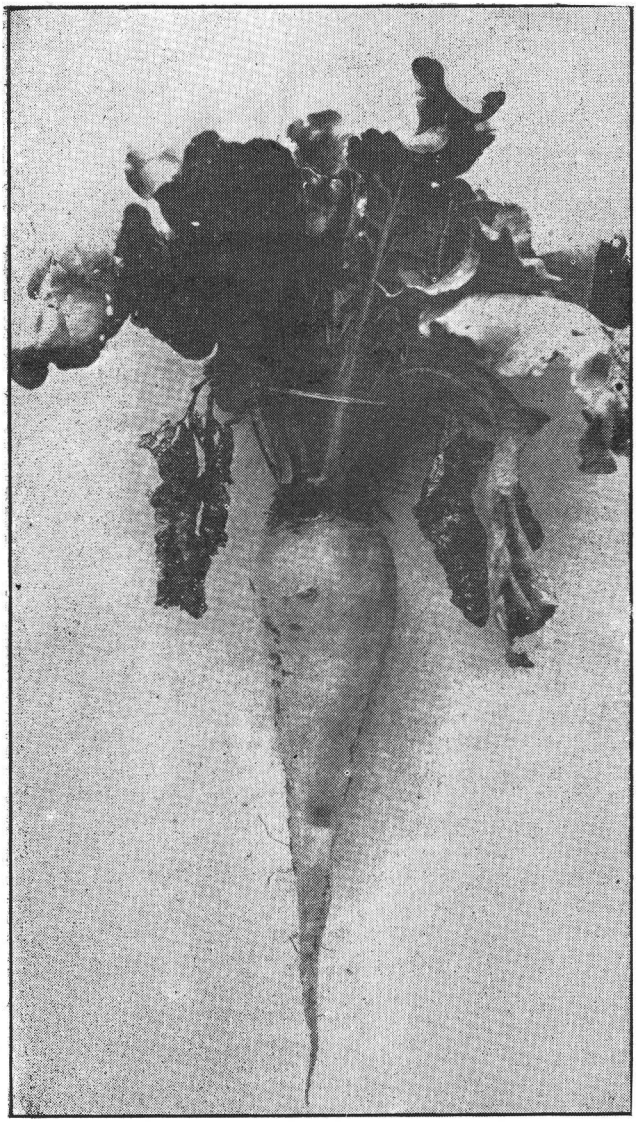


PLATE I, A TYPICAL SUGAR BEET.

INTRODUCTION.

In February, 1893, this Station published in Bulletin No. 23 under the title, "The Sugar Beet in Oregon," the results of a series of experiments in sugar beet culture which covered a period of three years. The edition of that bulletin was very soon exhausted. Since the publication of these results, we have been much gratified to note the interest they aroused in the state, and also the attention which has been directed toward our state as one adapted to sugar production. Several attempts have been made in different localities to secure the location of a sugar factory, but through unfortunate combinations of circumstances, and the extreme caution with which any investments have been made in manufacturing enterprises during the last few years, these attempts have achieved no success.

The present publication is intended to review fully the work there presented, and to add such results as have been obtained since the former bulletin. With these results is included information thought to be of value to those interested in this possible new industry in Oregon. We are indebted to a number of publications for the general information, among which are the "Sugar Beet," "The American Agriculturist," and the bulletins of various Experiment Stations.

March 1, 1897.

PRODUCTION OF SUGAR IN OREGON, FROM AN ECONOMIC STANDPOINT.

H. B. MILLER, Director.

One of the most important industrial questions in the United States, to-day, is how to produce our sugar supply. This is as important to the people of Oregon as to any part of this country. In consideration of this matter, it is of primary importance to examine the economics of it before much effort is wasted.

We must be able, with our soil and climatic conditions, fuel, lime, and other elements employed in the production of sugar, to produce it as cheaply as other sections of the country, or the industry will be short-lived and wasteful. It is well settled that we cannot produce the sugar from cane in competition with the Southern States and the Islands. If other states can produce higher grade beets in unlimited quantities for less money; if fuel, lime, transportation and other factors are greatly in their favor, so that the cost of production and distribution would be less for them, it would not be wise or economical for Oregon to undertake the production of sugar from beets.

The economic theory of supply and demand (a product of a purely commercial era), has given place, under pressure of the present age of science and industrial production, to the law of cost of production, as the regulator of values.

The values of things are no longer fixed by the merchant who merely buys and sells; but are regulated by the scientific skill, the ability and judgment of the producer and manufacturer, combined with natural forces. The natural advantages of soil, climate, power, transportation, etc. combined with capital, regulate the price.

The general who directs industrial forces, if he wins in the contest, must be wise in the selection of these elements and a master in directing them. There is a growing fever of excitement throughout this country in the matter of sugar production from beets. Nearly every state has the subject under discussion and rumors are multiplying regarding the erection of factories.

California has achieved the greatest success thus far in the production of sugar from beets, and from reliable reports, it is fair to expect that California will soon have a dozen factories in operation.

At the present time there are three factories in operation in California, two in Nebraska, one in Utah, one in New Mexico, one in Wisconsin, and one in Canada.

The total consumption of sugar in the United States is about 5,000,000,000 lbs. per annum, and not over one-fifth of it is produced in this country. We have passed the experimental stage in the production of sugar from beets, and it has been clearly proven that the United States can and should produce all of the sugar we consume.

During the last five years it has taken three-fourths of the money received in this country from exported wheat and flour, to pay for imported sugar.

For the past five years over one hundred millions of dollars per annum have been sent to foreign countries for sugar. It seems to be a certainty that this country will very soon stop that outgo of money by producing all of this at home and that mostly from sugar beets. Oregon pays out about one million of dollars per annum for sugar, and her part in this general problem is to determine whether or not she can keep this amount within her boundaries. The question is one to be settled by a scientific and economic examination of the facts involved in production.

The world's consumption of sugar has increased fifty-five per cent in ten years, hence there is no danger of short consumption. The consumption per capita is seventy-nine pounds in England, and sixty pounds in the United States. The cheaper cost will without question, increase consumption; therefore the important question for us to determine is this,—can Oregon produce the sugar from beets and carry it to the people as cheaply as California or other states? We must carefully analyze the elements that enter into the production of sugar from beets, and compare them with the cost of the same elements in other sections.

First:—Can we produce good beets?

Second:—Comparative cost of production,

Third:—Cost of power and fuel,

Fourth:—Cost of lime rock,

Fifth:—Cost of other materials,

Sixth:—Economy of sugar beet industry in its relation to our other agricultural industries.

The answer to the first question will be found in our favor

after a careful examination of the extended reports herein made by Prof. Shaw. The sugar contents and purity are the factors to be examined to determine the quality of the beets.

The following, taken from a Wisconsin bulletin on beet sugar, by W. A. Henry, is a clear explanation of the relation of sugar contents and purity to the value of the beet:

"In the pages which follow we speak of the per cent of sugar in the juice and the coefficient of purity. Let us understand the meaning of these terms. A hundred pounds of sugar beets contain about 95 pounds of juice. This juice not only contains sugar but various other substances, largely mineral matter, which are a great hinderance, causing serious losses of sugar during the manufacture. A hundred pounds of average beet juice will carry about fifteen pounds of solid matter, of which twelve pounds may be sugar, and three pounds matter not sugar. If we divide the number of pounds of sugar, (12), by the total pounds of solid matter, (15), we get .80 which sum is called the coefficient of purity; that is. beet juice with 15 parts solids, 12 of which are sugar, is said to have a coefficient of purity 80. If the sample of juice contains 16 parts solid matter and 12 parts sugar, as before, then the coefficient of purity is only 75.

When reducing the beet juice to make sugar, each pound of foreign matter, not sugar, keeps at least one pound of sugar from crystallizing. This true, we see at once that the manufacturer desires beet roots not only carrying much sugar, but also with a high coefficient of purity. Immature beets. those grown on soils rich in vegetable matter or fertilized with fresh barnyard manure, those grown on land recently cleared from the forest, or on drained swamp lands, are all liable to carry a great deal of solid matter not sugar in the juice and consequently are quite unsatisfactory to the sugar manufacturer. Large beets are likewise always poor in sugar. The leaf stems of the beet, as well as the crown of the beet root itself also carry much foreign matter. In practice, the manufacturer recovers about seven out of every ten pounds of sugar contained in the beet root."

The following table gives some interesting figures relative to the sugar contents and the coefficient of purity of the sugar beet juice, from several states where sugar is produced together with Oregon and Washington.

	Sugar in juice.	Purity.
Wisconsin, averages,.....	12.44	76
Nebraska, 5 years,.....	13.5	80
Utah, in 1891 averaged,.....	11.0	80
" " 1894 "	12.7	80.2
" " 1895 "	13.5	81.5
Chino, Calif., 1891, averaged...	13.0	80
" 1894-5 "	15.	.....
California, average 5 yrs.....	14.9	83
Washington, 1st result,.....	14.2	82.6
" 1895 2d "	15.2	83.8
Oregon, 1891.....	14.13	78.08
" 1892.....	15.7	78.08
" 1892 to 1897.....	14.9	83.

The examination in Washington covers twenty-seven counties, and that of Oregon has covered the eastern, southern, and western sections.

One important thing will be observed in this table, viz: that the sugar contents and purity have all been below Oregon and Washington to begin with, and have improved under cultivation.

The quantity of sugar per acre has increased in Utah from 1452 lbs. in 1891, to 3116 lbs. in 1895; and in California at Chino, it has increased from 1888 lbs. in 1891 to 3309 lbs. in 1892. It is only reasonable to suppose that the same would occur in both Oregon and Washington, and in that case, this country would certainly equal, if not excel any part of the United States in the production of the sugar beet.

The second element, the cost of production, is more difficult to determine because of the imperfect data at hand.

In Utah, the average yield per acre in 1891 was 6.6 tons; in 1895 it had increased to 11.5 tons. In Wisconsin the yield in 1896 was about 12 tons per acre; while the estimates from 400 experiments was 15 tons per acre. In Nebraska the yield per acre for 1895 was about 13 tons. The average production of beets per acre in Germany for 1894 was 12.8 tons. In Oregon the average yield, estimated from 40 experiments in different parts of the state was 20.5 tons in 1892, and 23.2 tons in 1893. When we note the fact that the quantity per acre has gradually increased at other places, and when we observe that beets in general are very prolific and thrifty growers all over the state, and when we note the further fact that our climatic conditions give us a good position in the sugar beet belt, we are safe in saying that no other section will excel us in the quantity per acre that we can produce.

We have no definite data from which we can give accurate statements of labor required to produce a ton of good beets. From the reports received at this Station, we feel safe in saying that this state can produce an average of from twelve to fifteen tons per acre at a cost of from $2.50 to $4.00 per ton. The reports from Washington experiments confirm this statement and indicate that this territory, comprising Oregon and Washington, can produce superior beets with a large yield at a low cost, as compared with other sections of the country.

For the third problem,—cost of power and fuel:—the aver-

age cost of fuel at the various factories now in operation in the United States is $3.50 per ton of coal. The use of wood, coal and water power in Oregon will give us at least equal if not superior advantages of power and fuel.

The cost of lime rock at the various factories ranges from $2.00 to $3.00 per ton. In Southern and Eastern Oregon, the price of lime rock would not exceed this and in some places it would be less. In the Willamette Valley the lime rock would no doubt cost from $3.00 to $4.00 per ton.

The amount of lime rock required per ton of sugar is about one ton, hence its cost is an important item in producing sugar.

The fifth item,— cost of other materials, such as coke, soda, sulphur, tallow, general laboratory supplies, wages, etc., should be about the same here as elsewhere.

The sixth point of examination,—the relation of the sugar beet industry to other agricultural pursuits, is a matter of economy largely in our favor. The residuum has been used both for beef and milk purposes and it is claimed that it has no equal as a milk producer. Oregon is sure to be a great dairy state and there is no better combination than sugar beets and dairying. Every combination for rotation of crops, especially fitting to Oregon, provides for root crops and clover. Nothing would be more certain to develop intensified farming and diversity of crops than the sugar beet industry.

The residuum of lime is of great value, especially in Western Oregon as a fertilizer for our fruit orchards. The product contains 67 per cent of lime carbonate. It is well known that the soils of the Willamette Valley are not overcharged with lime, and this material would be valuable especially in our prune orchards.

From this general examination of the subject, it seems clear that there are no serious obstacles in the way of producing sugar from beets in Oregon. The indications all point in the direction of as low a cost of production as can be had at any point in the country. The opportunities of distribution are such that the industry cannot fail to thrive if the cost of production is low. We shall carry on experiments at the Station and at various other places during the coming season with a view to determine more definitely the elements of quality and value of sugar beets in Oregon.

A REVIEW OF OREGON SUGAR BEETS.

By G. W. SHAW, A. M., Chemist.

The reasons for undertaking these investigations may be stated as follows: The consumption of sugar in the United States is greater than in any other nation. At present this country does not produce one-fifth of the sugar she uses. To show the sources of this foreign sugar for the last five years the following table is inserted:

TABLE I

*Showing sugar supply of the world from 1890-1895 inclusive.**

SOURCE.	1890-1891 Tons.	1891-1892 Tons.	1892-1893 Tons.	1893-1894 Tons.	1894-1895 Tons.
Germany	1,331,965	1,280,000	1,224,000	1,375,000	1,800,000
Austria	778,873	850,000	793,000	834,000	1,050,000
France	694,537	750,000	580,000	570,000	814,000
Russia	524,000	530,000	450,000	647,000	600,000
Belgium	200,000	295,000	166,000	220,000	230,000
Holland	61,307	50,000	65,000	72,000	90,000
Other Countries	80,000	61,900	97,000	119,000	.....
Miscellaneous†	2,525,649	2,630,000	2,782,000	3,197,000	4,792,000
Total	6,196,331	6,346,900	6,157,000	7,034,000	7,859,000

We can hardly understand why the foreign countries have been allowed to outstrip us to so great an extent, we continuing to import and consume, while there are portions of the United States equally, if not better, adapted to sugar production than France, Germany, or Austria.

Few people realize what the establishing of sugar factories in the United States, in sufficient number to supply the home demand for sugar, would mean. To give some idea of the benefits to be derived and to show the channels which the money would reach, the attention of the reader is invited to the following figures, which are based upon data from the Lehi, Utah, factory:

*Compiled from data in "The Sugar Beet." †Cane sugar.

Cost of 21,574,000 tons raw material	$115,313,337.00
Cost of fuel	10,867,500.00
Cost of coke	2,753,100.00
Cost of limestone	3,238,112.00
Cost of sal soda	170,750.00
Cost of bags and ducking	5,505,737.00
Cost of tallow	217,350.00
Cost of sulfur	483,000.00
Cost of muriatic acid	281,550.00
Cost of laboratory and other supplies	4,023,000.00
Wages	42,603,562.00
Total that would be expended at home	$185,545,998.00

The cost of machinery and transportation of raw and manufactured material is not included in these estimates: probably they would add a third to the total. But even on this basis we have an expenditure on home industries and labor far exceeding—nearly doubling—that of the value of all the wheat exported from the United States.

Certainly no one will attempt to deny the incalculable benefit to be derived from keeping at home the whole, or even the larger part, of this financial drain upon our country, by supplying the American market with American sugar.

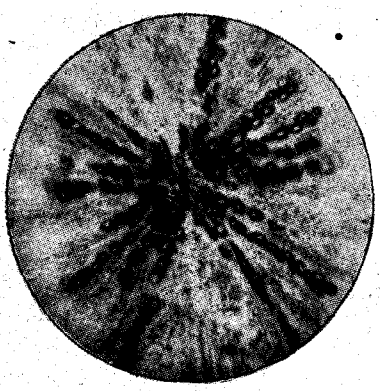
The experiment stations of many states have been investigating this subject for the past few years, and many thousand analyses of American raised beets have been made. In addition, factories have for some years been in successful operation in several states. The nine factories in six states will probably turn out this season not far from 75,000,000 lbs. of granulated sugar. Thus, there is no longer any doubt but there are portions of the United States well adapted to the production of sugar from beets. The initiatory twist has certainly been given to the industry in this country, and we may expect to see a great impetus imparted to it in the near future.

Can Oregon stand in the line of sugar producing states and thus reap the rewards that are bound to follow in the wake of such an industry? Can she not gain the advantages to be derived from the building up of prosperous communities around the factory, furnishing better markets for other home products, and

encouraging the farmer to adopt more scientific methods of cultivation, which would certainly extend to other farm crops than beets, until its influence would be felt all along the line of agricultural pursuits? If the soil and climate of Oregon is favorable to the production of beets rich in sugar, and economic conditions are inviting, then there is a new and profitable industry possible for our state, one which Mr. Paddock, in a speech before the U. S. Senate, claims is more important than any twenty others in this country. That there is an abundant *home market* is evidenced from the fact that the people of this state alone, according to an estimate on the basis of 60 lbs. per capita and a population of 350,000, consume 21,000,000 lbs. of sugar per annum. It was to seek an answer to these questions that these experiments were conducted.

In the back of this bulletin will be found a table showing analyses of all beets which have been received at the Station in a suitable condition. Analyses numbered from 1 to 96 were made during the season of 1891–1892, and those from 96 to 161 during the season of 1892–1893; the remainder have been made since that time. Following this table wil be found another showing analyses of Oregon grown beets sent to th U. S. Department of Agriculture, at Washington, D. C.

The Beet as a Sugar Plant.



The beet is a hardy, biennial plant, indigenous to Southern Europe, and more recently introduced into Canada and the United States. Internally the beet root is built up of a large number of concentric rings formed of a much larger number of small cells, each of which is filled with a watery solution of small bodies other than sugar. A cross section of the beet is shown in the accompanying illustration. These contain a number of crystalloid salts, as the phosphates, malates, oxalates

of calcium, and potassium, the salts of the latter being by far the most prominent. The juice also contains a large number of colloid substances, as the albuminous and pectinous compounds. The sugar present in fairly ripe beets is crystallizable and identical with cane sugar.

Crystallizable sugar was obtained from beets in 1847, but it was about a half century later before any success was achieved in its extraction. At first only about three per cent of crystallized sugar could be obtained, although the beet contained from six to seven per cent. The demands of the Napoleonic wars on the one hand, and human needs on the other, continued to concentrate attention upon the beet as a sugar producing plant, until in 1813 a report of the French minister of the Interior stated that during the year past 7,700,00 pounds of sugar had been made, which was the output of 334 factories. In other European countries the industry had assumed a commanding position. From that time to the present there has been a steady growth of the industry till now more than one-half the sugar of the world is made from beets, and instead of receiving a bounty in Europe, as at first, it is now subject to an internal tax. In the meantime, by selection and cultivation, the sugar in the beet has been increased to 15 per cent, a large portion of which, by the improved methods of extracting and purifying, can be obtained as crystallized sugar. The industry has constantly grown in Europe until she now has about 1450 factories in operation.

History in the United States.

Notwithstanding the continuous growth of sugar beet culture in the foreign countries, as indicated above, its early career in this country was marked by a succession of failures, on acount of poor business management and unsuitable locations. As early as 1830 attention was directed to the subject in America by two gentlemen in Philadelphia, without success. David L. Childs, eight years later manufactured sugar from beets, in a limited way, for a short time. There was then an interim of active interest till 1863, when an enterprise was started at Chatworth, Ill., by the Gennet Brothers, from Germany, but the undertaking proved disastrous. The company in order to counteract unfavorable local conditions moved to Freeport in the same state. The

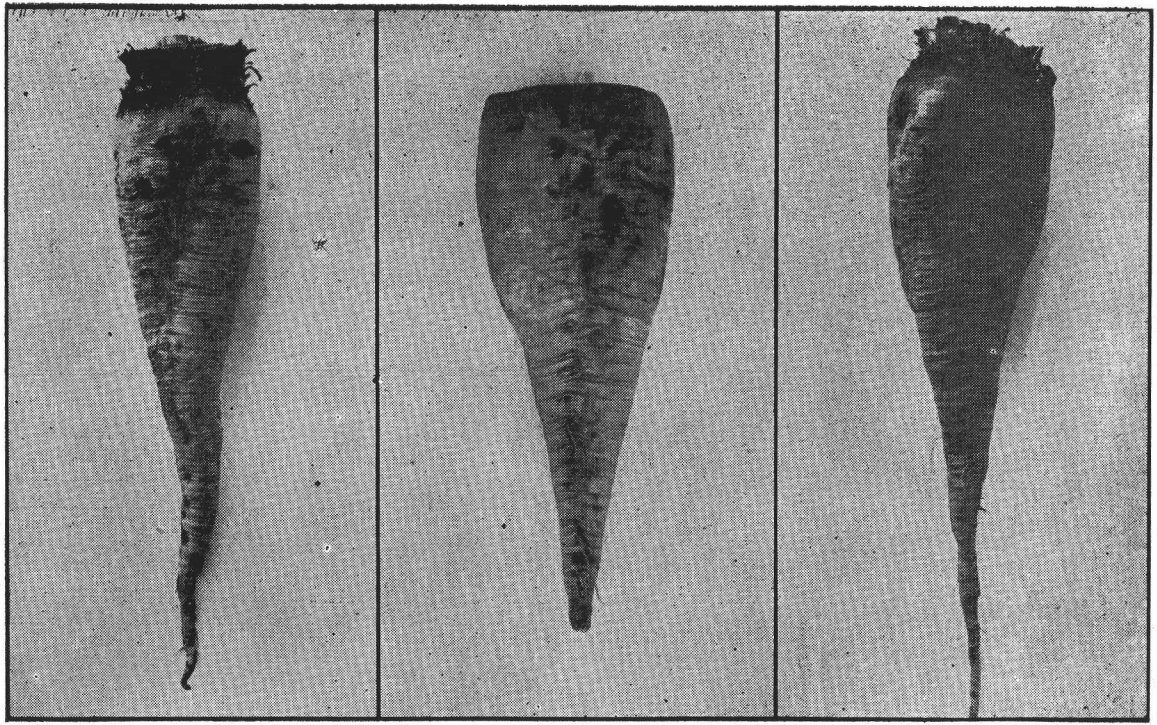


PLATE II, SHOWING BEETS OF GOOD FORM.

unfavorable climate of this locality, however, finally caused the factory to succumb. In the meantime the industry had made a start at Black Hawk, and Fon du Lac. Wis., both of which proved unsuccessful. The machinery from each of these places was soon moved to Alvarado, California, where the enterprise led a struggling existence till 1876. In 1879 the company re-organized, and since that date, under the efficient management of Mr. E. H. Dyer, has been in successful operation. From this beginning the industry has grown to the proportions before indicated.

What is a Good Sugar Beet?

At the outset of our discussion, I desire to say that many people have a wrong idea as to what constitutes a good beet for sugar purposes. Contrary to a popular idea which is quite extant in the state, the beet should be small, with a large leafy top. Brien says: "The size of the beet is in the inverse ratio of its sugars and salts; the content of water increases with the size and weight of the beet."* In general, the standard adopted seems to be a beet weighing from 1½ to 1¾ lbs., carrying 14 per cent sugar, and having a purity of 80 per cent, although factories will accept beets weighing as high as 3 lbs., and having as low as 12 per cent sugar. In addition good sugar beets should be long tapering roots, without branching rootlets. A typical sugar beet is shown in the *frontispiece*.

The average sugar content and purity for the states where sugar is now being manufactured from beets is as follows:

	SUGAR.	PURITY.
California	14.9	83
Nebraska	13.5	80
Utah	14.5	80
Wisconsin	12.4	76

From a report by Commercial Agent Hawes, of Reichenberg, Aurtria-Hungary:

"The conditions required of a good sugar beet are:

(1) Regular shape (cone, pear or olive shape). Many side roots or prongs are disadvantageous, because they make cleaning more difficult and increase the waste. The leaves should be thick and should be of the characteristic shape and color, and those which lie flat are to be preferred as protecting the beet against frost.

(2) A medium size, say, 1 to 2 pounds. Small beets make a small crop,

*Journal des Fabricants de Sucre, Oct. 23, 1878.

while large beets contain comparatively little sugar. The length should not be more than 35 centimeters (14 inches).

(3) Rich in sugar—from 9 to 25 per cent.

(4) A white, compact, brittle substance. Such beets are more resistant to destruction by storage. A small head not protruding from the ground, as this head must be cut off, containing, as it does, very little sugar.

"It is very important to select the proper variety for a given district, because the different economical conditions of climate and soil require different varieties, if the largest possible crop is to be harvested. It is, therefore, quite necessary for every farmer to experiment with different varieties."

Climate and Soil Conditions.

CLIMATE.—The sugar beet does not differ from other plants in requiring certain conditions of climate and soil to yield favorable results. In foreign countries both of these questions have been pretty satisfactorily settled, but in some parts of the United States, notably California, the conditions that seem favorable, so far as rainfall is concerned, differ very materially from the foreign, hence the latter cannot be taken as an absolute guide.

The season for the growth of beets may be divided into three periods—that of germinating; that of plant formation; and that of sugar storing. The following is a comparative table showing the temperature averages for Germany and certain parts of Oregon during these periods:

TABLE II

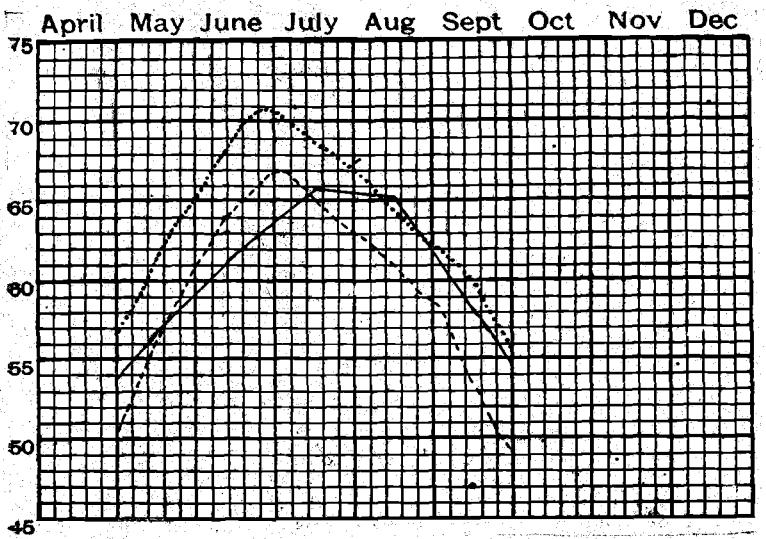
Showing Temperature for Periods of Growth.

Periods of Growth.	Av. Temp. Foreign.	Av. Temp. E. Oregon.	Av. Temp. Willam. Val.	Av. Temp. South. Oreg.
First	49.1	56.0	52.5	53.3
Second	63.3	65.0	64.4	64.5
Third.....	56.3	64.5	63.3	54.8

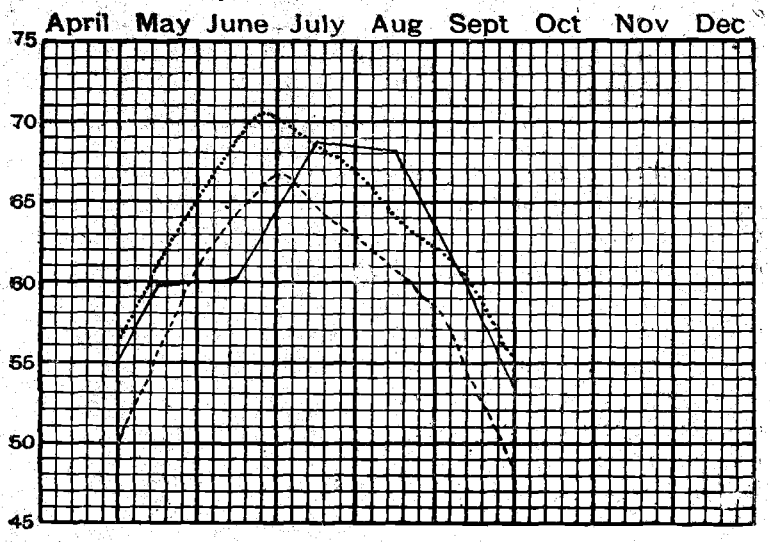
On the opposite page are given comparative temperature charts, which show the normal curve for the leading foreign sugar beet areas, and also for the Willamette valley and Eastern Oregon. That for Southern Oregon is not given since it so nearly covers that of Eastern Oregon as to be essentially a duplicate. Thus it is seen that *in the matter of temperature Oregon seems well suited to the conditions demanded by the sugar beet.*

The subject of temperature with reference to the sugar beet has been very carefully studied by Dr. McMurtie, who has constructed his mean isotherm for beet culture at 70° F. for June, July and August. Taking this as a basis, Mr. H. W. Wiley, in his

Comparative Temperature Charts.

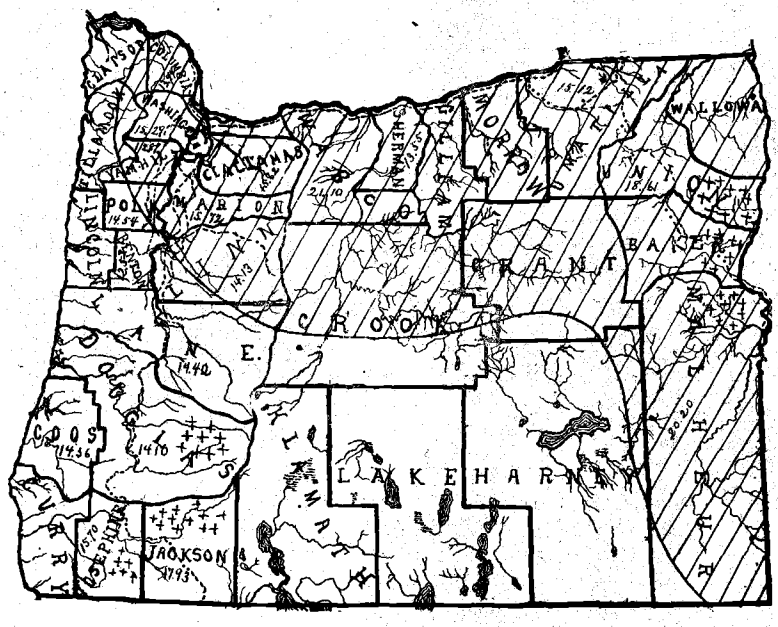


France .....
Germany - - - - - -
Willamette Valley————



France .....
Germany - - - - - -
Eastern Oregon ————

report on beet culture* gives a map of the United States showing 100 miles on each side of this isotherm, within which area favorable results may be looked for. The inserted map shows this area, shaded, as given for Oregon. On the same map are given the average sugar content for each county, as well as the lime



areas, indicated + +. It is not by any means certain that good sugar beets cannot be raised in other portions of the state than within the 100 mile limit. Concerning this, Bulletin No. 27, of the Department of Agriculture, says: "There are many localities lying outside the indicated belt, both north and south, where doubtless the sugar beet will be found to thrive. The map, therefore, must be taken to indicate only in a general way those localities at or near which we should expect success to attend the growth of sugar beets in the most favorable conditions other than temperature alone." This has already proven true in some instances, and the data here given certainly show that fully as rich beets can be produced outside of this area—in Southern Oregon—as within it.

*U. S. Department of Agriculture, Bulletin No. 27.

It is in the rainfall of the state that we find the greatest seeming deviation from those portions of the world which are taken as typical beet producing regions. This seeming difference should not be considered as a too serious drawback, nor would it appear so to those acquainted with all the conditions. The average amount of rainfall does not differ much from that of the beet-growing regions of other countries, yet it is not as evenly distributed. It must be borne in mind, however, that the soils of Oregon are much different with respect to their retentiveness of moisture, and that for all our crops the necessary moisture nearly all falls during the "wet season," and for this reason we do not usually consider the *monthly* rainfall as bearing so close relation to the crops as it does in most other states, but rather are wont to consider the *seasonal* precipitation as the more important factor. Consequently tables for seasonal precipitation are given rather than for the monthly. The places chosen are such as *fairly* represent the different portions of the state.

TABLE III

*Showing Seasonal Precipitation.**

LOCALITY.	SPRING. Mch-May	SUMMER. Jun - Aug	AUTUMN Sep-Nov	WINTER. Dec-Feb	Years Obsvd
LaGrande, Eastern Oregon	4.10	2.26	2.38	15.81	2
The Dalles, Central Oregon	2.93	.88	3.98	8.50	13
Albany, Willamette Valley	10.07	2.43	9.75	22.76	8
Roseburg, Southern Oregon	8.22	1 79	8.00	17.60	10
Newport, Coast Region.....	11.60	8.16†	10.72	34.50	2
Ashland, Southern Oregon	4.79	1.61	4.90	11.63	4
Lakeview, Lake Region. ...	4.32	3.09	3.18	6.79	3

SOIL.—Beets seem to have little preference in soils, yet they are the most grateful for a sandy loam of considerable depth. Speaking concerning this matter Commercial Agent Hawes says:

"The best soil for quality, as well as quantity of production, according to the experiments of Orth, are those that consist of mild, moist loam about 50 centimeters (20 inches) deep, then loam or marl 1 to 2 metres (3 to 6 ft.), and, under this, sand. Such soils, which are easy to cultivate, have a high degree of absorption, can combine nourishments, and give the plant physically a good start. Such soils are called "natural sugar-beet soils."

Bassett‡ quotes Chaptel as follows:

"Soils which are dry, calcareous, light, etc., are not well suited to the beet. Strong clay soils have little aptitude for the culture of this root. In

*Compiled from State Weather Service data. †For two months only.

‡Guide Practique du Fabricant de Sucre.

order that the root may prosper, it needs, in general, a mellow fertile soil, the arable stratum of which should be 12 to 15 inches thick. The root succeeds more or less well in all arable soils, but the products vary wonderfully according to the nature of the soil."

"Vilmorin considers that any good soil that will grow wheat and has an arable statum of 12 to 15 inches, will be well suited to this culture."

So far as the chemical constituents of the soil are concerned, phosphoric acid seems to bear the closest relation to the amount of sugar, or, if this be wanting, sugar will not be provided, while a lack of lime would be replaced by potash, soda, or magnesia.

Champion and Pellet consider phosphoric acid as an indispensable base for the formation of sugar in the beet. They classify the order in which the plant food is indispensable as follows: (1) phosphoric acid, (2) lime, (3) nitrogen, (4) potash.

It is foreign to our purpose to discuss, at this time, the soils of Oregon to any length, but in connection with the last statement I desire to direct attention to the fact that the soils of Oregon are well—yes, abundantly—supplied with phosphoric acid, that they surpass those of France in lime, and equal them in potash. Below are contrasted analyses of some of the French sugar beet soils with those of the natural divisions of this state, and those of California. These results, I think, speak for themselves, and need no further comment.

TABLE IV

Showing Average Comparative Composition of Soils.

ANALYSIS OF FINE EARTH	France.		Oregon.			California.
	Somme	Nord.	Eastern	Willam Valley.	South'n	
Insoluble matter	81.80	82.50	66.59	65.18	62.45	67.88
Soluble Silica			13.12	5.02	8.74	8.96
Potash (K_2O)	.06	.14	.43	.23	.34	.64
Soda (Na_2O)	.09		.22	.18	.21	.28
Lime (CaO)	.51	.42	1.22	83	2 22	1.08
Magnesia (MgO)	.....	.....	.75	.79	.80	1.49
Manganese (Mn_3O_4)	.....	.....	.10	.08	.25	.06
Iron (Fe_9O_3)	2.88	2.18	10.69	16.45	15.35	15.02
Alumina (Al_9O_3)	7.24	8.62				
Sulfuric Acid (SO_3)	.....	.....	.04	.03	.01	.05
Phosphoric Acid (P_2O_5)	.09	.08	.14	.21	.13	.08
Carbonic Acid (CO_2)	.40	.70	.....	.....	.....	.....
Nitric Acid	.....	.....	.....	.....	.....	.....
Hydrochloric Acid	.....	.....	.....	.....	.....	.....
Water and organic matter	5.60	4.84	6.21	10.77	9.52	4 40
Other matter	1.85	1.52	.....	.....	.. ....	.....
Humus	.....	.....	1.44	1.63	2.25	.75

PART II.

THE EXPERIMENTS.

Having now compared the climatic and soil conditions of the state with those of the natural habitat of the beet, and found them apparently favorable to its culture, the questions arise as to whether beets rich in sugar will actually be produced under these conditions; whether such beets can be produced at a price a factory can afford to pay, and still leave a fair profit for the farmer. I shall submit in evidence, first, the conditions under which the beets were grown: second, the particular results obtained: third, the yield: fourth, the cost.

When these results are considered and compared with those obtained in other states, and particularly with those obtained in states in which the manufacture of sugar is now being successfully conducted, I believe it will be admitted that none offer greater inducements than are offered in some parts of Oregon.

Seed and Cultivation of the Beets.

Each year arrangements were made with farmers in different parts of the state to cultivate a small plat of beets, the seed being furnished by the Station. Although there was a hearty and ready response to the Station's offer to furnish seed to those who would agree to forward samples for analysis, accompanyed by a report—blanks for which were furnished—there were many who never responded to a single inquiry after they had received the seed, notwithstanding the fact that they had expressly agreed to report results.

The seed used for the experiment was obtained from the Department of Agriculture, at Washington, and of E. H. Dyer, Alvarado, Cal., all of it being imported and the very best that could be obtained. From the former place two varieties were obtained, the Klein Wanzlebener and the Vilmorin Improved; from the latter the Dippe Klein Wanzlebener. In addition to these, a small quantity of Lane's Imperial sugar beet seed from Thorburn, of New York, was planted at the College. The State Board of Commerce distributed some seed throughout the

state, and a number of beets from parties who received seed from that source were sent to the Station for analysis.

To secure a uniform method of cultivation the following directions, taken from competent authorities in this country and Europe, were sent out with each package of seeds :

Method of growing Sugar Beets to be followed by those taking part in the Co-operative Experiments with Sugar Beets in Oregon.

SOIL.—This should, where possible, be a light loam, preferably containing some lime. The land should be well drained. The beet gets the greater part of its food from the ground at a depth of 8 to 12 inches. Hence freedom from excess of water is necessary.

PREPARATION OF LAND.—The land selected should have been plowed the fall before planting of seed. As soon as it can be properly worked in the spring the land should be plowed again, this time to the depth of 12 inches. Allow to lie until about one week before the time of seeding. Then plow once more to the depth of 4 to 5 inches, and work the soil into a fine and *light* condition (i. e., do not pack it down with a drag). After allowing land to lie 5 to 7 days plant the seed. The object of allowing the land to lie is that sufficient moisture may be drawn from below for the germination of the plant, and that the land may be warmed by the sun, after pulverization. No manure should be applied unless in the shape of well-rotted compost put on in the fall. The land on which the beets are to be grown should be measured approximately, and enough ground planted so that it will be possible to take the eightieth of an acre from the plot without including any *outside* rows. In ordinary soil the rows should be eighteen inches apart; in very rich, less; and in poor soil more than that distance apart. The conditions should be such that the beets cannot attain a greater weight than two pounds each. The seed should be planted one-half to three-quarters of an inch deep, and about 20 pounds of seed to the acre. Plant, when possible, in April.

CULTIVATION.—This should be thorough, and should begin as soon as the plants show in the row. When the beets have put out four leaves, thin them out so as to leave the plants standing about 4 to 6 inches (not farther) apart in the row. The weeds should be kept down and the ground well stirred.

It should be remembered that a beet which grows up out of the ground is worthless for sugar, also that the beets must not attain to a weight greater than two pounds each, and must be smooth and tapering in shape.

EXPERIMENTS OF 1891.—That the results of this season's work may be better interpreted, tables are given below for precipitation and temperature in 1891, and the departure from the normal is also indicated for various parts of the state, the same general regions being taken as are indicated above. These tables are also compiled from the reports of the State Weather Service.

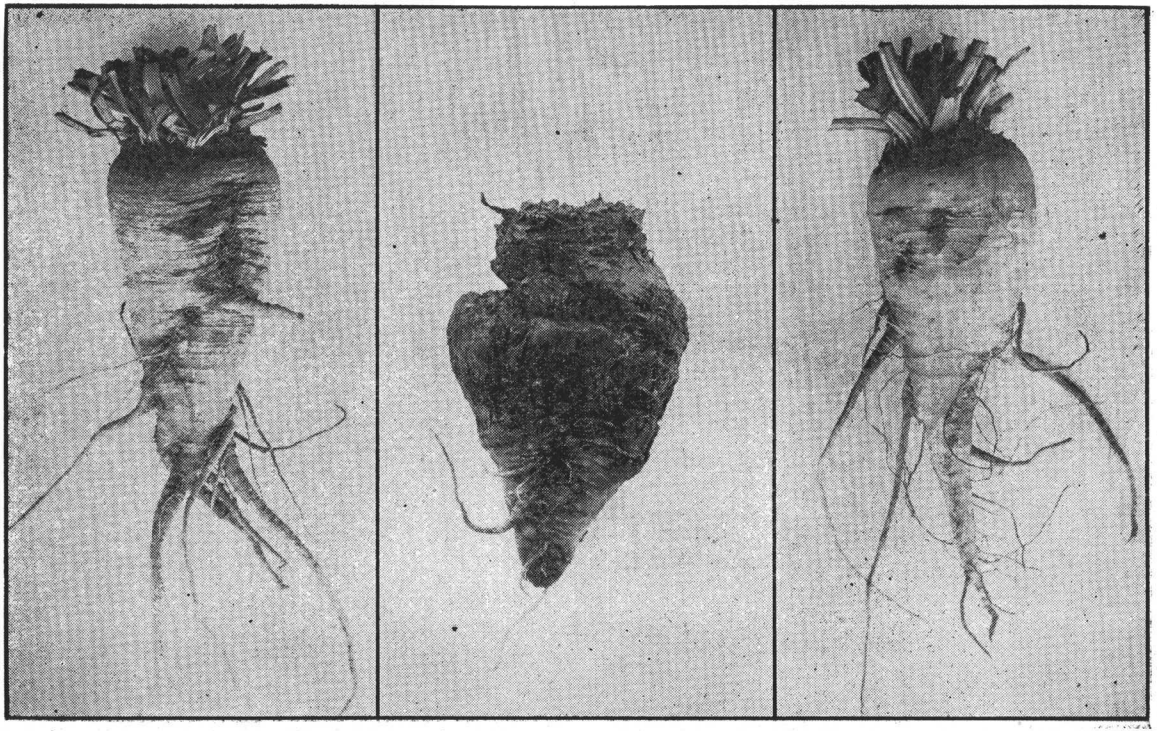


PLATE III, POORLY CULTIVATED SUGAR BEETS.

TABLE V

Showing Precipitation for 1891.

LOCALITY.	March		April		May		June		July		Aug.		Sept.		Oct.	
	A	D	A	D	A	D	A	D	A	D	A	D	A	D	A	D
Coast	5.83	-2.01	8.20	+3.67	3.37	+ .13	4.33	+2.04	.66	- .52	1.21	+.40	4.18	+1 82	6.46	+0.69
Willam'te Valley	2.39	-2.54	3.46	+ .71	1.99	- .26	3.08	+1.30	.30	- .41	.86	+.49	2.36	+ .84	5.09	+1.57
South'rn Oregon	2.81	- .03	1.39	- .22	3.22	+1.51	1.92	+1.08	.74	+ .49	.33	+.07	1.04	+ .29	1.70	-0.17
Eastern Oregon	1.99	- .20	.50	- .41	1.52	- .47	2.68	+1.13	1.45	+1.05	.32	+.07	.61	+ .16	0.61	-0.54

TABLE VI

Showing Temperature for 1891.

LOCALITY-	March		April		May		June		July		Aug.		Sept.		Oct.	
	A	D	A	D	A	D	A	D	A	D	A	D	A	D	A	D
Coast	44.6	-1.1	50.2	+1.6	55.	+1.1	57.8	- .7	61.0	+1.4	64.5	+4.8	58.3	+ .5	55.7	+2.7
Willamette Vallley	42.9	-3 0	50.4	- .3	57.7	+1.2	58.3	-3.2	96.3	+ .6	68.0	+2.8	58.7	+ .6	55.2	+3.8
Southern Oregon	46.2	-1 2	51.7	- .9	57.9	-1.1	59.2	-5.0	68.3	- .6	71.0	+3.8	60.9	+1.4	55.2	+2.9
Eastern Oregon	35.6	-5.8	49.7	- .6	58.3	-1.5	58.2	-2.0	69.2	+ .3	69.5	+1.2	59.0	+ .2	51.5	+3.2

In the tables given above the average temperature and precipitation are given by months in the column marked "A," in the column marked "D" is noted the Departure (plus or minus) from the normal of the respective localities.

It will be noticed that in general the spring rains lasted until quite late thereby causing delay in the time of planting, nearly all of which was done in May, whereas under ordinary circumstances the seed could doubtless be in the ground by the middle of April at the latest.

A great many letters written by the growers to the Station show that the cultivation was not in all cases what could be desired, and the same thing was also indicated by some of the beets received. This seems to be particularly true concerning the preparation of the ground, for many beets were of an irregular shape as shown in *Plate III*, which is made from photographs of beets received at the Station. It will be noticed that these beets are all "scraggly," showing that the ground was not worked to a sufficient depth. The beets shown in this plate are poor, and would not be easily disposed of for sugar purposes. It should always be borne in mind that beets which are profitable for the manufacturer are also profitable for the farmer.

In addition to being irregular in shape, which is of itself bad, branching beets are usually sun-burned, as they have usually been lifted partially out of the ground by their own growth. In some instances beets were received at the Station from which it would be necessary to reject fully one-half the beets as unsuitable for sugar manufacture, because allowed to grow above the ground.

One of the worst things to befall a beet crop is growth above ground.

The best beets for sugar purposes are the long, tapering roots, without branching rootlets, and if the soil has been properly prepared, and the cultivation has been of the proper kind, beets will always take the tapering form shown in *Plate II.*

RESULTS.—The analyses made at the Station during the season of 1891–1892 may be summarized as follows:

TABLE II

Showing County Averages for 1891.

County.	No.	Sugar.	Purity.
Benton	39	12.30	74.12
Clackamas	7	14.55	77.30
Columbia	1	13.74	79.42
Douglas	9	12.99	73.45
Jackson	3	18.93	80.99
Lane	16	14.32	79.95
Linn	5	13.54	79.91
Marion	1	15.99	78.38
Polk	1	14.72	78.08
Union	3	15.84	79.89
Washington	11	13.96	78.79
Yamhill	1	10.73	76.64
Average		14.13	78.08

An examination of the results reveals that the analyses had a wide range, viz: from 6.77 per cent to 22.44 per cent sugar in in the juice. Of the 95 analyses made 8 fell below 10 per cent; 76 showed over 12 per cent, and 37 over 14 per cent sugar. An average of 81 analyses for the Willamette Valley shows 13.76 per cent sugar and a purity coefficient of 77.89; the average beet weighing a little over 1¼ pounds, while an average of 10 analyses of beets from Southern Oregon showed 13.38 per cent sugar with a little larger beet. For the entire state the average weight was 608.5* grams; sugar in juice, 14.13 per cent; purity, 78.08 per cent.

The results obtained from the different kinds of seed were as follows:

Klein Wanzebener	14.3	Sugar	in	Juice.	79.0	Purity.
Dippe Klein Wanzebener	13.2	"	"	"	77.1	"
Vilmorin Improved	13.4	"	"	"	76.2	"

YIELD AND COST.—An attempt was made to collect reliable

*One pound = 453.5 grams.

data as to these items, but the reports received were very meagre. The average of all reports concerning yield was 20.5 tons per acre, the extremes being 5.1 and 44.2 tons. The yield as reported is given below.

TABLE VIII

Showing Estimated and Theoretical Yield.

GROWER.	Post Office.	County.	Reported Yield in Tns.	Theoretical Yield in Tons.*	Probable Yield of Sugar per acre.
Edward Albright	Ashland	Jackson	12.0	10.18	3584.0
A. W. Lucas	Monmouth	Polk	30.0	27.50	8832.0
D. S. K. Buick	Roseburg	Douglas	25.0	.....†	2385.8
H. C. Perkins	Llewellyn	Lane	18.0	32.50	4386.4
J. Voorhees	Woodburn	Marion	21.5	40 50	6184.2
J. S. Powell	Philomath	Benton	32.7	15.80	9364.6
W. E. Smith	Vale	Malheur	20.0	15.40	7076.0
J. H. Rinck	Buxton	Washington	17.4	9.90	5056.4
John Henry	Beaverton	Washington	5.1	21.10	1287.2
R. Scott	Milwaukee	Clackamas	44.2	53.40	9025.6
J. H. Crow	Lorane	Lane	11.0	9.50	3130.6
C. D. Thompson	Corvallis	Benton	5.1	21.10	1287.2
Average			20.5	23.34	5133.3

So far as reports were received, the cost of production ranged from $11.25 to $24.18 per acre, some including harvesting and some not, which represented all hand work. This subject is treated more definitely later in the bulletin.

Considerable disappointment is felt that farmers to whom seed was sent in the majority of cases did not take the trouble to report more carefully the two items of yield and cost. These are two vital items to the farmer—the very ones which affect him most. It matters little how high a per cent of sugar Oregon beets contain, if they cannot be produced at a price a factory can afford to pay, we may just as well stop all talk about the industry. Right here I desire to urge upon any who may undertake future work the *absolute necessity* of reporting these two items estimated as closely as possible.

EXPERIMENTS OF 1892.—For the investigations of 1892 the following varieties were used, Desprez' Early Rose, Vilmorin Improved, Klein Wanzlebener, and White Imperial, all of which

*The so-called theoretical yield assumes there are 40,000 beets to the acre, which in general holds true for beets weighing less than 800 grams.

†Weight of beet over 800 grams. See previous note.

are favorite kinds, the first being much used in California. Unfortunately the seed was delayed in reaching us, so it could not be distributed to the farmers as early as it should have been to secure the best results. Had the seed reached us in due time, it could have been put into the ground in April for at that time there was favorable weather for seeding, but by the time the seed had been distributed cold weather set in and continued till May, after which the weather became very dry rendering the conditions for a fair trial very unfavorable. The temperature conditions for the season are indicated on the charts given on the following page, which also give the normal temperature for this and the previous season. The rainfall for the season was below the normal and reports all read "very dry," "extraordinary dry," "weather very unfavorable." In fact nearly all the beets in the eastern portion of the state failed to mature, and in many instances the seed failed to germinate. So far as the season's climate is concerned, then, the experiments were greatly handicapped and we were "in pursuit of knowledge under difficulties."

The cultivation for this season was the same as for the previous year except that the rows were placed 20 inches apart.

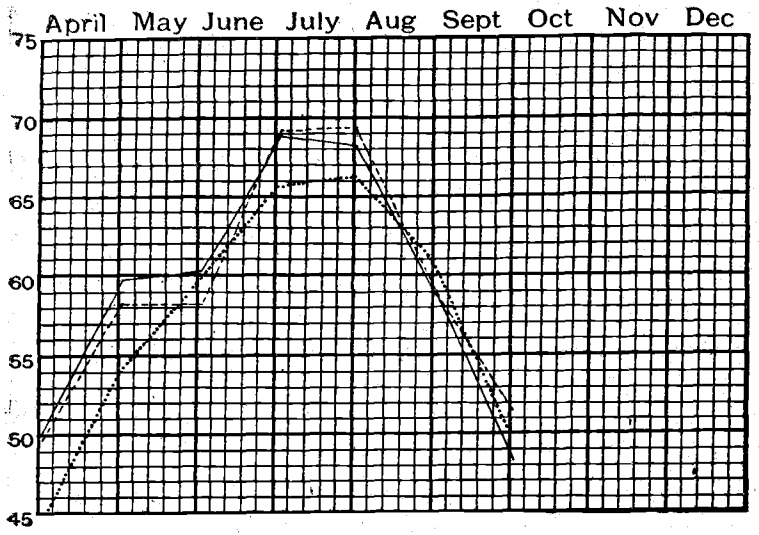
Owing to the disturbed condition of the experiment the results are doubtless poorer than would have been the case had the season been one of more nearly normal condition. Still the results confirm the conclusions of the previous year, that Oregon possesses the conditions necessary for the production of excellent beets for the purpose of beet sugar manufacture.

RESULTS.—Seed was sent to 140 farmers. twenty of whom reported absolute failure of crop on account of unfavorable weather, and two on account of insect pests and squirrels.

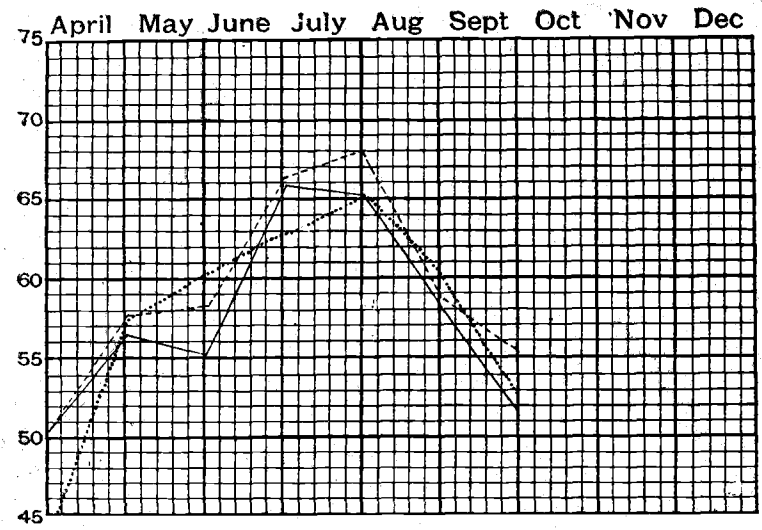
The average of all analyses for the state was 15.7 per cent sugar in the juice, with a purity of 78.08, against 13.75 per cent and a purity of 77.57 for previous season. Out of the 65 analyses made only 11 indicated less than 12 per cent sugar in the juice, and 41 samples indicated over 14 per cent, the extremes being 9.4 per cent and 23.8 per cent. The average for the different natural divisions of the state were as follows:

Willamette Valley, 44 samples.....14.7 per cent.
Eastern Oregon, 11 samples.....19.2 " "
Southern Oregon, 10 samples .....15.1 " "

Comparative Temperature Charts.



Normal for Eastern Oregon ———
Mean for Eastern Oregon 1891 - - - - - -
Mean for Eastern Oregon 1892 .....



Normal for Willamette Valley ———
Mean for Willamette Valley, 1891 - - - - - -
Mean for Willamette Valley, 1892 .....

Expressed by counties the averages are as follows:

TABLE IX

Showing Averages for 1892 by Counties.

County.	No. Analyses.	Average for 1892.	Purity.
Benton	17	12.80	86.50
Clackamas	1	15.10	87.83
Douglas	9	15.20	81.15
Jackson	1	15.00	84.74
Lane	2	15.20	84.05
Lincoln	3	16.20	83 00
Linn	1	17.10	73.74
Marion	2	13.80	74.60
Polk	5	14 50	73.30
Union	7	19 80	87.33
Washington	10	15 50	78.79
Yamhill	5	13.70	82.83
Josephine	2	15.70	88.00
Wasco	1	21.10	90.50
Malheur	1	20.20	84.90

The results of the different varieties of seed have been calculated only for the Willamette valley since in the other portions of the state there was not enough of any one kind used to give any valuable indications.

Vilmorin Improved.....13.4 per cent sugar.....76.2 purity.
Imperial Rose.....14.0 " " " .....84.7 "
Klein Wanzlebener.....15.0 " " " .....81.9 "
White Imperial.....15.9 " " " .....82.3 "

Experiments from 1893-1897.

While no definitely outlined experiments have been conducted since 1892, yet the Station has furnished more or less seed to various parties, who have sent the beets to be analyzed. In other cases beet seed has been furnished by other parties, and analyses have been made in all cases when beets were forwarded to the Station. The average of the results of 23 analyses made since 1892 shows 15.05 per cent sugar in the juice, and a purity of 89.8 per cent. In addition to these analyses, the following were also made, but the beets having received several rains before being sent, which had induced a second growth, and a number of the beets having been grown on alkali soil, the results were not taken into account in making up the averages.

TABLE X.

Lab. No.	Grower.	Av. Weight Grams.	Sugar in Juice.	Sugar in Beet.	Purity.	Solids.	Solids not Sugar.
780	W. G. Hunter	1997	13.6	12.93	70.5	19.3	5.7
779	L. Oldenburg..	1517	12.0	11.40	64.2	18.7	6 7
781	S. F. Newhard	717	5.0	4.75	57.7	8.8	3.8
782	C. A. Dunn.....	419	18.4	17.48	80.0	23.0	4.6
783	A. W. Gillis...	796	14.0	13.30	76.2	18.5	4.5
784	M. Reynolds...	225	10.0	9.50	66.7	16.5	6.5
785	W. A. Messner	474	20.9	19.85	82.5	25.2	4.3
786	A. Goodin.....	290	20.2	19.19	83.7	24.1	3.9
	Average.....	804	14.3	13.55	72.7	19.3	5.0

Average of all Results.

Let us now collect the results which have been thus separately set forth. In the same table I beg to include the averages from analyses made at Washington, D. C., by the U. S. Department of Agriculture. These last mentioned results really indicate a little too high, probably about 10 per cent, on account of the time that necessarily elapsed between harvesting and analyzing, which would result in a loss of water.

Expressed by counties the averages are as follows:

TABLE XI

Showing Average of all Analyses for each County.

County.	No. Analyses	Av. of Analyses made at Station.	Purity.	No. Analyses	Average for U. S. Dept. Agriculture.	Purity.
Benton.....	42	12.57	79.63	5	14.34	82.8
Clackamas.....	8	15.62	78.76	3	15.36	84.2
Columbia.....	1	13.74	79.42	3	15.30	81.7
Coos.....	0	.....	.....	5	14.56	82.6
Douglas.....	18	14.10	77.98	1	17.74	84.3
Jackson	4	17.93	81.00	1	18.94	83.9
Lane.....	18	14.42	80.19	6	14.24	85.4
Lincoln*	....	.....	.....	..	.....	.....
Linn.....	6	14.13	73.43	1	14.15	79.4
Marion.....	4	15.17	74.60	2	14.15	81.1
Polk.....	16	14.54	74.10	1	12.10	79.8
Union.....	30	18.61	85.10	2	14.35	81.8
Washington.....	2	15.29	80.98	3	12.49	80.7
Yamhill.....	7	12.87	82.76	0	.....	.....
Josephine.....	2	15.70	81.21	0	.....	.....
Wasco.....	1	21.10	90.50	0	.....	.....
Malheur.....	1	20.20	83.44	0	.....	.....
Sherman	0	.....	.....	1	13.55	72.2
Umatilla.....	0	.....	.....	1	15.12	80.9
Multnomah.....	1	16.90	76.80	..	.....	.....

*Averaged with Benton County.

If we omit, in making up the average for the state, those samples which indicate less than 10 per cent sugar in the juice (which were very few, as will be observed on examination of the table in the back part of the bulletin) as being beets which had not received proper cultivation, the averages for the state will be

	SUGAR.	PURITY.
For the season of 1891	14.3	78.2
For the season of 1892	15.9	81.4
Since 1892	15.0	84.8
Mean	15.0	81.5

TABLE XII

Showing Results of Varieties in Willamette Valley.

	Sugar.		Purity.	
	1891	1892	1891	1892
Klein Wanzlebener	14.3	15.0	79.0	81.9
Dippe Klein Wanzlebener	13.2	.....	77.1	.....
Vilmorin Improved	13.4	13.4	76.2	76.2
White Imperial	.....	15.9	.....	82.3
Desprez' Early Rose	.....	14.0	.....	84.7

Yield.

Attempts were made in these experiments to secure reliable data as to both the yield and cost as has been indicated above.

Altogether the reports for 1892 were quite complete. The results given are calculated from a measured plot according to the following instructions which were sent with each package of seed.

"When the beets seem to be mature select an average row and gather every plant along a distance which should vary as follows, according to width between rows:

From	rows	16	inches	apart	gather	75	feet.
"	"	18	"	"	"	66⅔	"
"	"	20	"	"	"	59.8	"
"	"	22	"	"	"	54¾	"
"	"	24	"	"	"	50	"

"The number of beets growing in the row, of the length mentioned above, must be counted. The tops are then to be removed, the beets carefully washed free from dirt, wiped and weighed. When the row is not long enough to meet the conditions, take enough from the adjacent row to make up the required length. The number of beets harvested multiplied by 435.6 will give the total number per acre. The total weight of beets harvested multiplied by 435.6 will give the yield per acre."*

Upon the above basis the reports on the following page were made.

*Circular of U. S. Department of Agriculture.

J. S Powell....	Benton	15.8
College Farm.....	"	5.8
G. R. Woodruff.....	"	18.0
"	"	38.0
C. J. Bishop.....	"	23.8
William Bogue.....	"	15.1
Average.....		19.1
A. J. Thompson	Clackamas...	9.3
D. S. K. Buick.....	Douglas.....	25.0
W. L. Tower.....	"	8.2
B. D. Dyer	"	6.7
M. Lemmer.....	"	17.4
J. H. Bard.....	"	40.4
"	"	36.1
W. H. Norcross.....	"	17.4
Average...		21.6
Edward Albright.	Jackson.....	12.0
T. E. Hills.....	"	27.4
Average.....		14.7
H. C. Perkins.....	Lane.....	18.0
J. H. Crow.....	"	9.5
R. S. Reed.....	"	22.8
R. E. Cartwright.....	"	30.2
Average.....		20.2
M. Snyder.....	Linn.....	11.7
W. E. Smith...	Malheur.....	20.2
J. Voorheees.....	Marion.....	21.5
J. W. Beatty.....	"	45.0
Average.....		33.2
A. W. Lucas.....	Polk.....	30.0
J. D. Stewart...	"	21.7
C. D. Nain.....	"	44.4
Average.....		32.0
M. J. Duffy.....	Union.....	5.0
J. E Reynolds.....	"	22.0
Aveage.....		13.5
J. H. Rinck.....	Washington	17.0
"	"	10.0
John Henry	"	5.0
S. P. Reeder.....	"	14.0
J. D. Rowell.....	"	21.0
O. P. Pointer.....	"	8.
Average.....		12.6
M. O. Lownsdale...	Yamhill.....	47.0
J. H. Sample.....	"	6.8
Average.....		26.8
E. F. Meissner.....	Joseph ne.....	15.2

Segregating the results of 1892 from those of 1891, it is found that notwithstanding the unfavorable season the average yield for the state was 23.18 tons per acre against 20.5 tons for 1891.

The average yield reported in California in 1896 was 14 tons per acre. The following averages have been obtained in other states :

Minnesota.....	15.0	tons per	acre.
Wyoming.....	7.5	" "	"
South Dakota.....	8.1	" "	"
Nevada	20.0	" "	"
Colorado.....	26.0	" "	"
Iowa.....	20.0	" "	"
Indiana.....	30.0	" "	"
New York.....	19.5	" "	"

With the exception of California, the yields above given were obtained in experimental culture as in Oregon. That from California was based upon actual results obtained by farmers in producing beets for the factory. Other results obtained in the same manner are as follows :

TABLE XIII.

	1891	1892	1893	1894	1895
Lehi, Utah....	6.60	6.50	9.70	11.47	11.54
Chino, California.....	7.26	7.50	11.70	9.16	11.03

One striking feature in the above table is the increase in yield after the first two years—after farmers had become

acquainted with methods of cultivation. To produce the highest yield, both in tons and in the per cent of sugar, requires a certain amount of skill, which has to be learned by careful observation and study, which fact is illustrated in the above table.

Mr. John Henry, of Beaverton, and Mr. R. Kuhne, of Tigardsville, Oregon, both undertook quite carefully conducted experiments during the past year. The former reports a yield of 10.5 tons per acre, which cost $42.89, not including delivery to the factory. Concerning the cost Mr. Henry writes:

"In this experiment the cost per acre of beets is far too high. I put the seed in with a hand instead of a horse drill, and dug with a spade instead of a horse puller.

"The fact which I sought was the cost between the time the seed was in the ground till the crop was ready to dig, with labor costing 10 and 12½ cts. per hour, and it was just $12.14. In the total is included

Preparing the acre	$5.00
Seed, 8¾ pounds	2.62
Interest on land	8 00.

"The ground had an ordinary plowing in March, and was plowed ten (10) inches deep, and seeded May 21st. Previous crop was corn, manured."

It should be stated that Mr. Henry's beets were excellent samples, analyzing 18.3 per cent sugar in the juice, with a purity of 86.7. For such beets as these a factory would pay about $5 per ton.

Mr. Kuhne's report showed a yield of 13 tons per acre, which cost $35. These beets would have commanded from $4.50 to $5.00, according to their sugar content which in all cases was high, and the purity exceptionally good, thus giving a return of about $60 per acre, or a profit of $25.

I consider these results quite trustworthy, and fairly indicative of what may be expected from careful, intelligent work. Mr. Henry is a very careful worker, and has had much experience in vegetable growing. Mr. Kuhne has had many years experience both in Germany and this country in growing beets for sugar purposes.

It is evident that, as with every other crop, the yield and cost of beets must necessarily depend upon many things, as variety, distance between rows, soil, cultivation, and season, hence this will always be a more or less varying factor. I think, however, that for the Willamette Valley and Southern Oregon in general, when farmers have become accustomed to the business, an average of 15 tons per acre is a very conservative estimate.

In Eastern Oregon the uncertainty of the season renders the ability to irrigate almost an essential condition, and if this is met, there can be little doubt but that the yield would even exceed that for the Willamette Valley.

Turning elsewhere for additional information I offer the following from the Watsonville *Pajaronian* which gives a review of the cost and returns from sugar beet crops in the Pajaro valley during 1891. In explaining the results the writer says the results are taken from the cultivator's own figures. In each instance the land belonged to the beet grower, and his estimated value of the rent given. In the article mentioned there are given statements of ten growers of which we select the lowest, and the highest.

L. E. PEARCE—15 ACRES.

"Plowing and preparing land, $5 per acre—31 cents per ton—total $75. Seed, $1 02 cents per acre–6 cents per ton–total, $15.30. Hoeing, thinning, topping and loading into wagon, $24.23 per acre–$1.50 per, ton–total, $362.45. Plowing out and hauling, $8.08 per acre—50 cents per ton—total, $121.20. 241,147 tons yielded $1205.73; profit per acre, $42.05; per ton, $2.63; estimated rent of land, $15 per acre—93 cents per ton."

J. PEDERSEN—15 ACRES.

Plowing and preparing land, $7 per acre—30 cents per ton—total $105. Seed, $1.09 per acre—5 cents per ton—total, $16.35. Thinning, hoeing, topping and loading into wagon, $28.43 per acre—$1.20 per ton—total, $426.45. Plowing out and hauling, $9.48 per acre—40 cents per ton—total, $142.20. 350.17 tons yielded $1,750.86; profit per acre, $70.72; per ton, $3.05; estimated rent of land, $20 per acre—84 cents per ton.

I also present the statement of four growers near the Chino factory, which shows the cost to the time of harvesting.

STATEMENT OF F. MOORE.

Preparing soil, 20 acres	$58.75
Seed, 302 lbs. at 12 cents	36.24
Planting	13.00
Thinning	75.00
Hoeing	24.00
Cultivating	27.50
Total expense	$234 49
Expense per acre	11.72

STATEMENT OF W. C. RIGHTMIER.

Preparing soil, 17 acres	$68 90
Seed	20 40
Planting	6.80
Thinning	88.40
Hoeing	34.00
Cultivating	34.00
Total expense	$251.60
Expense per acre	14.80

STATEMENT OF BRENTTINGER & TIFFANY.

Preparing soil, 50 acres	$150.00
Seed, 15 lbs. per acre, at 12 cts.	90.00
Planting	20.00
Thinning	308.00
Cultivating	25.00
Hoeing	60.00
Total expense	$653.00
Expense per acre	13.06

STATEMENT OF MR. PRIMS.

Preparing soil, 10 acres	$25.00
Seed 108 pounds	12.96
Planting	4.50
Thinning	45.25
Hoeing	54.00
Cultivating	11.50
Total	$153.21
Expense per acre	15.32

PART III.

Cultivation.

Too much cannot be said upon this subject. for *in the cultivation lies the secret of success in sugar beet culture.* It has been said, "The sugar is hoed into the beet," and this is literally true. The foregoing results were all obtained while the farmers were entirely unfamiliar with the careful culture so essential to success in this industry. The sugar beet is a thoroughbred, and needs close attention. When neglected it will show a double resentment by giving (1) a small sugar content and low purity, (2) a small yield. Small size, regular tapering roots, growing entirely below the ground are three essential points to be secured in beet culture. Whatever method of cultivation be followed, these three points should ever be the object. In many cases all three had been neglected in the cultivation of the beets above described, the directions to the contrary notwithstanding. This has undoubtedly had the effect of lowering the average for the state by at least one per cent.

I consider the beets produced by Mr. Henry and by Mr. Kuhne, before mentioned, as being the most indicative of what may be expected in Oregon, when growers understand the cultivation of beets for sugar purposes. Particularly do I think this is true of Mr. Kuhne's beets, for the gentleman for many years was connected with the Oxard factory in Nebraska as an expert grower of beet seed. These beets were received Oct. 1, and gave the following results:

TABLE XIV

Showing Analyses of Oregon Beets Produced by an Experienced Grower.

Lab. No.	Av. Wt. in grams.	Sugar in Juice.	Purity.	Variety.
748	275	17.0	91.4	Klein Wanzlebener (German Seed.)
749	337	16.6	89.2	Vilmorin, Blanche ameliore (Fr. ")
750	268	17.8	88.2	Kuhne's Improved (Nebraska ")
Av.	290	17.1	89.7	

The above samples had received the first rains. On Dec. 8, after the second heavy rain, beets from the same plats were again subjected to analysis.

PLATE III A. SUGAR BEET FIELD.

TABLE XV.

Lab. No.	Av. Wt. in Grams.	Sugar in Juice.	Purity.	Variety.
761	222	16.5	81.1	Klein Wanzlebener (German seed.)
762	198	14.0	77.7	" (Nebraska ")
759	329	15.4	93.0	Vilmorin Blanche ameliore (Fr. ")
760	.....	12.4	90.7	" " " (Nebraska ")
758	158	13.6	85.0	Kuhne's Improved (Nebraska ")
	236	15.2	86.3	Av. of same varieties as in table XIV.

Mr. Henry's beets gave the following results:

TABLE XVI

Showing Analyses of Well Cultivated Beets.

Lab. No.	Av. Wt. in Grams.	Sugar in Juice.	Purity.	Date Received	Variety.
732	281	18.3	86.7	Sept 22 96	White Imperial, German
756	279	18.8	92.1	Nov. 2, 96	" " "
757	279	16.1	71.2	Nov. 2, 96	Klein Wanzlebener
		17.1	83.3		Average.

When these results are compared with those of other states in which the cultivation has become reasonably good, I think it will be admitted that Oregon need stand second to no state in producing beets suitable for sugar purposes. Prof. Wiley in his notes on the analyses made at the U. S. Department of Agriculture, says: "The samples from Oregon are uniformly rich in quality, and if they truly represent the capabilities of the state, there is certainly a bright future for the sugar beet industry on that portion of the Pacific coast."

If we turn to either California or Utah, we will find evidence that in neither place did the farmers at first reap the greatest rewards, and this could not be expected in Oregon. In these two states there has been a progressing richness of the beet as better methods of cultivation were adopted, as instance:

TABLE XVII

Showing Effect of Improved Culture.

STATE.	1891	1892	1893	1894	1895
California, Chino.....	13.0	14.0	14.0	15.0	15.0
Utah, Lehi...	11.0	11.8	11.6	12.1	13.5

Not only has the sugar per cent increased, but also the yield per acre:

YEAR.....1891	1892	1893	1894	1895
Utah, tons.....6.60	6.50	9.70	11.47	11.57

A small beet is desirable, for the sugar content and purity varies inversely as the size of the beet. The size of the beet can be largely governed by close planting, which not only gives a richer beet but also a greater yield. Pagnoul has conducted experiments extending over 8 years intending to show this.

DISTANCES APART IN INCHES.	PER CENT SUGAR.	YIELD PER ACRE.
Wide distance, 20 × 20	10.2	28.40
Narrow distance, 17 × 8	12.2	36.05

The same may be shown by the following Oregon produced beets, selected at random from the tables:

TABLE XVIII

Showing Quality of Small and of Large Beets.

SIZE.	VARIETY.	Weight in Grams.	Per cent Sugar in Juice.	Purity.
Small.	White Imperial	192	20.60	84.32
"	Klein Wanzlebener	341	19.00	67.80
"	White Imperial	250	16.70	88.30
"	Early Rose	165	17.70	76.60
"	Klein Wanzlebener	236	16.20	76.04
"	Vilmorin	350	18.00	82.13
Average..		256	18.00	76.19
Medium.	White Imperial	538	14.70	71.80
"	Klein Wanzlebener	865	14.15	81.79
"	White Imperial	803	10.90	83.20
"	Desprez Early Rose	980	14.00	82.90
"	Klein Wanzlebener	920	15.99	78.38
"	Vilmorin	1021	13.40	54.10
Average..		856	13.86	75.36
Large.	White Imperial	1623	14.00	74.20
"	Klein Wanzlebener	1880	14.41	80.55
"	White Imperial	1416	19.30	77.20
"	Desprez Early Rose	1970	11.90	85.00
"	Klein Wanzlebener	1700	12.88	80.00
"	Vilmorin	1700	9.81	68.12
Average..		1715	13.71	77.51

Thus it is seen that the method of planting conducive to the production of beets rich in sugar, also gives the largest yield.

Good cultivation demands that the beet root be entirely below the ground. If above ground the sugar content decreases rapidly in the upper portion, which under any circumstances is the poorest in sugar which fact is well shown in the following tables:

TABLE XIX

*Showing Effect of Good Cultivation.**

		Amt. of sugar	Purity.
Well grown, average of	top	15.5	82.7
	bottom	16.6	83.0
Poorly grown, average of	top	11.4	69.9
	bottom	13.6	77.2

Also from beets analyzed at the Station:

TABLE XX

Showing Relative Quality of Top and Bottom of Root.

	Sugar in Juice.	Purity.
Top of No. 782	17.0	76.6
Middle of No. 782	18.6	83.4
Bottom of No. 782	20.4	86.8

The matter of securing good beets rich in sugar, as well as a good yield, is almost entirely dependent upon careful cultivation. They cannot be produced on a large scale by any one person, nor in as careless a manner as most crops. The industry offers no inducement for the naturally tired farmer. The sugar beet requires much work, but when well cared for will give larger returns. There is no royal road to wealth even through the sweetness of the sugar beet.

The soil requires special preparation. The first plowing, which should be in the fall, should be followed by a spring plowing to a depth of not less than 10 inches, and almost without exception in Eastern Oregon and the Willamette Valley the ground should be sub-soiled to a depth of 15 inches. This I deem essential in portions of Oregon to prevent the beet from growing out of the ground. If the beet comes in contact with a hardpan, it is pushed directly upward by its own growth, and in most cases the root splits into several branching prongs, as illustrated in *Plate III.*

Allow to lie until about one week before the time for seeding. Then plow once more to a depth of 4 to 5 inches, and work the soil into a fine and *light* condition (i. e., do not pack it down with a drag.) After allowing land to lie 5 to 7 days plant the seed. The object of allowing the interim is that sufficient mois-

*Bulletin 67, Ontario Experiment Station, Guelph.

ture may be drawn from below for the germination of the plant, and that the land may be warmed by the sun, after pulverization. No manure should be applied unless in the shape of well-rotted compost put on in the fall. In ordinary soil the rows should be eighteen inches apart: in very rich less; and in poor soil more than that distance apart. The conditions should be such that the beets can not attain a greater weight than two pounds each. The seed should be planted one-half to three-quarters of an inch deep, and about 20 pounds of seed used to the acre. The seed may be soaked before planting, which should be done as early in April as the conditions will allow.

The cultivation must be thorough, and should begin as soon as the plants show in the row. When the beets have put out four leaves thin them out so as to leave the plants standing about six inches (not farther) apart in the row. The weeds should be kept down and the ground well stirred.

Several special tools have been devised for the cultivation of the crop, a description of which can be found in the publications of the U. S. Department of Agriculture. These, however, will only be needed in case the industry should attain a footing which demands a large supply of beets. As soon as the beets begin to to show any tendency to grow out of the ground, earth should be well ridged up along the rows to cover the upper part of the beets.

The beets should not be harvested till perfectly ripe, which will be indicated by a yellowish green color of the outer leaves, which fall and form a wreath around the plant.

Just what will be found the *best* method of keeping beets after they are ripe, till they can be used at the factory, cannot be answered at present with any degree of certainty It may be found possible in Eastern and Southern Oregon to leave the beets in the ground till needed at the factory. This would be possible if it is found that the slight second growth which might be induced would not cause a greater loss of sugar than would be occasioned by siloing. If this method can be practiced it means a material saving in handling the crop. If the loss by such a method is too great, then either the silo, consisting of a pit lined with straw, or sheds, as used at Norfolk, Neb., shown in the accompanying illustration, which also well illustrates the magnitude of the industry as there operated, may be used. Either of these

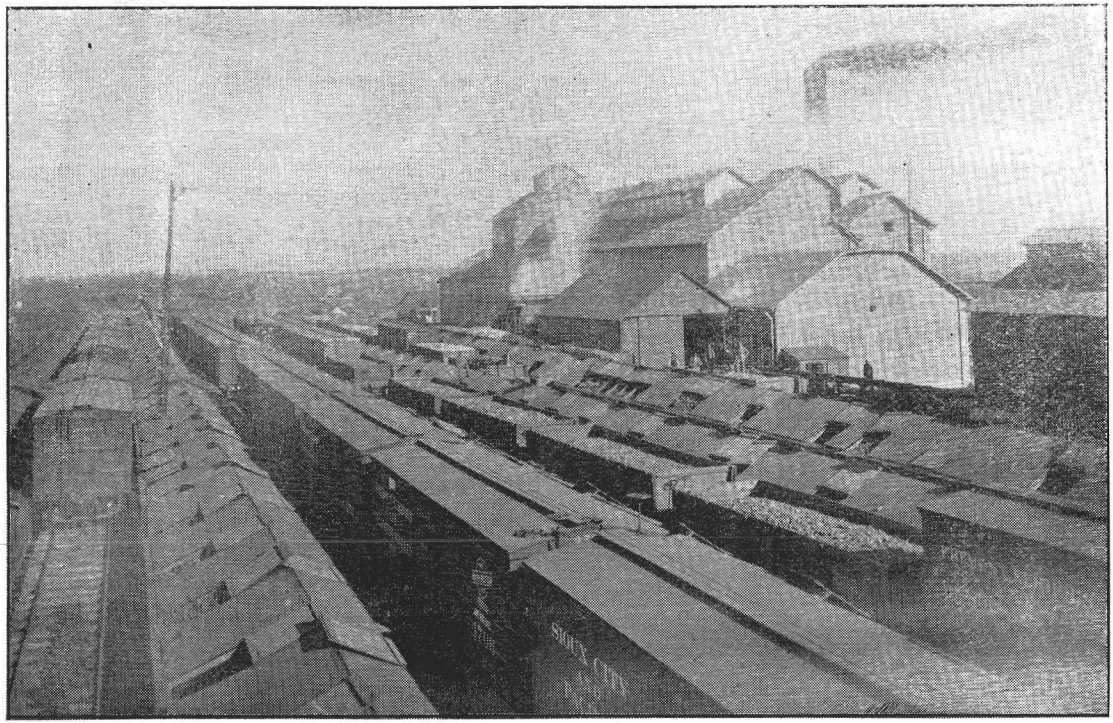


PLATE III B. EXTERIOR OF BEET SUGAR FACTORY, NORFOLK, NEBRASKA.

methods, I am satisfied can be used successfully in the eastern or southern part of the state, but in the Willamette Valley probably the shed will be the only feasible means. Experiments are to be made this season to determine the rate of decrease in sugar content and purity by allowing the beets to remain in the ground till used.

The producing of beets rich in sugar is an important matter from a financial standpoint, for it costs nearly as much to produce beets containing the minimum of 12 per cent sugar, as to produce those carrying 18 per cent. The former would bring but $3.50 per ton, or, assuming a yield of 12 tons per acre, an income of $42 per acre, while the latter would bring $4.50 per ton, or $54 per acre, which is a very material difference.

The growing of beets is particularly adapted to small farms, and offers remunerative employment to nearly the whole family. Much of the work can be done by the children, thus giving fair returns for their labor. as well as the profit on the crop.

Further the industry is bound to show results in a better system of general farming, for it will induce careful attention to the best practice in order to obtain the optimum results. He who produces the best quality of beets will obtain the best price for his product. Hence the industry will be an educational one in the truest sense.

Beets Instead of Bare Fallow.

If farmers undertake sugar beet growing the crop should be one of rotation. This could well be substituted for the bare fallow, to which wasteful practice so many farmers in this state are wedded.

It has been found both in Europe and in this country that it is much more profitable, as well as better for the land, to raise a crop of beets than to allow the ground to lie fallow. Instead of substituting beets for some other crop they should be made supplemental to those at present available. No farmer should think of giving up cereals or potatoes for beets; but he can, by proper culivation, devote one-fifth of his land to beet culture and raise as much from the remainder as though none of the land was occupied by beets. There is no crop which could better fall into a rotation suitable to Oregon than sugar beets. In California it has been found a most excellent crop to precede barley, giving both a better yield of grain and a better quality.

In this connection let us use the words of Mr. E. H. Dyer, taken from a circular sent in 1885 to the members of congress. In relation to establishing the industry in California, he says:

"One of the greatest obstacles we had to contend with, was to induce the farmers of California to cultivate beets in a manner to be profitable to manufacture into sugar. We had to convince them that beets properly raised for sugar were not exhaustive to the soil. We have, at this time, overcome most of the farmers' prejudices, and now have no difficulty in obtaining an abundant supply of beets, cultivated properly for sugar. Our farmers have ascertained by actual experience, that beets are very desirable to rotate with other crops; cereals raised on land planted to beets the preceding year give large returns."

This is the more true since the beet is not exhaustive to the soil, and the richer the beet in sugar the truer is the above statement. The sugar is produced by a combination of carbon dioxid from the air with water, and investigation shows that the salts of the beet are inversely proportional to the sugar. The part of the beet which removes the largest amount of mineral matter, i. e., the leaves and crown, is either returned to the soil directly, or indirectly by being fed to stock.

Enemies.

It is not proposed to discuss this subject at length in this Bulletin. There were but few pests reported as troubling the sugar beet. The most to be feared is perhaps, *Monoxia guttulata*, (Lec.) as reported by Prof. F. L. Washburn, and described in Bulletin No. 14, of this Station.

There was also sent to this Station, and referred to the Entomologist, another insect which was said to be troubling the beets raised in Clackamas county. This pest, known as the "flea beetle"--*Phyllotreta decipiens* (Horn), belonging to the family *Chrysomelidae*, is about ⅛ inch long, and of a black color. With other members of the same family, it has the femurs of the hind pair of legs strongly developed, and when alarmed jumps with so much alacrity that it is difficult to catch, hence the popular name of the family. They are found on radishes, turnips, potato vines, etc. It is not likely that they are a serious enemy of the sugar beet.

The "cut worms" were also reported to have caused considerable damage to the beet in Central Oregon. In fact, they were reported as having in some instances destroyed the entire crop.

Gophers also caused some trouble in Benton county, and are said to have shown a decided preference for the sugar beets.

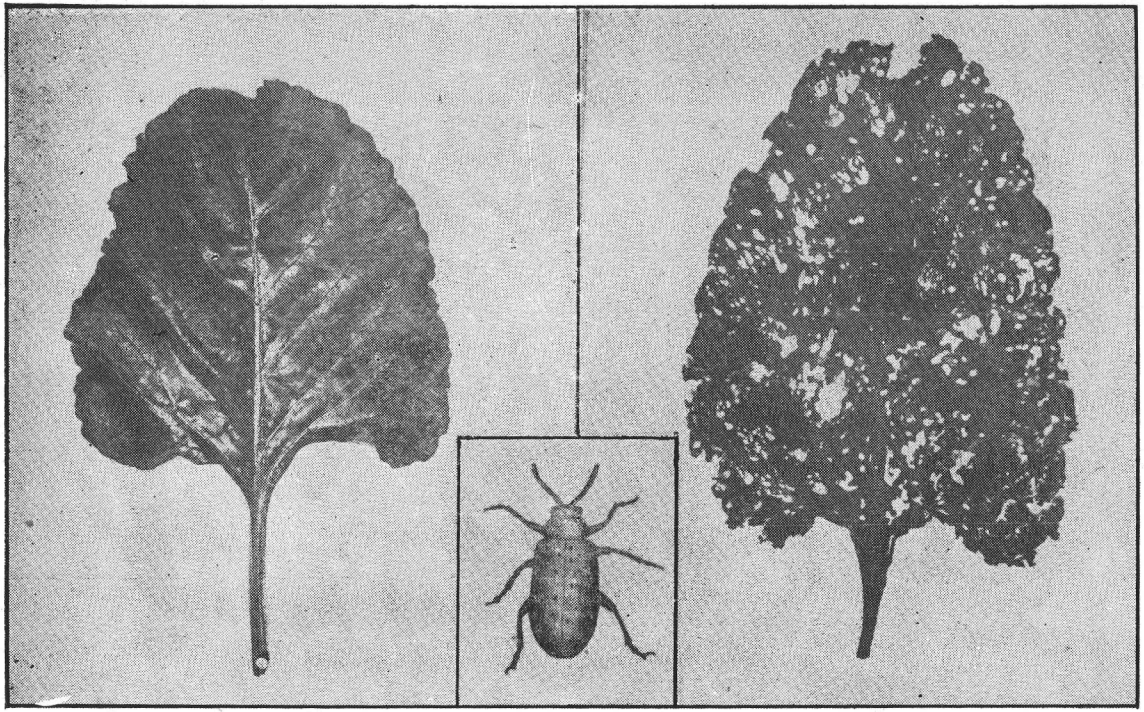


PLATE IV, *MONOXIA GUTTULATA* AND ITS WORK.

PART IV.

The Factory.

One of the most frequent questions asked is concerning the location and cost of a sugar factory, hence I deem it advisable to present here such information as can be given briefly.

Before considering the cost it is well to determine whether or not all the requisites can be furnished, for the cost will be governed by these considerations.

The first requisite is *an abundant supply of pure cool water*, which is absolutely indispensable. A factory of 300 tons capacity uses daily no less than 1,000,000 gallons of water.

Second, there must be *an adequate supply of fuel*, which can be had at a reasonable cost. The cost of fuel at other places is given elsewhere in this Bulletin. A factory of the above named capacity would use about 100 tons of coal, or its equivalent per day.

Third, *good transportation facilities* are essential, hence, other things being equal, it is best to locate where both river and railroad transportation can be secured, and usually near some center of population, although the latter is not absolutely essential.

Fourth, *there must be an available supply of suitable limestone*, of which about 3 car loads per day are used. It ordinarily requires a ton of lime to each ton of purified sugar.

Fifth, *the enterprise requires a large capital* to erect buildings, purchase expensive machinery and secure skilled labor. It is often asked if a factory could not be started on a small scale by the coöperation of a few farmers. Suffice it to say that experience has amply demonstrated this to be entirely impracticable. The average capital invested in a factory using 350 tons of beets per day is about $500,000. Such a factory would expect to run 125 to 150 days which period is called the campaign. To carry on the work of such a factory about 200 men would be required, of which the following must necessarily be skilled labor, a superintendent, and an assistant, ten employes skilled in diffusion, etc., a chemist, and a machinist. These would be sufficient for train-

ing others in the business.

Dr. Wiley, chief of the Division of Chemistry, Department of Agriculture, in Bulletin 27, says:

"The cost of a beet sugar factory depends on so many conditions that it will be impracticable to give anything more than a rough estimate of it. Much depends on the character of the building itself, and this, for various reasons, should be made fire-proof, thus entailing the constructon of a building of considerable cost. In regard to both the building and the machinery, the total cost will depend largely on the capacity of the house; the cost, however, does not increase in the same ratio as the capacity. In other words it may be stated that the cost of a beet sugar factory capable of working 400 tons of beets per day would not be double the cost of one working 200 tons. A beet sugar house based on an estimate of 300 tons per day would probably be more in keepin with the character of the houses that which are to be built in this country for sometime to come than any other. With a proper fire-proof building, and the best and latest machinery, such a factory would cost, ready for work, from $150,000 to $200,000. Factories, of counse, can be built at much less cost than this, but doubtless at the sacrifice of efficiency in some of its parts, so that true economy would advocate the construction of a high priced factory of the best workmanship and of the most approved style."

Mr. M. Swenson, of the Walburn-Swenson Company, of Chicago, manufacturers of sugar machinery, writes to the Wisconsin station as follows:

"The cost of the machinery complete in every particular for a beet sugar factory having a capacity of from 300 to 350 tons of beets per day, including all pumps for water supply, boilers, engines, etc., the whole to be of the very best design and workmanship, and capable of making white sugar direct from the beets, without any refining would be in the neighborhood of $170,000 on cars in Chicago. The machinery for a factory having double this capacity would cost about $260,000.

"These prices you will of course understand are somewhat approximate as prices vary very much.

"The cost of a first-class brick building, including boiler house for the smaller sized factory, would be from forty to fifty thousand dollars. This would also include foundations, lime kilns, etc. Just what the cost of the sheds for holding the beets would be I cannot say, but I am of the opinion that four or five thousand dollars would be suficient to cover this item. All the castings, etc., for the lime kilns are included in the price of the machinery, and the brick work would be easily within the above cost of buildings.

"A building for the larger plant would probably cost $75,000 if put up in every way first-class.

"There is no doubt but there is much misconception as to the cost of a factory of this kind, and many people write us thinking that with an old building and a second-hand boiler and engine that has been used for some other purpose, they have a good nucleus for a beet sugar factory, and that for twenty or thirty thousand dollars it can be all fitted up. Any attempt of this kind is simply throwing money away, and it would be a great misfortune to the beet sugar business to have it gone into without sufficient capital to erect a factory of proper size, as well as of the most modern construction."

A sixth requisite for a factory is *an unfailing supply of beets*. To supply the demands of a factory of 300 tons of beets per day

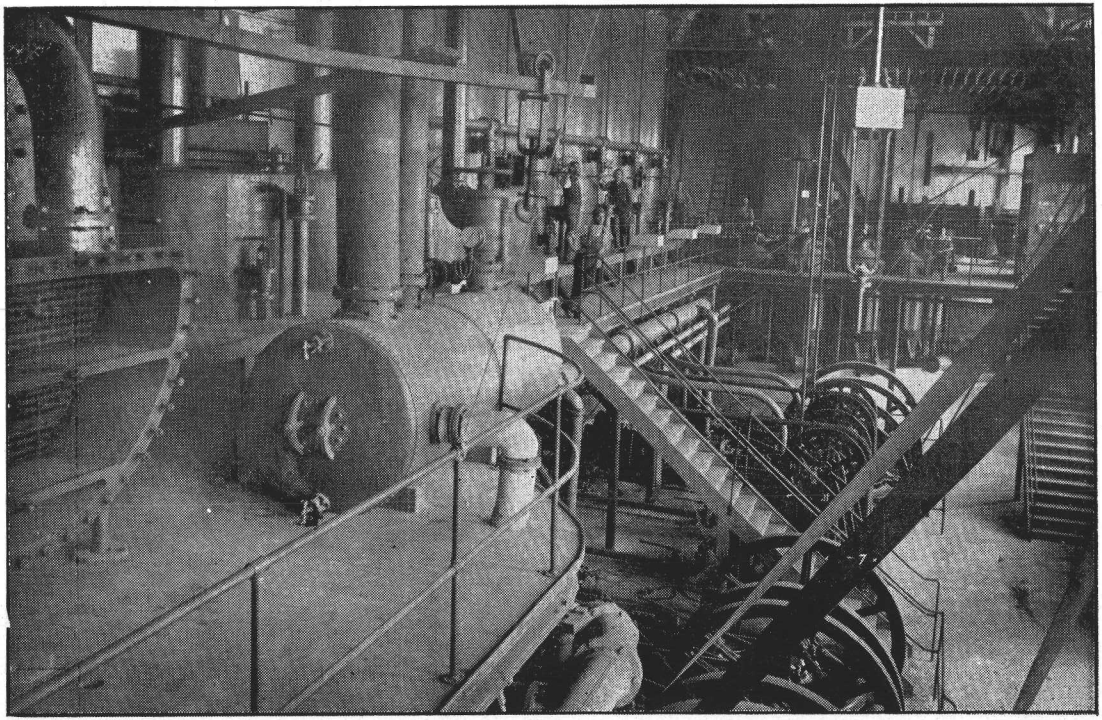


PLATE V. INTERIOR OF BEET SUGAR FACTORY, NORFOLK, NEBRASKA.

would require about 3000 acres of land each year. Since beets should not be produced two consecutive years upon the same soil 6000 acres of beet land must be available.

THE MANUFACTURE OF SUGAR.—The campaign in countries where early frosts interfere is of about 100 days duration, but in Oregon it could be extended to 150 days, or even longer, by storing the beets as before described. A detailed description of the process of sugar munufacture would not be in place in this publication, hence only a short resume is inserted.

The beets, after leaving the storage bins or pits, are thrown into canals, and by machinery washed free from dirt. By revolving knives they are cut into thin slices or "cosettes," which are macerated in water, in this process passing through a battery of several cells, known as juice stations, which remove all the sugar. The juice is now passed to a cooling reservoir, after which it is purified by means of lime, carbonic acid and filter process. The purified juice is now evaporated in vacuum pans to a kind of sugar containing about 6 per cent of water. This is known as "masse cuite." This is passed to a centrifugal machine, or granulator, where it is dried and sifted into a hopper, from which it is drawn into barrels or sacks ready for the market as granulated white sugar. The syrup is reboiled and again passed through the granulator. The chips are used for cattle food, the press cakes and other refuse are used for fertilizing purposes, and the waste syrup used for the manufacture of alcohol. When beets are sound it takes about 15 hours to convert them into granulated sugar. If they are frozen it takes a little longer.

The manufacturer has practically all the risk to run, unless he can actually be assured of a sufficient supply of beets. If he cannot be thus assured, of course we will have no factory, for no man or combination of men would invest much capital in an enterprise which would be entirely at the caprice of the farmers. The question as to whether or not farmers should grow beets depends upon whether or not factories are established to use the beets, and *vice versa*, hence it is a question of double issue and can only be solved by coöperation. It is a lamentable fact—yet no less a fact—that the farmer looks upon the manufacturer as one who is, at all times and under all circumstances, trying to get the better of him, and this serves as a great barrier to success in

the production of beet sugar. In this industry, as in no other, are the producer and the manufacturer linked hand in hand, and what is money in the pocket of one is also money in the pocket of the other. It matters not how well equipped and manned a factory is unless it is amply supplied with beets it is doomed to failure. In Nebraska two factories existed several years before farmers supplied beets sufficient for a profitable campaign.

If Oregon enters the arena, it must be with the most modern appliances. If this cannot be done we would best not undertake the enterprise. It is best to go slow but sure in a matter of so great moment, for a failure from lack of beet supply would be a serious blow to future work. Let farmers coöperate in thoroughly investigating and satisfying themselves as to the cost of producing good beets. The Station stands ready to determine the quality of the beets free of cost, and to publish the results, provided the experiments are conducted in accordance with our directions. Let meetings be called and definite work be planned. For determining the cost of cultivation ordinary seed may be used, and the crop can be utilized as feed for cattle. Each farmer who enters upon the experiment should plant several rows of genuine sugar beet seed in order to determine the quality of the beets he is able to produce. This seed cannot be had of the regular seed dealers, but must be obtained from some of the factories. The Station will furnish directions for cultivation free of cost, or they will be found in this bulletin.

It is of little use for a few farmers in each county to plant a few rods of beets. The work should be done on a larger scale, and undertaken as a business proposition, in order that very tangible results may be secured as a basis for future work. It is already demonstrated that Oregon can produce beets rich enough in sugar, but it is not yet proven that she can produce them in sufficient quantities to supply the needs of a sugar factory. Cooperation of farmers is needed for this work from now on, and it is hoped that various farmers' organizations will take hold of the matter in a determined and systematic manner. It is a matter of supreme importance to the farmers of the state, particularly in Southern and Eastern Oregon. Will the farmers organize for the work? We shall be glad to advise with any organization having the above object in view.

Resume.

The development of the beet as a sugar producing plant dates from 1847. It now yields from 15 to 20 per cent sugar and furnishes about one-half of the world's sugar supply. The early history of beet sugar manufacture in this country was marked by several failures, but for several years past factories have been operated successfully in California, Nebraska and Utah. Factories have also been erected in Wisconsin, New Mexico, and New York.

A good sugar beet should weigh about 1¾ lbs., should contain about 14 per cent sugar, and should have a purity of 80 per cent.

Systematic experiments in sugar beet culture were conducted during the years 1890—1892 to ascertain if Oregon could produce such beets.

Oregon is in the sugar beet belt. In the matter of climate the state is well suited to the conditions demanded by the sugar beet. (See map on page 14, and temperature charts pages 13 and 23.)

The apparent difference in rainfall from that of foreign areas should not be considered a too serious drawback, for the *seasonal precipitation in the Northwest, as in California*, is the influencing factor in crop production. When thus considered the precipitation compares well with areas now successfully producing beets for sugar purposes.

Any good wheat soil is a good beet soil, but beets are most grateful for a deep sandy loam. Oregon soils are abundantly supplied with phosphoric acid, the indispensable element for successful beet production, which fact is likely to bring the beets to an early maturity.

In the experiments the standard varieties of seed were used. In the experiment of 1891 it was impossible to plant seed till May, while ordinarily it can be done early in April. The beets did not receive as good cultivation as was desired.

In 1891, of the 95 analyses made, only 8 fell below 10 per

cent, 76 showed over 12 per cent and 37 over 14 per cent sugar in the juice. For the entire state the average sugar content was 14.13 with a purity of 78.08. The average reported yield was 20.5 tons per acre.

Of the three varieties, original Klein Wanzlebener, Dippe Klein Wanzlebener, and Vilmorin, the first gave the best results.

The experiments of 1892 were handicapped by a "very dry" and unfavorable season. The average of all analyses for the state was 15.7 per cent sugar in the juice and a purity of 78.08.

Of 65 analyses made 41 showed over 14 per cent, and 11 showed less than 12 per cent. The range was from 9.4 to 23.8, but most of those running below 12 per cent were immature beets. Forty-four samples from the Willamette Valley showed 14.7 per cent sugar in juice; 10 samples from Southern Oregon showed 15.1, and 11 samples from Eastern Oregon, 19.2. White Imperial variety gave the best results, being above Klein Wanzlebener, Imperial Rose, and Vilmorin in the order named. The average reported yield was 23.18 tons per acre.

The average of the results of 20 analyses made since 1892 is 14.9 per cent sugar in juice with a purity of 89.8. Discarding poorly cultivated beets the mean of all analyses for the above three periods is 15 per cent sugar in the juice and 83.1 per cent purity.

Of the varieties previously mentioned White Imperial and original Klein Wanzlebener have given the best results in the order named.

Experience elsewhere shows that the highest results are not obtained by farmers at first, but that both the sugar content of the beet and the yield increase as farmers become more careful in the culture.

The cost o cult vation in Oregon will not be far from $35 per acre. Twelve tons per acre is a very conservatively estimated yield.

The sugar beet is a thoroughbred, and demands very careful cultivation. The sugar is hoed into it.

The sugar and purity are both lowered by a second growth. Three samples eets grown by an experienced grower gave 17.1 per cent sugar, and 89.7 per cent purity on Oct. 1. On Dec. 8, after the second heavy rain beets from the same plats analyzed

15.2 per cent sugar, and 86.3 purity.

A small beet, with the root grown entirely beneath the soil, is demanded. This can be had by close planting and proper cultivation. The method conducive to the production of the most sugar also gives the largest yield in tons. The matter of securing good beets rich in sugar is almost entirely dependent upon careful cultivation.

Soil for beets should be thoroughly pulverized and sub-soiled to a depth of 15 inches. Seed should be soaked in urine and water before planting, which should be done in April. Keep absolutely free from weeds, and the soil well ridged up along the the rows of beets.

The growing of beets is particularly adapted to small farms, offering employment for the whole family.

The beet crop should be one of rotation, and should replace the bare fallow as it is better for the land.

A factory would cost about $200,000. The requisites are an abundant supply of water, fuel, and limestone, good transportation facilities, and an unfailing supply of beets.

If Oregon engages in the business, and hopes to succeed, it must be with the most modern appliances.

It is already demonstrated that Oregon can produce beets sufficiently rich in sugar, and with an exceptional purity. The question now before the farmer is, can he produce them in sufficient qnantity and at a sufficiently low price. Coöperation of farmers is urged to settle this question.

The Station offers to direct the work, analyze all beets and publish results free of cost.

Table XXI

Showing Analyses of Sugar Beets, 1891-1896.

	GROWER.	LOCALITY. POST OFFICE AND COUNTY.	SUGAR. Weight in Grams.	Sugar in Juice.	Sugar in Beet.	Solids not Sugar.	Brix.	Purity.	Pounds Sugar Per Ton.	VARIETY OF BEETS.
1	Ewd. Albright	Ashland, Jackson	244	14.00	13.1	5.3	19.3	72.53	280.0	Klein Wanzlebener.
2	A. W. Lucas	Monmouth, Polk	624	14.72	13.3	4.2	18.8	78.08	294.4	" "
3	D. S. K. Buick	Roseburg, Douglas	1700	9.81	9.3	4.6	14.4	68.12	196.2	
4	"	" "	1140	10.07	9.1	3.9	14.0	71.21	201.4	Vilmorin Improved.
5	J. Voorhees	Woodburn, Marion	920	15.99	14.6	4.4	20.4	78.38	319.8	Klein Wanzelebener.
6	H. C. Perkins	Llewellyn, Lane	739	17.06	16.0	4.3	21.3	80.09	341.2	" "
7	"	" "	600	14.96	12.7	5.3	20.3	69.26	299.2	
8	L. F. Wilson	Corvallis, Benton	389	13.46	10.9	6.3	19.8	66.36	269.2	Unknown.
9	College Farm	" "	375	13.28	12.0	4.4	16.4	80.97	265.6	Vilmorin.
10	H. C. Perkins	Llewellyn, Lane	1200	17.70	16.1	4.3	22.0	80.45	354.0	Klein Wanzlebener.
11	College Farm	Corvallis, Benton	335	12.03	11.4	3.1	15.2	79.91	240.6	Lane's Imperial.
12	" "	" "	250	12.39	11.6	2.5	14.9	83.15	247.8	" "
13	" "	" "	330	14.63	12.7	2.7	17.3	84.57	292.6	Klein Wanzlebener.
14	" "	" "	216	14.02	12.6	2.8	16.8	83.45	280.4	" "
15	" "	" "	208	16.35	14.0	3.5	19.8	82.56	327.0	Dippe Klein Wanzlebener.
16	" "	" "	312	13.80	11.9	4.5	17.0	79.41	270.0	" "
17	J. S Powell	Philomath, "	384	13.08	12.4	3.8	16.9	76.80	261.6	Vilmorin Improved.
18	"	" "	388	11.36	10.8	5.2	16.6	78.48	227.2	" "
19	"	" "	465	11.97	10.8	5.0	17.0	79.45	239.4	" "
20	"	" "	594	13.07	11.8	5.1	18.2	65.06	261.4	" "
21	C. J. Bishop	Tidewater, Lincoln	397	14.46	13.7	5.1	19.6	73.77	289.2	
22	College Farm	Corvallis, Benton	185	12.86	11.5	3.0	15.9	80.88	257.2	Dippe Klein Wanzlebener.
23	" "	" "	285	12.51	11.3	3.3	15.9	78.61	250.2	Klein anzlebener.
24	" "	" "	200	9.73	0.0	2.5	12.3	79.10	194.6	Lane's Imperial.
25	" "	" "	200	13.00	11.9	2.9	15.9	81.76	260.0	Vilmorin Improved.
26	" "	" "	780	12.88	11.5	3.7	16.6	77.59	257.6	Klein Wanzlebener.
27	" "	" "	642	12.05	11.0	4.7	16.8	71.78	241.0	Vilmorin Improved.
28	J. D. Wilson	Yoncalla, Douglas	348	14.75	14.0	3.8	18.5	79 72	295.5	" "
29	"	" "	496	14.32	13.3	6.0	20 4	70.16	286.4	" "
30	A. R. Shipley	Oswego, Clackamas	....	12.00	10.9	3.1	15.1	79 47	240.0	Dippe Klein Wanzlebener.
31	"	" "	945	12 71	11.8	4.6	17.4	73.04	254.2	" "
32	John Rickard	Corvallis, Benton	11 0	9.81	8.4	5.1	15.0	65.40	167.0	Klein Wanzlebener.

33	John Rickard	Corvallis, Benton	700	6.76	6.0	4.7	11.5	58.78	135.2	Vilmorin.
34	" "	" " "	650	8.16	7.0	3.4	12.6	64.92	163.2	"
35	I. N. Sanders	Union Union	350	18.07	16.6	4.9	22.0	82.13	361.4	"
36	"	" "	475	15.52	14.4	3.7	19.3	80.04	210.4	"
37	C. L. Gowell	Toledo, Lincoln	205	17.29	16.1	4.0	21.3	80.37	345.8	Klein Wanzlebener.
38	P. Cooper	Roseburg, Douglas	1150	13.42	11.5	2.8	16.3	76.19	278.4	Vilmorin Improved.
39	B. F. Collins	Fir, Washington	375	9.95	9.4	2.6	12.6	78.96	199.0	" "
40	G. W. Mitchell	Newberg, Yamhill	975	10.73	9.8	3.2	14.0	76.64	214.6	Klein Wanzlebener.
41	B. F. Collins	Fir, Washington	1145	12.17	11.38	3.2	15.4	78.90	243.4	" "
42	G. W. Mitchell	Newberg, Yamhill	1115	11.64	10.52	4.5	16.1	72.29	232.8	" "
43	J. C. Johnson	Scapoose, Columbia	465	13.74	13.14	3.6	17.3	79.42	274.8	Vilmorin.
44	J. H. Rinck	Buxton, Washington	225	15.61	14.58	4.2	19.8	78.83	312.2	Klein Wanzlebener.
45	W. H. Smith	Roseburg, Douglas	665	10.34	9.12	2.0	12.3	84.64	406.8	Unknown.
46	H. Marks	" "	1230	10.80	10.26	4.2	15.0	72.09	261.0	"
47	John Withers	Lebanon, Linn	187	12.93	11.62	2.6	15.7	82.23	258.6	Vilmorin Improved.
48	John Henry	Beaverton, Washington	480	14.38	12.62	1.8	16.2	88.70	287.6	Redtop.
49	"	" "	340	13.02	12.14	5.1	18.2	71.53	260.4	Klein Wanzlebener.
50	College Farm	Corvallis, Benton	475	13.36	12.06	3.4	16.8	71.78	267.2	Vilmorin.
51	" "	" "	509	12.51	11.91	3.1	15.7	79.61	250.2	Klein Wanzlebener.
52	" "	" "	283	12.05	11.52	4.8	16.9	71.30	241.0	Dippe Klein Wanzlebener.
53	" "	" "	170	12.12	11.10	3.9	16.0	75.75	242.4	" "
54	" "	" "	155	12.82	11.68	3.8	16.7	76.75	256.4	Lane's Imperial.
55	" "	" "	225	12.42	11.18	3.4	15.9	78.11	248.4	Vilmorin.
56	Samuel Howard	Eugene, Lane	1300	13.00	11.97	3.9	17.0	76.47	260.0	Unknown.
57	"	" "	1018	11.30	9.81	4.1	15.4	73.37	226.0	"
58	R. Scott	Milwaukee, Clackamas	1213	12.82	12.91	2.98	16.8	82.26	276.4	Klein Wanzlebener.
59	"	" "	200	12.18	11.66	4.2	16.4	74.26	243.6	" "
60	T. Pavey	Yaquina, Lincoln	850	16.23	14.43	2.6	18.9	85.82	224.6	Unknown.
61	E. Terpenning	Eugene, Lane	865	14.15	13.76	3.1	17.3	81.79	183.0	Klein Wanzlebener.
62	"	" "	1880	14.41	13.58	3.3	18.0	80.55	288.2	" "
63	"	" "	550	15.18	13.74	1.9	17.0	89.29	303.6	" "
64	M. H. Harlow	" "	1700	12.88	12.38	3.2	16.1	80.00	757.6	" "
65	"	" "	930	15.36	14.20	2.8	18.2	84.39	307.2	" "
66	"	" "	340	17.61	15.74	2.0	19.6	89.84	352.2	" "
67	"	" "	575	14.82	13.09	2.7	17.6	84.20	296.4	" "
68	W. W. Crow	Lorane, Lane	682	11.30	10.22	4.7	16.0	76.62	226.0	Dippe Klein Wanzlebener.
69	J. H. Crow	" "	215	15.69	14.23	2.7	18.4	90.70	313.8	" " "
70	C. J. Bishop	Tidewater, Lincoln	875	13.42	12.24	3.3	16.8	79.88	268.4	Klein Wanzlebener.
71	W. R. Wise	Newbridge, Union	1150	13.95	12.67	4.1	18.0	77.50	279.0	" "
72	J. H. Rosebrook	Toledo, Lincoln	450	13.68	12.16	4.7	18.4	74.34	273.6	Dippe Klein Wanzlebener.
73	"	" "	460	13.42	11.92	3.8	17.3	77.57	268.0	Unknown.
74	C. J. Bishop	Tidewater, Lincoln	927	14.68	13.95	3.9	18.6	78.82	293.6	Vilmorin.
75	John Gage	Stafford, Clackamas	720	16.05	15.07	5.3	22.4	71.65	321.0	Klein Wanzlebener.
76	"	" "	875	13.42	12.14	4.7	18.2	73.73	268.4	" "
77	C. J. Bishop	Tidewater, Lincoln	412	15.57	14.85	2.4	18.0	86.00	311.4	Bulteau Desprez.
78	"	" "	405	14.17	13.12	2.3	16.6	84.75	283.4	" "
79	James Wilkinson	Beaver Creek, Lincoln	1075	12.55	11.59	4.6	17.3	72.54	251.0	Unknown.
8	Albert Brown	Philomath, Benton	825	12.03	11.23	4.3	16.4	73.35	240.6	"

Table XXI (Continued)
Showing Analyses of Sugar Beets, 1891-1896.

	GROWER.	LOCALITY. POST OFFICE AND COUNTY.	Weight in Grams.	SUGAR. Sugar in Juice.	SUGAR. Sugar in Beet.	Solids not Sugar	Brix.	Purity.	Pounds Sugar per Ton.	VARIETY OF BEET.
81	J. H. Rinck	Buxton, Washington	305	15.71	14.38	6.2	20.0	71.40	314.2	Klein Wanzlebener.
82	"	" "	250	18.80	16.09	3.0	10.9	89.94	376.0	" "
83	Edward Albright	Ashland, Jackson	325	20.56	16.30	3.1	24.7	87.21	411.2	" "
84	"	" "	255	22.24	20.99	3.2	25.5	79.88	287.6	" "
85	G. H. Baber	Forest Grove, Washington	830	14.38	13.08	3.6	18.0	76.94	292.4	Unknown.
86	J. G. Stevenson	Eugene, Lane	495	14.62	13.25	4.3	19.0	77.30	151.4	Vilmorin Improved.
87	"	" "	475	7.57	5.88	5.3	12.9	70 87	226.8	" "
88	J. B. Riddle	Riddle, Douglas	865	11.34	10.48	4.6	16.0	68.04	241.0	Klein Wanzlebener.
89	"	" "	1010	12.05	11.93	4.6	17.7	83.01	380.0	" "
90	W. E. Smith	Vale, Malheur	350	19.00	17.69	2.8	22.9	81.98	272.2	" "
91	O. P. Coshow	Brownsville, Linn	450	13.61	11.58	3.0	16.6	72.16	226.6	Unknown.
92	"	" "	950	11.33	10.53	4.3	15.7	72.16	397.4	"
93	"	" "	750	9.87	8.48	1.7	11.6	85.08	200.0	"
94	"	" "	600	10.00	8.98	2.7	12.8	76.12	304.8	"
95	A. N. Ault	Forest Grove, Washington	375	15.24	15.00	6.0	21.3	71.54	266.0	Vilmorin Improved.
96	E. F. Meissner	Kerby, Josephine	393	16.00	15.20	5.5	21.5	74 41	320.0	Early Rose.
97	A. J. Thompson	Oswego, Clackamas	325	15.20	14.40	2.3	17.5	86 85	314 0	" "
98	J. J Odale	Union, Union	405	16.10	15.20	1.6	17.7	90.95	332.0	Klein Wanzlebener.
99	A. J. Goodbrod	" "	817	23.00	21.90	3.9	26.9	85.50	460.0	" "
100	College Farm	Corvallis, Benton	2468	12.60	11.90	1.8	14 4	90.95	252.0	" "
101	" "	" "	2900	11.20	10.60	2.0	12.6	88.80	224.0	Vilmorin.
102	" "	" "	3326	15.50	14.70	2.2	17.7	87.50	301.0	White Imperial.
103	" "	" "	4526	13.90	13.20	1.8	15.0	92.60	278.0	Early Rose.
104	S. P. Reeder	Greenville, Jackson	532	18.20	17.30	3.8	22.0	78.68	374.0	White Imperial.
105	College Farm	Corvallis, Benton	270	12.70	12.00	2.7	14.7	86.53	254.0	Klein Wanzlebener.
106	" "	" "	300	12.60	12.00	1.4	14.0	90.00	252.0	Vilmorin.
107	" "	" "	303	13.90	13.10	1.8	15.7	89.10	278.0	White Imperial.
108	" "	" "	305	10.00	9.50	1.7	11.7	85 88	200.0	Early Rose.
109	T. E. Hills	Ashland, Jackson	783	15.00	14.20	2.7	17.7	84.74	300.0	Desprez Early Rose.
110	J. M. Hirsch	Union Union	605	17.00	16.20	1.5	18.5	93.40	340.0	Unknown.
111	College Farm	Corvallis, Benton	340	11.00	10.40	3.2	14.2	77.40	220.0	Klein Wanzlebener.
112	" "	" "	490	9.80	9.30	3.1	12.9	76.29	196.0	Vilmorin.
113	" "	" "	263	11.40	10.80	1.2	12.6	90.46	228.0	White Imperial.

114	College Farm	Corvallis, Benton	296	13.70	13.10	1.7	15.4	88.97	274.0	Early Rose.
115	H. Buxton	Forest Grove Washington	1970	11.90	11.30	2.1	14.0	85.00	238.0	"
116	"	" " "	525	13.10	12.40	3.0	16.1	81.42	262.0	"
117	"	" " "	1045	14.30	13.60	1.8	16.1	88.80	286.6	"
118	T. R. Cornelius	Cornelius, Washington	567	12.00	11.40	3.0	15.0	80.00	240.0	Desprez' Early Rose.
119	George R. Woodruff	Philomath, Benton	620	9.40	8.90	2.1	11.5	87.70	188.0	Early Rose.
120	"	" "	640	12.90	12.30	2.8	15.7	82.17	258.0	Vilmorin.
121	"	" "	776	11.90	11.20	2.6	14.5	82.17	238.0	Klein Wanzlebener.
122	M. P. Jones	Perrydale, Polk	1022	13.40	12.70	1.4	24.8	54.10	268.0	Vilmorin.
123	W. C. Tower	Oakland, Douglas	1938	20.60	19.60	3.7	24.3	84.32	412.0	White Imperial.
124	J. D. Rowell	Scholl's Ferry	341	19.00	18.00	9.0	28.0	67.80	380.0	Klein Wanzlebener.
125	College Farm	Corvallis, Benton	375	... ...	... ...	....	... ..	... ...	.....	Early Rose.
126	" "	" "	367	14.40	13.50	2.4	16.8	85.70	288.0	Klein Wanzlebener.
127	" "	" "	250	16.70	15.80	2.2	18.9	88.30	234.0	White Imperial
128	B. D Dyer	Myrtle Creek, Douglas	291	11.30	10.80	3.0	14.3	79.02	226.0	Unknown.
129	B. F. Cartwright	Eugene, Lane	568	15.10	14.30	2.9	18.0	83.09	302.0	Desprez' Early Rose.
130	Michael Lemmer	Roseburg, Douglas	458	15.00	14.20	1.6	16.6	73.40	300.0	Klein Wanzlebener.
131	O P. Pointer	Hillsboro, Washington	538	14.70	14.00	6.0	20.7	71.80	294.0	White Imperial.
132	M. Snyder	Plainview, Linn	617	17.10	16.20	6.1	23.3	73.40	342.0	Early Rose.
133	J. D. Leonard	Carlton, Yamhill	750	18.70	17.70	5.7	24.4	76.60	374.0	Klein Wanzlebener.
134	Jas. Edson	Ballston, Polk	1416	19.30	18.20	5.7	25.0	77.20	386.0	White Imperial.
135	S. W. Gaines	Hubbard, Marion	558	14.60	14.00	6.7	21.3	68.50	292.0	Unknown.
136	M. O. Lownsdale	Lafayette. Yamhill	980	14.00	13.30	3.0	17.0	82.90	280.0	Early Rose.
137	"	"	1050	12.50	12.00	3.4	15.9	78.60	250.0	Klein Wanzlebener.
138	C. J. Bishop	Tidewater, Lincoln	800	14.20	13 40	2.5	16.7	85.00	288.0	Early Rose.
139	M. J. Duffy	Cove, Union	676	21.50	20.40	2.9	24.4	88.10	430.0	Unknown.
140	R. S Reede	Creswell, Lane.	660	15.30	14.40	2.7	18.0	85.00	306.0	Vilmorin.
141	B. C. Hawley	Logan Clackamas	352	15.10	14 30	1.9	17.0	88.80	302.0	Klein Wanzlebener.
142	J. K. Simpson	North Yamhill, Yamhill	351	14.80	14.10	2.2	17.0	87.00	296.0	Desprez' Early Rose.
143	B. F. Church	Monmouth, Polk	770	15.40	14.40	1.6	17.0	90.58	308.0	Vilmorin.
144	W. E. Church	Vale, Malheur	570	22.20	19.10	3.6	23.8	84.90	404.0	Desprez' Early Rose.
145	C. D. Nain	Ballston, Polk	1623	14.00	13.30	4.6	18.6	74.20	280.0	White Imperial.
146	J. H. Rinck	Buxton, Washington	165	17.70	16.80	4.1	21.8	76.60	354.0	Klein Wanzlebener.
147	William Bogue	Toledo, Lincoln	873	15.00	14.20	3.6	18.6	80.60	300.0	Early Rose.
148	Z. W. Beatty	Chemawa, Marion	840	13.00	12.30	3.1	16.1	80 70	260.0	Vilmorin.
149	R. S. Barclay	Tidewater. Lincoln	210	19.40	18.40	3.5	22.9	83.40	388.0	White Imperial.
150	C. C. Stanley	Imbler, Union	319	23.80	22.60	2.1	25.9	91.90	476.0	Desprez' Early Rose.
151	John End	Warmic, Wasco	330	21.10	20.00	2.2	23.3	90 50	422.0	Early Rose.
152	E. F. Meisser	Kebyville, Joephine	400	15.40	14.60	2.1	17.5	88.00	308.0	Desprez' Early Rose.
153	J. H. Bard	Oakland. Douglas.	623	14.50	13.70	4.1	18.6	77.90	290.0	White Imperial.
154	"	"	843	16.10	15.30	5.1	21.2	75.90	322.0	Unknown.
155	P. J. Bond	Peel, Douglas	225	14.10	13.40	1.8	15.9	88.61	282 0	"
156	"	" "	246	21.50	20.40	2.4	23.9	85.77	430.0	Klein Wanzlebener.
157	J. E. Reynolds	La Grande, Union	633	20.90	19.80	2.4	23.3	85.42	418.0	Desprez' Early Rose.
158	Robert Deal	"	236	16.20	15.30	6.1	22.3	76.04	324.0	Early Rose.
159	F. Clairhorn	Oakland, Douglas	323	13.50	12.80	3.1	16.4	82.30	270.0	Vilmorin.
160	W. H. Norcross	Central Point, Jackson	803	10.90	10.30	2.2	13.1	83.20	218.0	White Imperial.
161	A. H. Sampson	Lewisville. Polk	930	11.30	10.70	4.6	15.9	71.00	226.0	Vilmorin

Table XXI (Continued)
Showing Analyses of Sugar Beets, 1891-1896.

	GROWER.	LOCALITY. POST OFFICE AND COUNTY.	Weight in Grams.	SUGAR. Sugar in Juice.	SUGAR. Sugar in Beet.	Solids not Sugar.	Brix.	Purity.	Pounds Sugar per Ton.	VARIETY OF BEET.
451	H. L. Heath	McMinville, Yamhill	.....	11.55	10.97	1 45	13.0	88.84	231.0	New Danish.
452	"	" "	.....	12.10	11.79	.90	13.0	93.04	242.0	French.
463	D. K. Bill	Hillsboro, Washington	.....	13.60	12.92	3 40	17.0	80.00	372.0	Unknown,
464	Max Steaples	" "	.....	14.20	13.49	4.00	18.2	78.02	284.0	"
465	W. H. Bucher	" "	.....	13.90	13.20	4.30	18.2	76.37	278.0	"
466	B. W. Thorne	" "	.....	14.90	14.16	4.00	18.9	79.36	298.0	"
487	W. B. Kingley	McMinville, Yamhill	.....	13.00	12.35	... ..	... ..	... ...	... ...	"
589	College Farm	Corvallis, Benton	400	12.60	11.97	4.20	16.8	75.00	252.0	Kielholz Klein Wanzlebener.
590	" "	" "	456	14.40	13.60	3.30	17.7	81.35	288.0	Lion Most Saccharine.
591	" "	" "	665	14.70	12.70	2.30	16.8	86.31	299.0	" Improved Imperial.
732	John Henry	Beaverton, Washington	281	18.30	17.39	2.80	21.1	86.70	366.0	White Imperial, German.
748	R. Kuhne	Tigardville, "	275	17.00	16.15	1.60	18.6	91.40	340.0	Klein Wanzlebener.
749	"	" "	337	16.60	15.78	2.00	18.6	89.20	322.0	Vilmorin, blanche ameliore.
750	"	" "	268	17 80	16.91	2.50	20.3	88.60	356.0	Kuhne's Improved.
751	"	McKee, Marion	149	17.30	16.44	3.00	20.3	85.20	346.0	Unknown.
755	H. E. Dosch	Hillsdale, Multnomah	264	16.90	15.45	5.10	22.0	76.80	338.0	"
756	John Henry	Beaverton, Washington	279	18.80	17.86	1.60	20.4	92.10	376.0	White Imperial, German.
757	"	" "	305	16.10	15.22	6.50	22.6	71.10	322.0	Klein Wanzlebener.
759	R. Kuhne	Tigardville, "	326	15.40	14.63	1.00	16.4	93.00	308.0	Vilmorin.
760	"	" "	.....	12.40	11.78	2.40	14.8	90.70	248.0	"
761	"	" "	223	16.50	15.70	3.70	20.2	81.10	330.0	Klein Wanzlebener.
762	"	" "	198	14.00	13.20	4.00	18.0	77.70	280.0	" "

Table XXII
Showing Analyses of Oregon grown Sugar Beets made by the Department of Agriculture at Washington, D. C.*

GROWER.	COUNTY.	Weight in Grams.	Sugar in Juice.	Sugar in Beet.	Purity.	Solids.	VARIETY.
Herman Benke..	Benton	370	13 88	13 18	79 3	17 49	German.
J. J. Nye.....	"	355	13 30	12 65	78 4	16 97	"
C. J. Bishop..	"	335	15 40	14 63	87 5	17 61	Bulteau Desprez.
G. H. Rosebrook	"	300	14 05	13 35	83 1	16 89	Klein Wanzlebener.
Henry Delinger..	"	1589	15 05	14 30	85 4	17 64	
Average.....	.....	628	14 34	13 71	82 8	17 32	
Thomas Daniels	Clackamas ...	500	19 88	18 88	87 6	22 68	
O. P. Yoder.....	"	105	14 55	13 82	86 5	16 83	Klein Wanzlebener.
Richard Scott.....	"	1155	12 25	11 62	77 0	15 91	" "
Average.....	.....	586	15 56	14 78	84 2	18 47	" "
Clarence Reed.....	Columbia.....	275	16 50	15 67	83 9	19 67	" "
"	"	830	15 60	14 82	79 8	19 67	" "
J. C. Johnson.....	"	535	13 90	13 21	86 0	16 17	
Average... ..	.....	546	15 30	14 56	81 7	18 50	
J. M. Perkins.....	Coos.....	1030	13 00	12 35	80 8	16 31	Klein Wanzlebener.
Mat Kerrigan.....	"	600	14 50	13 77	83 8	17 31	Vilmorin.
"	"	330	14 65	13 92	80 5	17 71	Klein Wanzlebener.
John Fox..... ..	"	975	16 80	15 96	87 0	19 31	
T. T. Smith.....	"	865	13 85	13 16	79 1	17 51	Vilmorin Improved.
Average.....	....	860	14 56	13 83	82 6	17 63	
W. L. Tower.....	Douglas	340	17 74	16 85	84 3	21 03	German.
Edward Albright	Jackson	570	18 94	17 99	83 9	22 57	
J. G. Stevenson..	Lane	115	12 15	11 54	77 5	15 67	Vilmorin Improved.
W. N. Crow.....	"	595	14 05	13 36	77 7	18 09	
H. L. Perkins....	"	475	13 95	13 25	81 2	17 17	
J. H. Crow.....	"	230	17 50	16 63	84 6	20 68	
C. J. Dodd.....	"	815	15 10	14 35	83 9	17 99	French.
L. Martin.....	"	1100	12 67	12 05	82 5	15 35	
Average.....	.....	550	14 24	13 53	85 4	17 49	
John Withers.....	Linn.....	180	14 15	13 42	79 5	17 81	
Jacob Raber.....	Marion	1365	12 35	11 73	76 2	16 17	
Jacob Voorhees..	"	560	14 45	13 73	85 7	16 87	
Average.....	....	962	13 40	12 73	81 1	16 52	
James Douglas..	Polk	880	12 10	11 50	79 8	15 17	German.
J. E. David.....	Sherman	435	13 55	12 86	72 2	18 77	
J. H. Logan.....	Umatilla	395	15 12	14 36	80 9	18 69	French.
W. R. Wise.....	Union	980	14 10	13 40	81 0	17 39	
"	"	1130	14 55	13 82	82 6	17 59	
Average.....	....	1055	14 32	13 61	81 8	17 49	
J. H. Rinck.....	Washington..	250	12 67	12 04	85 8	14 77	Klein Wanzlebener.
A. N. Ault.....	"	430	15 00	14 25	82 0	18 29	Vilmorin.
"	"	1365	9 80	9 31	68 3	14 38	"
Average.....	....	681	12 49	11 86	80 7	15 48	
Average for the state.....		644	14 57	13 84	82 2	17 72	

*Compiled from Bulletin No. 33, U. S. Department of Agriculture.