U. S. DEPARTMENT OF AGRICULTURE.

REPORT

OF

THE CHEMIST

FOR

1893.

BY

H. W. WILEY.

FROM THE REPORT OF THE SECRETARY OF AGRICULTURE FOR 1893.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1894.

U. S. DEPARTMENT OF AGRICULTURE.

REPORT

OF

THE CHEMIST

FOR

1893.

BY

H. W. WILEY.

FROM THE REPORT OF THE SECRETARY OF AGRICULTURE FOR 1893.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1894.

CONTENTS.

REPORT OF THE CHEMIST.

SIR: I submit herewith a report of the work done in the Division of Chemistry during the year ending December 31, 1893.

Very respectfully,

H. W. WILEY,
Chemist.

Hon. J. STERLING MORTON,
Secretary.

WORK OF THE DIVISION AT THE WORLD'S FAIR.

ARRANGEMENT OF LABORATORY APPARATUS AND FIXTURES.

An attempt was made at the Columbian Exposition in Chicago to exhibit the work of the Division of Chemistry in a practical way. There is little of interest in a chemical exhibit which shows simply apparatus and chemical appliances without in any way portraying chemical work. It was believed that the most valuable method of showing to the people the utility of an exhibit of this kind would be by having chemical work in progress. In the arranging of the apparatus, therefore, this end was kept in view, and some difficulty was experienced in so arranging the fixtures and apparatus as to secure a pleasing exhibit and at the same time not interfere with practical work. Nevertheless, the idea of an exhibit was not abandoned as such, and an attempt was made to so dispose the apparatus that the part of it which was not in use should at all times be open to the inspection of the public. These conditions made the arrangement of the laboratory for the double purpose a matter of considerable study.

The work tables of all descriptions were arranged with a view to the provision of a large amount of storage room. They were covered with tiling and painted white and finished with an enameled surface. Each of the analytical tables was provided with a large number of gas connections, water service, etc.

Among the special features of the laboratory was a complete outfit for use in the analysis of sugar beets for purposes of seed selection. This apparatus consisted largely of special rasps for removing and pulping a portion of the beet for analysis. Apparatus for the analysis of beets for manufacturing purposes was also exhibited.

The apparatus for the examination of ordinary agricultural products was also complete, and represented the most modern forms adopted for this purpose.

PRACTICAL TESTS AND ANALYSES.

The practical work which was accomplished during the continuation of the World's Columbian Exposition was as follows:

Sugars.—The number of samples of sugar analyzed for the jury of awards was 454. The examination consisted solely of the polarization of the sugar for the purpose of determining its saccharine value. The judges of awards based their decisions largely on the results of this polarization. The sugars examined consisted not only of those of domestic origin, including cane, sorghum, beet, and maple sugars, but also foreign exhibits from every sugar-producing territory.

Whiskies, brandies, etc.—A large number of samples of whiskies, brandies, and liquors was also analyzed for determining their percentages of sugar and alcohol.

Olive oils.—Olive oils of foreign and domestic origin, numbering in all 128, were examined to determine their purity.

Tannin.—For the determination of the tanning value of the various materials exhibited for that purpose, many samples were analyzed and the percentage of tannin therein accurately determined.

Baking powders.—All the baking powders and so-called yeast powders on exhibition were also analyzed and the percentage of leavening power determined, and this analysis was used as the basis of the awards.

Hops.—All the samples of domestic and foreign hops were also subjected to a careful chemical analysis to determine their percentage of extract given up to ether and alcohol, the percentage of moisture which they contained, and their total percentage of nitrogen. These data were also used in making the awards in this class by the jury.

Cereals.—The most laborious analyses made, however, were those of the cereals. In all 532 samples of cereals and cereal products were examined. The analysis consisted in the determination of the moisture, ash, nitrogen content, percentages of oil and indigestible fiber; the digestible carbohydrates being determined by difference in the usual way. Based on the data obtained by analysis, the food values or nutritive values of these samples were calculated. In this calculation the relative value of the different nutritive principles was fixed as follows: The starch and soluble carbohydrates were represented by a nutritive value of 1; the fats and oils by a nutritive value of 2.5, and the albuminoids, obtained by multiplying the percentage of nitrogen by 6.25, by 2.5. The total nutritive value of the cereal was calculated on the above basis. The following may serve as an example:

Let a sample of wheat have the following composition:

	Per cent.
Water	7·54
Ash	1·81
Oil	2·29
Fiber	1·64
Albuminoids	12·53
Starch and soluble carbohydrates	74·19

The relative nutritive value of this wheat would then be—

74·19 × 1·0 =	74·19
2·29 × 2·5 =	5·73
12·53 × 2·5 =	31·33
Sum	111·25

The data obtained in the analyses of the cereals on exhibition will prove of great value in fixing a standard of excellence for the cereal

products of all quarters of the world. It is to be presumed that the cereals on exhibition represented the best products of all countries. Of the samples on exhibition only the very best were selected by the judges for chemical analysis. It is therefore but just to assume that the data obtained in these analyses represent the very best that can be furnished by each particular country. It is believed, therefore, that a detailed report of these analyses will prove of the greatest interest to agricultural chemists throughout the world, and it is the intention to make such a report as soon as possible.

Artificial colors.—Examination was also made for the jury of awards of the artificial colors used in butter and cheese. Most of these, as would be expected, were annatto ground in oil. Some of them, however, were found to be colors of aniline origin, probably tropaeolin. The use of annatto in coloring butter and cheese is in most countries permitted by law, but the use of other coloring matter of doubtful hygienic effect is something to be discouraged. In all cases it was recommended that no award be given to butter colors other than those composed of annatto.

Beers, ales, porters, stouts.—The analyses of the beers, ales, porters, and stouts which were on exhibition excited perhaps more interest than any other series of analyses undertaken at the World's Exposition. The great rivalry between leading brewing firms created a widespread interest in the results of the work. The awards which were made on the exhibits of malt liquors were based partly on the judgment of the jury of experts and partly on the results of the chemical analyses. Inasmuch as there has been widespread comment made upon the methods of analysis employed, it has been thought wise to give in brief a resumé of them. In doing this it has been found desirable to add the results of some special experiments, made since the closing of the Fair, to determine the chemical composition of beers of known origin. These beers were brewed on a small scale in the laboratory, so that we were absolutely certain of the materials of which they were composed. As will be seen, the general result of this examination shows, with one or two exceptions, the entire validity of the basis of judgment employed.

In the preparation of the samples of beers of known components no attempt was made to produce an article which would be equal as a beverage to the beers of commerce. Indeed, it was well understood that such an attempt would be in vain.

The expert treatment of malt and its substitutes necessary to produce a sparkling and attractive beverage can be secured only in commercial or model breweries. The object we had in view, however, was fully accomplished by the experiments, as it was the chemical and not the commercial character of the beers which was to be investigated.

BEER ANALYSES FOR JURY OF AWARDS.

The analyses of domestic and foreign beers made by the Division of Chemistry for the jury of awards at the Columbian Exposition are valuable in helping to fix a standard for the judgment of fermented liquors. The following standards were fixed in advance for the chemical tests:

Alcohol—	
For beers	3 to 6 per cent.
For ales, porters, etc	5 to 9 per cent.
Albuminoids—	
Minimum percentage for malt products	0.5 per cent.

No limits were fixed for ash extract and polarizing bodies. Where the alcohol fell without the limits fixed, 2 points were deducted from the total allowed in the chemical judgment, viz, 45 points. The same deduction was made for a deficiency of albuminoids.

The presence of salicylic acid in moderate quantities in the beer, as determined by the qualitative test, indicated the deduction of 2.5 points from the total, and its presence in large quantities the deduction of 5 points.

In the qualitative examination of the ash the presence of a considerable quantity of hydrochloric acid indicated a subtraction of 2 points and of a large quantity of 3 points from the total.

The same rule was made in regard to the presence of considerable and large quantities of sulphuric acid. These tests were, however, qualitative only.

In testing for hydrochloric acid a mere opalescence or pronounced opalescence was neglected, as it could have come from the water used in brewing, and the same rule was made in regard to sulphuric acid. A moderate precipitation in each case was taken as an indication of the presence of a considerable quantity and 2 points deducted accordingly. A heavy precipitation in each case indicated the presence of a large quantity and 3 points were deducted. These recommendations were made in such a way, if possible, as to cover the fact that in many waters used in brewing considerable traces of both hydrochloric and sulphuric acids are found. This is notably true of the water used by the brewers in Burton on the Trent, where as much as 25 grains per gallon of sulphate of calcium are found in some of the waters used, and as much as 10 grains per gallon of chloride of sodium.

It is not the purpose here to enter into a discussion of the merits of saline waters in brewing as compared with those of pure waters. It is, however, believed that beers containing large quantities of sulphates and chlorides can not be regarded in the same light in relation to health as those which contain only moderate quantities or traces of these bodies. This remark is especially applicable to the presence of sulphates.

In regard to the albuminoid percentages, the standard was fixed because it was believed that when a pure malt had been used in brewing the percentage of albuminoids would be constantly, or almost always, above one-half of 1 per cent. The use of rice or glucose as a partial substitute for malt would therefore tend to diminish the percentage of albuminoids in the beer. As is well known, the presence of an excess of albuminous matter in beer tends to produce cloudiness, and it is also the nidus for subsequent and injurious fermentation. It is not, therefore, implied by fixing a standard in this way that a high percentage of albuminoids is desirable in beer, but the object of the standard is to determine whether or not pure malts have been used in brewing.

The quantity of solid matter contained in the beer and its polarization were not considered in determining its grade number, but these determinations were made in order to complete so far as possible the analysis in the short time allowed for the work. No attempt was made to determine whether any bitter principles other than those present in hops had been used in the brewing.

BEERS BREWED IN THE DEPARTMENT LABORATORY.

Before giving the data representing the composition of the beers exhibited, it is desirable to call attention to the numbers obtained in the examination of some beers brewed in the laboratory of the Depart-

ment of Agriculture. These beers consist of pure malt beers and beers made by mixtures of malt and barley, glucose, rice, and hominy grits in varying proportions. The beers were all brewed in the same way and under the same conditions. They therefore give an excellent basis for comparison with beers brewed from unknown materials. It is not unusual for brewers to maintain that they use nothing but pure malt and possibly barley in making their beers, but it is not always safe to accept assurance of this kind as a basis of scientific investigation. The water employed in our home brewing was Potomac water, which, as is well known, contains only a small quantity of saline matter, not to exceed 6 grains per gallon. In one instance, additions of saline matter, notably gypsum, were made to the water for the purpose of making it resemble in some respects the waters used in the breweries at Burton on the Trent.

Following are the results of the analyses of these home-brewed beers:

Analyses of the home-brewed beers.

Serial number.	Letter.	Specific gravity 15.5° C.	Alcohol volume.	Alcohol weight.	Albumen.	Polarization.	Extract.	Ash.
			Per cent.	*Per cent.*	*Per cent.*	*Degrees.*	*Per cent.*	*Per ct.*
12,865	A	1·0237	3·88	2·97	·1282	17·3	7·51	·102
12,866	B	1·0164	4·72	3·70	·5657	8·4	5·35	·252
12,867	C	1·0163	4·75	3·73	·1188	7·9	5·83	·184
12,868	D	1·0123	5·58	4·39	·2563	7·1	5·09	·212
12,869	E	1·0249	4·05	3·16	·1375	17·9	7·62	·139
12,870	F	1·0188	4·91	3·86	·2938	13·9	6·35	·155
12,871	H	1·0212	4·50	3·51	·2657	14·5	6·84	·337
Malt*		1·0096	3·66	2·85	·5625	5·2	4·00	·294
Glucose*		1·0116	5·60	4·41	·1250	7·2	5·30	·196

* To which gypsum was added.

The quantities of grain, etc., used in the preparation of these beer samples were as follows:

A.—200 grams malt....800 grams rice.
B.—1 kilo malt.
C.—200 grams malt....800 grams glucose.
D.—500 grams malt....500 grams glucose.
E.—200 grams malt....800 grams corn grits.
F.—500 grams malt....500 grams corn grits.
H.—500 grams malt....500 grams rice.

Sample A.

The rice in the case of sample A was stirred into 3 liters of boiling water and the mixture placed on the steam bath. When the rice became a paste, it was removed and allowed to cool to 65° C. The malt was then added and the temperature kept at that point for two hours. The wort was then strained off through a sieve, 2 liters more water added to the grains, and mashing resumed at 65° C. for another hour. The wort was then strained off through a sieve and the grains pressed in a cotton bag. The united worts were treated as given below.

Sample B.

The malt in sample B was placed in 3 liters of cold water and the temperature gradually raised to 65° C. The rest of the operation was as just described.

Sample C.

In sample C the glucose was dissolved in 3 liters of boiling water, the temperature allowed to fall to 65° C. and the malt added. The rest was as above.

Sample D.

Sample D was treated exactly as was sample C.

Samples E, F, and H.

Samples E, F, and H were treated in exactly the same way as sample A.

TREATMENT OF THE WORTS.

The united worts in each case were brought to a boil, 15 grams of hops added, and the boiling continued fifteen minutes. The liquid was then placed in a flask under the tap until the temperature was 12 to 15° C., and then filtered. The mixture of coagulated albuminoids and exhausted hops remaining on the filter was mixed with the grains resulting from the mashing. The density of the wort was taken and when necessary cold water (previously boiled) was added till the density reached about 14° Brix. The volumes, densities, and polarizations of the resulting liquids were as follows:

Sample.	Cubic centimeters.	Total solids.	Polarization.	Total solid matter.
		0° *Brix.*	*Degrees.*	*Grams.*
A	3,680	12·8	29·2	521·8
B	4,000	13·0	20·4	547·6
C	5,200	13·5	16·1	740·6
D	4,700	14·5	18·2	721·7
E	3,200	14·5	29·5	491·4
F	3,300	14·5	26·9	506·7
H	4,100	14·5	26·8	629·6

To each portion of wort were added 5 grams of hops and 200 cubic centimeters of Heurich's yeast. Portions for the polarization were measured out before the addition of the yeast. The addition of yeast took place at 10 p. m., December 9. On December 13 at noon the beers were filtered and bottled.

REMARKS ON RESULTS OF BEER ANALYSES.

The analysis of the samples of home-brewed beers fully bears out the wisdom of the selection of 0.5 per cent as the limit for albuminoids for pure malt beers. The other analyses show also, without the least particle of doubt, the admixture of other bodies with the malt. Before knowing the origin of the beers we took the table of analyses and were able to correctly indicate the proportion of malt in each sample by the percentage of albuminoids alone. Even in the case of the grits, which contained a considerable quantity of albuminous material, it is seen that the percentage of albuminoids is very slightly increased over that for the rice or glucose, showing conclusively that the malt is practically the sole source of the albuminoid matter in the beer. It thus appears to be demonstrated that the percentage of albuminoid in a beer is a direct criterion of the percentage of malt employed in the brewing.

The analyses of the home-made beers also show that the standard for alcohol adopted is a proper one. Only one of the nine samples examined fell below the standard, and this was doubtless due to the shortness of time allowed for fermentation.

On the other hand, in regard to the qualitative test for sulphates, the matter is not so clear. Inasmuch as in European countries highly sulphated waters are employed, it is not strange to have always found in these European beers a very large amount of sulphuric acid. In the American beers, however, the amount of sulphuric acid present in most cases is neglectable and only in a few cases did the grading of the beer suffer from the amount of sulphuric acid it contained. It seems, therefore, that the reaction for sulphuric acid is in no just sense a criterion for the addition of glucose or even of sulphites, and in fixing a scale of points, deducting a certain percentage from the grade of the beer for heavy reactions for sulphates should be practiced, not because it would indicate the presence of glucose in the brewing or even of sulphurous acid as a preservative, but simply because the presence of a large amount of sulphuric acid in a beverage is or may prove harmful.

In regard to the reaction for common salt, the matter appears somewhat plainer. Although common salt occurs constantly in waters used for brewing, yet it is not present in such quantities as to produce a

heavy, curdy precipitate in a solution of the ash. Unless attributed to mineral or other extraordinary qualities in the water, the occurrence of a moderately curdy precipitate or a heavy curdy precipitate on the addition of a solution of nitrate of silver to a nitric-acid solution of the ash would indicate the addition of common salt in the brewing. The addition of common salt in moderate quantities is not in any way prejudicial to health, but when the question which was to be decided in these cases is this, viz, Has anything been added beside the malt, hops, yeast, and water? then the presence of hydrochloric acid must be noticed. If, therefore, the analysis indicate the addition of common salt, on this hypothesis it will be proper to correspondingly diminish the number showing the grade.

The total number of beers, etc., examined is as follows: Wood beers, 102 samples; bottled beers, 130 samples. In the above term "beer" is included, of course, all the various forms of malt liquors, such as beers, ales, porters, stouts, etc. In addition to these quite a number of malt extracts was also examined for the jury of awards.

The total number of analyses made for the bureau of awards was 1,687.

EXPERIMENTS WITH SUGAR BEETS.

In harmony with the provisions of the act of Congress providing for experiments in the improvement of sugar-producing plants and the manufacture of sugar therefrom, the work of the Department in this direction was continued in two distinct lines.

The first of these consisted in the distribution of beet seed to those interested in the culture of the beet, as indicated in the report of last year. The Department having made no purchase of beet seed for distribution, Mr. H. T. Oxnard kindly donated for its use a sufficient quantity of the best imported seed.

SUGAR-BEET SEED DISTRIBUTED.

The number of packages of seed sent out was 2,428, and the number of persons to whom sent 348. The number of packages sent to each of the different States and Territories receiving seed was as follows:

	Packages.		Packages.
Alabama	12	Montana	2
Arizona	1	Nebraska	120
Arkansas	32	Nevada	50
California	347	New Jersey	10
Colorado	202	New Mexico	52
Connecticut	1	New York	90
Delaware	10	North Carolina	5
Florida	3	North Dakota	34
Georgia	200	Ohio	68
Idaho	4	Oklahoma	8
Illinois	17	Oregon	6
Indiana	83	Pennsylvania	3
Iowa	62	Rhode Island	3
Kansas	12	South Dakota	176
Kentucky	3	Tennessee	15
Louisiana	111	Texas	4
Maine	1	Virginia	33
Maryland	13	Washington	250
Michigan	43	West Virginia	1
Minnesota	69	Wisconsin	219
Mississippi	14	Wyoming	12
Missouri	27		

The number of packages of seed distributed was far less than in previous years, and the number of samples received for analysis was correspondingly diminished. The total number of samples received at the Chicago laboratory was 199, and the total number of samples received at the Washington laboratory was 84.

Accompanying each package of seed there was sent a copy of Farmers' Bulletin No. 3, which contains detailed instructions for preparing the land, planting the seed, and cultivating the beets.

SUGAR-BEET ANALYSES AT THE WORLD'S FAIR.

Arrangements were made for taking samples for analysis and these samples were sent chiefly to the chemical laboratory of the Department at the World's Columbian Exposition. As has already been indicated, one of the chief features of the chemical laboratory at the Exposition was the arrangement for the analyses of beets. In addition to this the Chicago laboratory was nearer to the localities in which the beets were chiefly grown, so that they could be sent for analysis in a shorter time than if forwarded to Washington. It was thought also that it would be an excellent illustration of the practical work of the laboratory to have the analyses made where they could be viewed by those interested. The wisdom of this course was apparent from the fact that at all times when analyses of beets were in progress large numbers of intelligent observers were watching the work. The questions which they asked showed that they were interested in the process and were receiving valuable instruction from observing it. Some of the samples of beets, however, were sent to the laboratory at Washington for examination.

UNSATISFACTORY RESULTS OF EXPERIMENTS.

The general results of the work this year were somewhat discouraging as compared with those of previous years. Throughout a great part of the beet-growing region the summer was excessively dry and large numbers of total failures were reported.

In former reports attention has been called to the fact that the present method of experiment is unsatisfactory, and the reasons therefor have been fully set forth. The farmers are so busy with other work that as a rule they are not able to give the proper attention to the experimental details. They do not have time to properly prepare the soil for beet culture, nor do they give to the growing beet proper attention. When the time for harvesting comes they are usually engaged in other farm work, so that the beets are not harvested at the proper time, nor are proper data obtained by means of which any accurate estimate of the yield per acre can be determined. The analytical data, therefore, of such work are usually fragmentary and far from teaching any valuable lesson in regard to the industry itself. In general, however, the data bear out those of previous years in showing the areas in this country where the best beets can be grown. It is in these regions that the development of the industry must be expected.

There is probably not a State or Territory in the Union which is not capable of growing sugar beets of fair quality. Even in the far South beets of fair sugar content have been produced, and with good tonnage, but when the competition of the world is to be met, with the price of sugar as low as it is now, only those parts of the country where the soil and climate are especially favorable can be expected to compete successfully with the beet-sugar industry already firmly

established in older countries. The sole valuable lesson, therefore, of this promiscuous distribution of beet seed is in the fact that as a rule those regions best suited to the growth of the sugar beet will gradually be outlined, and intending investors led to the proper localities for the establishment of factories.

The great success of the beet-sugar industry on the Pacific coast leads to the conclusion that if the northern part of the eastern and central portions of our country is to become the seat of a great sugar industry, every possible advantage must be taken of soil and location in order to compete successfully with the beet fields of California, Washington, and Oregon.

A LIMITED DISTRIBUTION OF HIGH-GRADE SEEDS.

It is not believed that further experiment with the promiscuous distribution of seed will be of any practical benefit. Nevertheless, many farmers apply each year for samples of seed, and incidentally some good can be done by supplying them with what they need. It is not necessary to enter into an argument here to show that the farmer will not be able on his own motion to secure beet seed of high grade. He can not even be sure that the sugar-beet seed offered by dealers is anything more than the seed of the common beet. He does not know the addresses of the growers of beet seed of established reputation. Even if he did, the cost and trouble of securing 2 or 3 pounds from abroad would be so great as to deter him from making the attempt. It seems proper to the writer, therefore, that as long as the Department is engaged in the distribution of seeds it should send to those who inquire for them small samples of the highest-grade beet seed which can be produced. While most of the samples will be productive of no great good, yet now and then one may reach a locality where it will excite interest, and possibly do much toward the future development of the industry. In addition to this it is not to be forgotten that the cost of sending out a few thousand packages of beet seed is very small, and the chemical analyses are secured without expending a single dollar over the usual cost of conducting the laboratory. If the farmers receiving these gifts of the Department would learn the single lesson of appreciating the scientific agriculture which has made the sugar beet possible, it would be an ample repayment of the whole cost of distribution.

EXPERIMENTS AT SCHUYLER, NEBR.

The experimental station at Schuyler, Nebr., established for the purpose of improving the sugar beet and demonstrating the most approved methods of its cultivation, was continued during the growing season of 1893.

THE SELECTION OF MOTHER BEETS.

During the previous autumn the different standard varieties of beets, as harvested from the experimental plats, were carefully culled for the selection of mothers. In the first selection of mother beets, as has been stated in previous reports, the general appearance of the beet only is considered. A plat of beets having been harvested, a skilled workman is assigned to the task of collecting those which seem to be

especially fitted for the purpose of producing seed during the coming year. Beets are selected that are perfect in form, with long and tapering tap roots, smooth exterior, and about one pound in weight. These beets are collected, care being taken not to bruise them, and they are at once placed in moist earth until the time comes for siloing for the winter. The tops of these beets which are to be preserved for growing are cut in such a way as not to interfere with the buds at the neck, a part of the stem of the leaf being left on the beet.

SILOING SUGAR BEETS—RESULTS.

The siloing of the beets should not be undertaken until late in the fall, when it becomes necessary to protect them from injury by frost. It is highly important that the temperature of the silo do not rise at any time above 45° F. A higher temperature than this induces growth and a consequent loss of saccharine content.

ARRANGEMENT OF THE SILO.

The beets preserved over the winter at the station were siloed in the following way: They were placed in the silos in a diagonal position, with the tops upward and carefully packed with moist sand. The silos were so arranged as to be easily ventilated. In the bottom of each silo, at the time the beets were placed therein, was placed a half ton of ice, in large pieces, for the purpose of rapidly cooling the temperature of the silo below the growth point. The drainage of the silo was so arranged that the water from the melting ice would not touch the beets. At the closing of the silos on the 5th of November the temperature, as indicated by thermometrical observations, was 43° F.; on the 20th of December the temperature was 42° F., and on the 21st of March, the date at which the silos were opened, the temperature was 39·2° F. These observations show how uniform the temperature of the silos was kept, and at such a point as to prevent to the largest extent any evaporation from the beets or any growth thereof.

The total number of beets placed in the silos was 6,378. When the silos were opened on the 21st of March, the beets were found to be in excellent condition; there had been in point of fact an increase of weight, rather than a loss. This was determined by placing in each silo a given number of carefully weighed beets. These same beets on the opening of the silo were taken out and at once reweighed. Any change in weight would of course be revealed by this duplicate weighing.

INCREASED WEIGHT OF SILOED BEETS.

An illustration of the increase in weight mentioned is given by the following experiment:

The weight of ten beets siloed on the 4th of November, 1892, was 4,840 grams. The weight of this same lot of beets on the 27th of March, when they were removed from the silo, was 5,400 grams—increase 560 grams, or 11·6 per cent. This increase was due to the fact that at the time of siloing the beets they had become wilted from excessive drought. The autumn at the station had been particularly dry, and the beets at the time of harvest were in a partly wilted state. These beets, being carefully packed in moist sand and kept at a low temperature, absorbed moisture during the winter, with the increase of weight noticed. Ordinarily there would be a decrease of weight in siloed

beets, but in the present conditions the reverse was true. Of the 6,378 beets which were siloed in November, 1892, 6,370 were found in perfect condition when the silos were opened, only 8 beets having been spoiled. This is a most remarkable showing, and indicates the care with which the siloing was done.

ANALYSES FOR DETERMINING SUGAR CONTENT.

The mother beets, when taken from the silos, are subjected to analysis in the manner described in previous reports. Each beet, after weighing, is turned over to the analyst, who, by means of a proper machine, removes a cylindrical section diagonally through the beet, thus securing a sufficient quantity for analysis without in any way injuring the beet for germinating purposes. The beet pulp thus secured is subjected to pressure and the juice obtained is analyzed. Inasmuch as the average marc or fibrous portion of the beet pulp amounts to about 5 per cent, the percentage of sugar in the beet is easily calculated by multiplying by ·95 the percentage found in the juice expressed.

The beets were divided by analysis into three classes: The first class included all those beets containing not less than 12 per cent nor more than 15 per cent of sugar; the second class, those beets which contained from 15 to 18 per cent of sugar, and the third or *élite* class, those beets having over 18 per cent of sugar. The number of beets falling into each classification as a result of the analysis of each variety is found in the following table:

Varieties.	No. 1 grade: Sucrose 18 per cent and upwards.	No. 2 grade: Sucrose 15 to 18 per cent.	No. 3 grade: Sucrose 12 to 15 per cent.
Original Kleinwanzlebener	36	465	448
Dippe's	6	483	1,176
Vilmorin's Improved	8	600	784
Lemaire	.....	.....	476
Desprez	.....	.....	168
Elite Kleinwanzlebener	7	210	224
Total	57	1,758	3,276

These percentages of sugar were determined by taking the analytical data obtained and calculating therefrom the content of sugar which the beets had at the time of harvest. The data for this calculation included the analyses at the time of havest, at the time of storage, and at the time of opening the silo. As a result of the analyses, 5,091 beets were accepted for the production of seed and 1,179 beets rejected.

Although the conditions of storage, as indicated above, were the most favorable, yet it must not be forgotten that the vital action of the beet in the silo is not altogether destroyed, but only reduced to a certain minimum. As long as the beet is alive there must be still some action of vitality, and this can depend only upon the consumption of the store of plant food which has been accumulated in the beet itself. Therefore, even in the favorable circumstances in which the beets were placed, and at a temperature of, say, 40° F., there was during the period of the storage sufficient vital action to diminish to a certain extent the total percentage of sugar in the beets. This was determined by analysis of average samples of beets at the time of storage and at the opening of the silos. Making correction for the increase in weight due

to the absorption of moisture during the winter, it was found that the average content of sugar in the beets of all varieties at the time of storage was 12, the average at the time of opening the silos had been reduced to 11·6, showing a loss of ·4 per cent of sugar during the winter.

Some of the varieties lost more sugar than others. For instance, in Vilmorin's Improved there was apparently a gain of 0·1 per cent of sugar during the winter, while in the Desprez variety the content of sugar had not changed, nor had it appreciably changed in the Elite Kleinwanzlebener variety.

At the time of the harvest of the beets, on the 10th of October, the average content of sugar therein was 15·1; at the time of their storage in silos it was 12, and at the time of opening in the spring it was 11·6 per cent. There had been, therefore, a total loss of sugar from the time of harvest of 3·5 points. This gave a total loss of sugar from the time of harvest to the time of analysis of 23 per cent, of which 20 per cent, in round numbers, occurred between the 15th of October and the 4th of November (the time the beets were placed in silo), and 3 per cent, in round numbers, from the time they were placed in the silo until their analysis in the latter part of March.

THE PRODUCTION OF SEED.

After the analysis and classification of the mother beets the planting was accomplished by setting them in ground which had been properly prepared. Planting was commenced on the 28th of April and completed on the 2d of May, the different grades being carefully separated in the plats. Special care was taken in this respect in regard to the No. 1 grade (the highest grade), so that it could be sufficiently distant from all other varieties to prevent any contamination by the distribution of the pollen in the fertilization of the seed. Of the 5,091 mother beets which were planted, less than 20 failed to grow, showing a remarkable vitality.

The weather during June was abnormally dry, with a high temperature; but this dry weather did not seem to affect the growth or stand of the plant. There was also another season of dry weather during the latter part of July and the first of August, the temperature being very high, causing the seed to mature somewhat early and thus reducing the quantity of yield. The quality of the seed, however, as indicated by its brightness and weight, was most excellent.

YIELD AND QUALITY OF SEED.

The following data give an idea of the amount of seed obtained in comparison with the yield of seed during the season of 1892. In that year the area planted to mother beets was 98·3 square rods, and the weight of seed obtained 595 pounds, giving a yield per acre of 968 pounds. In 1893 the area planted to mother beets was 113 square rods, and the weight of seed obtained 610 pounds, giving a yield per acre of 863 pounds.

On account of the high quality of the seed it was sold to the Oxnard Beet Sugar Company at a price far in excess of that paid for the best imported seed. The sum received for the seed was at the rate of $172.60 per acre. In regard to the sale of the seed, reference is made exclusively to the seed of the lowest grade. The high-bred seeds of grades No. 1 and No. 2 were reserved for use in experimental work.

COST OF PRODUCING BEET SEEDS.

The general result of the two seasons' experimentation in the production of seed is of the most satisfactory character. It has been shown that seed of the finest quality can be produced, and the germination of the home-grown seed has shown its high vitality. The fact that a practical beet-sugar manufacturer was willing to pay from 5 to 7 cents more per pound for the lowest or third grade of seed than he would for the best imported seed, shows in what esteem this seed was held for practical purposes. It is demonstrated that by proper care beet seed can be produced in this country on one acre of ground planted thereto of a value of at least $150. The actual cost of the production of this seed can not be inferred from the cost of its production in the small way in which it was grown. The extreme care exercised in preventing the varieties from mixing, making it necessary to plant in small plats at great distances, and the extra care and labor which such supervision required, would, of course, increase the cost greatly beyond that which would be incurred in the production of seed in a purely commercial way. The great point which has been demonstrated by these experiments is the fact that seed can be produced of the value of at least $150 per acre; that this seed is bright and clean and of high germinating power, and, as will be seen further on, will produce a better crop of beets for sugar-making purposes than the best imported varieties.

It remains for future experimental work to develop to the fullest extent the soil, climate, and cultural conditions affecting the acclimatization of the high-bred sugar beet of Europe to the conditions obtaining in this country.

EXPERIMENTS IN BEET CULTURE.

The preparation of the plats for planting was commenced in the autumn of 1892. Each plat was thoroughly plowed and subsoiled to the depth of 18 inches in October and the surface of each plat placed in proper tilth. The spring of 1893 found the ground in excellent condition, the surface having been thoroughly pulverized by the frost. The soil, however, in the spring was not thoroughly saturated with water on account of the extremely dry autumn and the failure of the winter's snows to furnish sufficient moisture on melting to thoroughly saturate the undersoil. This did not apply particularly to the surface of the soil, which was moist enough, but to the water reserve below the subsoil, and upon which the subsoil and the soil would be compelled to draw in case of another dry season. The preparation of the plats for planting was finished in April, and the seed, both of foreign and domestic production, was thoroughly tested in regard to its vitality. The planting commenced on the 10th of April and continued at intervals for six weeks.

Careful observations in regard to the germination of the seed showed that, as a rule, the home-grown seed appeared above ground from one to two days in advance of the corresponding imported varieties. In all cases, in order to secure proper tests, the home-grown and imported seeds were planted side by side, not only at the first but at all subsequent plantings.

On April 22 the temperature fell to 13° F., and this winter temperature put a decided check to the operations of the station and of necessity injured greatly the plantings which had been made previous thereto. By reason of this abnormally cold weather the close of April found

vegetation in rather a discouraging condition. For the sake of economy only 5 acres were planted in beets in the spring of 1893 instead of 8 acres, which was the originally intended area for the proper rotation of the station crops. In spite of these discouraging circumstances, however, all the plats presented an even appearance by the beginning of June. On the 7th of June a great dust storm swept over the district. The wind came up from the southwest at 4:30 p. m., and at 5 o'clock nearly every young beet plant had been cut off close to the ground. Only one acre of the total area planted escaped total destruction, and this was so badly damaged in places that the aftergrowth was very slow and the final crop the poorest on the station. The most serious result of this storm, together with another one which came on the 9th of June, was the total destruction of the plants which had been started from the first or highest grade of home-grown seed. The comparative tests were therefore made with the second grade of seed instead of the highest.

All the plats injured were replanted by the 15th of June. The rate of germination of the seed planted at this period was quite in contrast with that of the earlier plantings. The plants from the home-grown seed were visible above ground in 72 hours, while those of the imported seed were first visible after 124 hours, being a conclusive proof of the superior vitality of the home-grown seed.

The cultivation of the plats was more satisfactory than that of any previous years because the laborers employed were the same who had been employed in previous years, and their acquaintance with the methods of beet culture was therefore more thorough.

The meteorological conditions for the growing season are summarized in the following table:

Observations.	May.	June.	July.	August.	September.
	Degrees F.	*Degrees F.*	*Degrees F.*	*Degrees F.*	*Degrees F.*
Mean temperature 1893	58·4	72·2	75	70·7	65·1
Mean for 1892	55·3	66·6	75	72·8	66·5
Mean for 1891	59	68·4	69·9	70·2	65·1
	Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*
Rainfall 1893	4·27	1·64	4·69	2·61	2·03
Rainfall 1892	6·62	·50	2·50	3·36	·28
Rainfall 1891	1·38	11·59	6·71	2·22	·84

Fortunately the insect ravages which produced such disastrous effects on the crop of 1892 were entirely absent during the season of 1893. The cultivation of the crop and its laying by followed in due order, and on the 4th of September the first of the analytical work in the examination of the new crop was commenced.

ANALYTICAL DATA.

As a result of the first series of examinations in the beginning of September it was found that the home-grown seed had produced a greater weight of beets per acre, while they had the full equivalent of sugar content. Compared with the crop of 1892 the data are as follows:

The mean weight of all varieties of beets in 1892 in the beginning of September was 279 grams and the sugar content 10·6 per cent. At the same season in 1893 the mean weight of the beets was 389 grams and the mean sugar content 11·6 per cent. It is thus seen that in both the weight of the beet and the content of sugar the crop of 1893 at this season was superior to that of 1892.

On September 28, as determined by experiment, the mean weight of all home-grown varieties per acre was 13·5 tons, containing 15·8 per cent of sugar, or 4,266 pounds per acre. The mean weight of the imported varieties per acre was 13·3 tons, containing 15 per cent of sugar, or 3,990 pounds per acre.

The data given above were obtained upon beets planted during April and May. It may be of interest to compare these data with those obtained from beets planted later. The beets on which the following observations were made were planted on the 12th of June and on the ground where the previous early planting had been destroyed by the windstorms. This planting, as has already been mentioned, germinated in an unusually short time, and the subsequent growth was rapid and uninterrupted. As perfect cultivation as possible was given to the crop, and the surface of the soil was kept in good tilth during the entire growing season. On the 1st of September the plats presented a splendid appearance, although the beets were far from mature. After the 1st of September the extremely hot and dry weather began to affect the late-planted beets, and it was observed that they were ceasing to increase in weight. Small plats were subjected to irrigation in order to determine whether any difference would be observed between the irrigated and non-irrigated beets. At the time of the harvest of the beets, a month later, it was observed that the surface irrigation had not penetrated to a depth of more than 6 inches, and below that depth the soil was dry and hard.

The late-planted plats were examined analytically only once, and, as each variety did not contain more than a few hundred beets, most of which it was desirable to keep for seed, it was not thought wise to take a large number for examination nor to repeat the analytical work. A time for analysis was therefore selected when it was supposed the beets had approximately reached their maximum of value in weight and sugar content. The results obtained for the different varieties were extremely flattering. The highest sugar content was found with the Elite Kleinwanzlebener, namely, 16·4 per cent, with a purity of 81·6; and all the other varieties approximated closely these figures, except in one instance. The varieties were all grown from domestic seed produced upon the station. The weight of the beets, however, was rather low, being only about two-thirds of the normal weight of a perfect sugar beet, showing that the excessively dry weather of September had prevented them from attaining full growth. The weight per acre and the sugar per acre of each of the late-planted plats are given in the following table:

Table showing yield per acre of sugar derived from different varieties of beets.

[H, domestic; I, imported seed.]

Varieties.	Seed.	Date.	Weight per square rod.	Weight per acre.	Sucrose in the beet.	Sugar per acre.
			Pounds.	*Tons.*	*Per cent.*	*Pounds.*
Elite Kleinwanzlebener	H	Sept. 28	172	13·7	16·4	4,494
Vilmorin's improved	H	do	150	12·0	16·3	3,912
Dippe's Kleinwanzlebener	H	do	161	12·8	15·4	3,942
Lemaire	H	do	178	14·2	15·3	4,345
Knauer	H	do	190	15·2	16·3	4,955
Desprez	H	do	178	14·2	15·2	4,316
Original Kleinwanzlebener	I	do	143	11·4	16.0	3,648
Lemaire	I	do	190	15·2	14.0	4,256
Mean of varieties from home-grown seed				13·5	15·8	4,266
Mean of varieties from imported seed				13·3	15.0	3,990

Two of these experiments were also duplicated with imported seed, namely, those marked I in the table above. The low yield per acre was without doubt due to the severe drought.

There was an appreciable increase in the yield per acre of the irrigated plats without any appreciable decrease in the content of sugar. The mean yield per acre of the irrigated beets was 16·2 tons, the mean percentage of sugar in the beets 15·3, and the mean yield of sugar per acre 4,957 pounds. The irrigation, therefore, had increased the yield of sugar per acre, in round numbers, 700 pounds.

THE GROWTH OF BEETS AT DIFFERENT ALTITUDES.

A series of experiments was also made in connection with the work at the station in growing beets on the bottom lands of the Platte River. Heretofore it has been considered impracticable to grow beets on this soil, subject as it is to overflow in the spring and being of an extremely sandy nature. The level of the surface of this soil is very little above that of the river, hence the water line through the greater part of the year is very near the surface of the soil. These lands, of course, would be expected to produce a good showing only during an excessively dry year, as during the season of 1893. The spring of 1893 being immoderately dry allowed the lowlands to be worked and beets to be planted early in May. The germination was rapid and the beets grew without hindrance up to the time of maturity.

On September 23 the beets were analyzed, as were at the same time a similar number of beets grown by the same farmer, in the same manner and from the same seed, but upon dry soil lying higher. The comparison of the two harvests is shown by the following data: Grown on the lowland—mean weight of beets, 523 grams; mean percentage of sugar, 13·5; mean purity, 82·8. Grown on the dry upland—mean weight of beets, 381 grams; mean percentage of sugar, 11: mean purity 68·3. In this instance it is seen that the difference is wholly in favor of the beets grown upon the lowlands. The uncertainty of the possibility of the cultivation of these lands, however, in the spring makes this experiment only a matter of interest in showing the necessity for a moderate supply of moisture during the growing season.

The table-lands of Nebraska are not capable of supplying a definite amount of moisture from the subsoil to a growing crop, especially to one which requires so much water for its nourishment as the sugar beet. In this respect they are quite different from the lands of the Chino valley, California, in which crops of beets are often grown, receiving their water solely from subterranean sources. The practical lesson learned from this experiment does not indicate the continuous utility of the bottom lands of the Platte for beet-growing, but the necessity of a deeper and more thorough working of the subsoils of the uplands in order to increase the store and availability of the capillary water of the soil. Nevertheless, in this connection it may be well to speak of the fact that the Standard Cattle Feeding Company, of Ames, Nebr., planted during the last year about 500 acres of beets on what is practically bottom lands. The yield obtained per acre was quite satisfactory, and the content of sugar was also high. It is to be regretted that the officers of the company are not willing to have the data published in detail, but we are permitted to say that the results of the experiment were satisfactory both from an agricultural point of view and financially, the beets having been delivered to a factory and a fair profit realized therefrom.

UNFAVORABLE CLIMATIC CONDITIONS OF NEBRASKA.

The climatic conditions which have attended the three years experiments which have been conducted at Schuyler lead to the conclusion that the climate of Nebraska, in respect to its variations in temperature and rainfall, is not well suited to the production of uniform crops of sugar beets. The variations in temperature are phenomenal. Even during the summer very cold and very hot days may occur in quick succession. The variations in rainfall, moreover, are no less marked. At one time of the year excessive precipitation is likely to occur, followed naturally by excessive drought. All of these excesses of climate are without doubt injurious to the growth of a plant which has been developed under such even conditions as have characterized the growth of the sugar beet in Europe during the past seventy-five years. The plain deduction from these data is that the sugar beet, especially in such a climate as that of Nebraska, will have to undergo some changes, due to the effect of its environment, before it can accommodate itself perfectly to such changed conditions. Even after only two years of growth in the conditions there obtaining the domestic beet shows undoubted marks of superiority to the imported.

One encouraging feature of the problem, however, is found in the fact that in spite of these great variations in temperature and precipitation, and in spite of the fact that, with the exception of one year, we have heretofore had practically nothing but imported seeds for the production of the plants, yet we have been able to produce in three seasons, differing very widely in climatic conditions, crops of beets fairly satisfactory in both yield per acre and sugar content. This result shows that with the highest skill in agriculture a locality, even with such a variable climate as Nebraska, may be made in one sense practically independent of these excesses of seasonal changes.

SPECIAL EXPERIMENTS.

In addition to the general experiments which have been outlined above a number of special experiments in the production of sugar beets was also carried on at the Schuyler station as has been the custom in previous years. These experiments will be found more properly in the special bulletin (No. 39) on the subject of beet culture which has been issued by the Department.

GENERAL CONSIDERATIONS.

So many letters are addressed to the Department of Agriculture making inquiry in regard to the prospects of the beet-sugar industry in the United States that it seems proper to say a few words here on this subject.

The cultivation of the sugar beet is a style of agriculture so strange to American farmers as to require specific instruction and experience in order to successfully accomplish it. For this reason it is not difficult to foresee that any attempt by American farmers to plunge at once into intensive beet culture until they have learned its principles and practice must end disastrously. The great obstacle to the spread of the beet-sugar industry in the United States is without doubt an agricultural one. The experiments which have been conducted by the Department at Schuyler and the results of an immense amount of work done at the various agricultural experiment stations in the different States,

together with the practical work accomplished by the seven active beet-sugar factories in the United States, have demonstrated beyond any possible doubt the fact that beets of a reasonably high sugar content can be produced over wide areas and in quantities approximating those produced in the beet fields of Europe. In so far as the manufacturing is concerned, conditions are practically identical, although it must be admitted that in some parts of this country they are more favorable and in others less so than in Europe. As an instance of more favorable conditions, the experience of California may be cited. On account of the mild winters in that locality it is not found necessary in any case to silo the beets, and unless exposed to the danger of second growth they can be allowed to remain in the ground until the time for manufacture arrives. There is thus a considerable diminution of the expense of manufacture, an expense which comes from the labor of harvesting and siloing the beets and protecting them from frost.

On the other hand, the conditions in Nebraska are distinctly less favorable for manufacture than in Europe. In the climate of the former the access of winter is often sudden and early. It is not unusual for the thermometer to reach the zero point in November. It therefore becomes absolutely necessary that the harvest of the beets should be fully accomplished not later than perhaps the 20th or 25th of October. The whole excess of beets not manufactured at that time must therefore be preserved, and this preservation is an expensive operation in a climate where so severe a degree of frost must be expected. Then, again, the periods of cold may be separated by periods of great warmth. In this case another danger arises: the high temperature which the silos may attain at those times induces growth, or, if the buds making the growth possible are all removed, at least deterioration. Taking all parts of the country together, it may be said that the conditions of manufacture, including the abundance of fuel and its cheapness and the other factors active in determining the cost of production, are as favorable as in Europe. There is one exception to this, of course, and that is in the matter of labor, the cost of which in this country is double, sometimes triple, that paid in Europe for similar service.

During the past year 45,000,000 pounds of beet sugar have been produced in the United States.

EXPERIMENTS IN THE IMPROVEMENT OF SORGHUM AS A SUGAR-PRODUCING PLANT.

The experiments in the improvement of sorghum as a sugar-producing plant were continued at Medicine Lodge, Kans., during the season of 1893.

AN INSECT VISITATION.

A series of misfortunes attended the cultural work at this station. The first planting was entirely destroyed by chinch bugs during the early part of June, so that by the 15th there was nothing left of the first planting except one plat. The invasion of the chinch bug is largely due to the practice of rotating the crops of sorghum with other cereal crops in which the chinch bugs easily breed. It is therefore deemed advisable in future experiments of this kind to use other crops in the rotation. Root crops, vines, or, if possible, alfalfa, where it can be grown, would prove superior to the cereals as rotating crops.

TEMPERATURE AND RAINFALL.

The season as a whole was the driest which has occurred in that part of Kansas in a great many years. The spring was exceedingly hot and dry, and there was no rainfall during the whole of the months of March and April and very light showers in May. The planting time was preceded by eighty days of hot, dry weather, with high winds and not a drop of rain. During the latter part of May there was an abundant rainfall, amounting to 2.18 inches, but it fell at such intervals as to prevent its penetrating the soil to any great depth. During June 1.21 inches of rain fell, and this also in light, scattered showers. The month was very hot, with hot winds on several days. During July 1.44 inches of rain fell. The temperature during the whole of July was exceedingly high, with hot winds. During August 2.25 inches of rain fell, but the weather was exceedingly hot and there was a series of hot winds. The thermometer during this month frequently registered 100° F. in the shade. The rain also fell in light showers. During September 3.40 inches of rain fell, and this was the first time since planting that the land was wet to a depth of 4 inches. As a result, about the only growth the cane made was during the month of September. In October there was scarcely any rain—only .14 inch. A light frost was observed on the 3d and 5th, but no damage was done; on the 8th, however, the frost was severe enough to kill the leaves of the cane. Cane which was planted early in April did not come up until May on account of the ground being too dry to germinate the seed.

CULTURAL WORK.

The character of the preparation of the soil and its cultivation was the same as in previous years. The planting was done upon the plats of the station as usual, and several farmers residing in the vicinity of Medicine Lodge were also employed to grow plats of one acre each on the conditions of previous years, viz, that the plats should be at least 300 yards from any other crop, such as broom corn, the pollen of which could possibly influence the seed. These precautions are necessary in order to secure the varieties in a pure and uncrossed form.

In spite of the fact that the cane scarcely grew at all during the summer, that the whole of the growth was made during the month of September, and that the frosts were exceedingly early, a fair crop was obtained on most plats and with sufficient maturity before the frosts to secure seed selection. The result, however, would naturally be a depression of the content of sucrose in the cane and thus apparently show a deterioration during the year. This deterioration must be considered to be only apparent, however, inasmuch as the good qualities which have been secured by a long series of selections are still contained in the seed, although the actual content of sugar of the stalks bearing the seed for the present season has fallen far below that of some of the previous years. It is not to be doubted, however, that the canes produced by these seeds, under favorable climatic conditions, will continue to show the permanent improvement which has been secured by the processes of selection.

It is proper to state that on the appearance of the chinch bugs in the fields they were treated with the infected bugs which have proved so valuable as destructive agents to the chinch bugs in Kansas, and as a result one plat was saved from destruction.

COMPARISON OF DIFFERENT VARIETIES OF CANES.

The work of seed selection and the chemical work on the station were begun on the 4th of September, ten days later than usual. The comparison of the average of the varieties with the same varieties of last year almost uniformly shows a deterioration in the content of sucrose, and in many instances a very great deterioration in the purity of the juices. The average quality of the canes for the two years and of the different varieties is shown in the subjoined table:

Average quality of leading varieties of cane in 1892 and 1893.

Variety.	1892.		1893.	
	Sucrose.	Purity.	Sucrose.	Purity.
	Per cent.		*Per cent.*	
Collier	18·99	77·13	15·40	72·70
McLean	18·42	77·99	15·20	77·20
Link Crosses	18·36	77·04	16·42	75·50
No. 112	17·20	75·00	15·80	69·60
Link	17·05	74·09	14·30	73·30
No. 8X	16·75	75·40	14·80	77·69
No. 161	16·56	76·00	16·64	60·00
Colman	15·79	72·10	15·54	74·60
Folger	15·53	72·20	15·40	68·14

SELECTION OF SEED CANES.

By reason of the limitation placed upon the money which was to be expended at the station the amount of work undertaken was far less than that of previous years. As an illustration of this the number of seed selections may be instanced. During the season 14,956 selections of seed for propagation were made, against 49,912 last year. The number of seed heads of each of the standard varieties selected during the past season is as follows:

	Number.		Number.
Amber	1,100	Orange	1,597
Folger	2,964	No. 112	1,757
McLean	345	No. 161	151
Colman	868	No. 8X	478
Link	260	Collier	5,441

To those who have not followed closely the work of the Department in the improvement of sorghum by the selection of seed of canes having high sugar qualities, it may not be void of interest to give in tabular form a statement of the number of analyses which has been made for this purpose. Beginning with the year 1888, when the first selections of seed on scientific principles were made, the number of seed selections made in each year for the different standard varieties can be seen from the following table:

Number of seed selections made for different standard varieties of cane during the six years 1888–'93.

Variety.	1888.	1889.	1890.	1891.	1892.	1893.	Six years.
Amber	10	25	12	964	4,319	1,100	6,430
Folger	10	23	32	5,479	13,722	2,964	22,230
Colman		22	44	2,236	15,326	868	18,496
Collier	4	17	18	3,077	10,822	5,441	19,379
McLean			12	4,730	5,904	345	10,991
Link	25	62	147	124	5,310	260	5,928
No. 8				255	2,223	473	2,951
No. 112		7	20	220	1,621	1,757	3,625
No. 161		18	38	551	1,669	151	2,427
Orange	12	24	5	306	742	1,597	2,686
Various	2,058	13,956	14,668	11,364	28,287		70,333
Total	2,119	14,154	14,996	29,306	89,945	14,956	165,476

It is not necessary to call attention to the fact that the number of selections made was far inferior to the number of analyses. Only an approximate estimate can be made of the number of juices examined for seed selections, but it may be safely stated that only about 1 in each 3 was found of sufficient value in its preliminary analysis to warrant its selection as seed. If, therefore, the numbers given in the table are multiplied by 3 it will approximately give the total number of individual canes examined in this work. It is true that the skilled eye can and does select from the standing canes only those which seem likely to have the highest qualities; therefore the number of seed heads rejected by analysis is far less than would occur if the whole number of stalks of cane as they stand in the field were subjected to examination.

THE FUTURE OF THE SORGHUM INDUSTRY.

There is yet much to be done in the way of scientific selection before we can say that the sorghum cane has reached approximately its maximum of development, and even when it has reached this maximum state of development only the most scientific care in the production of seed as a special branch of sorghum culture will maintain the high grade which has been acquired. It is unfortunate that at the present time the economic production of sugar from sorghum is not sufficiently promising to encourage the investment of private capital in a work so absolutely necessary to secure success. With the cessation of the activity of the Department of Agriculture in this direction, dependence must be placed upon the interest which the different States may take in the matter for the continuance of this work. Not only should the method of selection which has been practiced by the Department be continued, but in addition to this, efforts should be made toward the improvement of the cane by intensive culture. So far we have relied solely upon the accidental variations of the plant as caused by the environment to produce those qualities which we desired to preserve by selection. No systematic attempt has been made to provide an environment for the special purpose of stimulating the plant to development in a given direction. The great and powerful forces of varied forms of culture and of different kinds of fertilization have never been brought to bear upon this plant for the purpose of improving it in its sugar-producing qualities. Enough has been done, however, to place the sorghum plant in a position to attract the attention of the capitalist as well as of the scientist.

THE DISPOSAL OF LEFT-OVER SEED HEADS.

The seed heads which bear in their vital principle the effects and results of this long series of experimental work have been distributed as follows: Seed heads of unbroken pedigree have been selected from each variety and preserved for the purpose of continuing the experimental work when thought desirable. Similar seed heads have been sent to those experiment stations which have expressed a willingness to coöperate with the Department in the prosecution of the work of improvement. The rest of the seed ha been put up in packages and distributed to those who are likely to take an interest in the growth of sorghum of high sugar-producing power. It is, moreover, very suggestive in respect of other farm crops that these also can be greatly improved in their desirable qualities by the same line of experimental research which has succeeded in bringing out of an unpromising sor-

ghum plant a promising source of sugar. Taking advantage of accidental variations of seed, changes in environment and intensive culture may be able to produce with almost any farm crop improvements in its qualities which will be of interest and value both to the producer and consumer thereof.

EXPERIMENTS AT RUNNYMEDE, FLA.

The experimental work at Runnymede, Fla., during the past year has been continued primarily with the growth of sugar cane and incidentally, as rotation crops, with the growth of garden vegetables, cassava, and tobacco.

CAPABILITY OF PINE LANDS FOR GROWTH OF CANE.

In regard to the sugar cane, the most interesting developments which have been secured are those relating to the capability of the pine lands for the production of sugar. The millions of acres of these lands in the State of Florida where the climate is suited to the growth of sugar cane have heretofore been supposed to have little value for this purpose. The results obtained at our station at Runnymede, however, have led to the belief that these lands are far more valuable for this purpose than has been supposed. It is an interesting fact that although these lands lie only a few feet higher than the peat or muck soils bordering the lakes, yet by reason of their physical characteristics the rate of radiation is so slow during the cool nights that frost is rarely known to attack even the tenderest vegetables on them, while it has often killed similar vegetables in the muck. This statement is also true of sugar cane. While the sugar cane in the muck is frequently frost-bitten, and in a few instances has been killed, no such damage has ever been observed on the cane grown on the pine lands. This important observation leads to the belief that the season for the manufacture of sugar from cane grown on these lands can be indefinitely prolonged. It can also be postponed in the winter until such time as the canes have reached their maximum content of sugar. With the muck lands in this part of the State such a postponement would sometimes be attended with danger, although in the muck soils lying 100 miles further south this danger would not exist.

CANE GROWN ON SANDY SOILS.

The best result obtained at Runnymede in the growth of sugar cane has been on the sandy soils mentioned. These soils appear to be pure sand. They do not contain a sufficient amount of vegetable matter to give them the dark color which is found in the hammock lands. They have apparently small quantities of mineral plant food, and yet with only a moderate degree of fertilization with the necessary mineral and organic elements excellent cane is grown, yielding from 10 to 12 tons per acre, and containing, as analyses have shown, as high as 19·5 per cent of sugar. These canes are shorter, stouter, hardier, and harder than the canes grown in the muck soil.

CANE-GROWING IN THE MUCK SOILS.

The result of the experiments in growing cane in the muck soils during the past year has emphasized the fact that the great trouble to be

anticipated in such soils, aside from their deficiency in mineral plant food, is due to deficient drainage. It is clearly demonstrated that in many of these soils the system of open ditches, the only system of drainage so far adopted, is totally inadequate to secure a proper freeing of the soil from water during the immense precipitation which occurs in that region from May to October. The fields of cane in these soils make excellent growth at first and until the access of the heavy rains and give every promise of a magnificent harvest. After the setting in of the rainy season, however, they begin to diminish in vitality and perish before reaching maturity. It is proposed to try to remedy this trouble, in an experimental way, by pursuing a system of tile drainage, and for the experiments during the coming year a sufficient amount of agricultural tiling has been ordered and placed in position to secure some reliable data in regard to the effect of such drainage upon the growth of the crop.

New varieties of seedling canes have been obtained through the courtesy of the Royal Agricultural Society of British Guiana, and these have been planted on the station at Runnymede, in addition to the other foreign varieties now growing there.

CASSAVA AS A ROTATION CROP.

Experiments with cassava as a rotation crop are still very promising. A large growth of cassava can be obtained per acre upon the sandy soils and even larger growths upon the muck soils. An average crop of 4 tons of roots per acre is not an extravagant statement to make concerning the yield of the pine lands. Experiments, already cited in annual reports, have shown that these roots have over 30 per cent of starch. Starch made from cassava is extremely pure, free from nitrogenous matter, and suitable both for food and for laundry purposes. It is believed that the production of starch can be made a very profitable adjunct to the growth of sugar in all those regions of Florida little exposed to the dangers of frost.

TOBACCO CULTURE—PROSPECTS.

Only a beginning has been made in the culture of tobacco, but it may be said that there is a fair prospect of growing upon these soils a tobacco which in many respects will approach in quality the celebrated Cuban products.

WOOD ANALYSES.

During the past year the Division of Chemistry has done a large amount of work for the Division of Forestry. This work has consisted in the examination of woods for tannin and tanning materials, and in the analysis of sections of pine trees to determine the character and distribution of the resinous bodies which they contain. This work has employed one analyst during almost the whole year, and part of the time two chemists have been engaged in these investigations.

TANNIN AND TANNING MATERIALS.

Some of this work has been of the most interesting kind. Chief among the good results which have been obtained is the investigation of the methods of determining the value of tannin and tanning materials.

As a direct result of the work which has been done, a system of coöperation has been established among the tannin chemists of the country similar in every respect to that secured in the Association of Agricultural Chemists. Samples of hide, powder, and tanning materials have been distributed to chemists from the Division of Chemistry for coöperative work, analysis, and the comparison of the results obtained. Already a uniform provisional system of analysis has been adopted, and it is to be expected that this work will become a part of the investigations of the Association of Official Agricultural Chemists and the chemists engaged therein will coöperate with that body in the further prosecution of the praiseworthy objects in view.

RESINS IN PINE TREES—ANALYSES.

Most interesting results have also been secured in the examination of the distribution of the resinous bodies in pine trees, both those which are unbled and those which have been bled for turpentine. The result of these investigations has been laid before the American Chemical Society and also transmitted to the Division of Forestry for its use.

Another valuable result of the work has been in the elaboration of the methods of analysis, especially in the investigation of a new method of determining the total amount of resin by the precipitation of the abietic acid which it contains as an insoluble copper salt. This process has greatly shortened the analytical methods, and also, it is believed, rendered them more accurate.

FOOD ADULTERATION.

The work of examining canned foods for adulterants and preservatives, to which reference was made in the last annual report, has been extended to complete the examination of canned vegetables. It was not found possible within the year to finish all the work necessary to this examination with all kinds of canned and preserved goods.

ADDED PRESERVATIVES.

With canned vegetables the work has been directed chiefly to the detection of any preservatives which may have been added and to the character of the vessels in which the goods are preserved, and, incidentally, to the food value and digestibility of the contents of the cans.

In the preserving of vegetables if they be subjected to a temperature sufficiently high and prolonged to kill all germs it is found that they are partially disintegrated and rendered less attractive to the eye. For this reason a lower temperature has been employed by some packers for the preservation of the foods, and the subsequent growth of germs which may not have been destroyed by this low temperature has in some instances been prevented by the addition of preservatives, such as salicylic, sulphurous, and boric acids.

Opinions are divided in regard to the wholesomeness or unwholesomeness of these added preservatives, the great weight of testimony being to the effect that while these bodies in small quantities are not injurious to health, yet the continual use of them, even in such small quantities, may finally become prejudicial. It is also shown that the same qualities which enable these preservatives to prevent the action of microörganisms, and thus preserve the food from decay, are also active in the digestive organs and hinder the normal functions of the digestive ferments. In other words, the forces which tend to preserve

in this way the vegetables from decay also tend in like manner to retard the processes of digestion. The fair conclusion is that the use of added preservatives in canned vegetables is objectionable. This conviction, however, is not strong enough to warrant the absolute inhibition of these bodies, but the consumer would be sufficiently protected if the law should require that on each can of preserved vegetables a statement should be found as to the character of the preservative used and the amount of it which has been added. The consumer and his medical adviser are thus properly forewarned of the danger which they may encounter in the way of such foods, and if in the face of this announcement they see fit to continue their use, it is a matter which rests solely with them, and they can not hold the guardians of the public health responsible for any ill effects which may follow. Concisely, the views which we have reached as a result of these investigations are these: First, that the use of added preservatives is, upon the whole, objectionable; second, that their absolute inhibition is not warranted by the facts which have come to our knowledge, but in all cases their presence should be marked upon the label of the can.

THE USE OF COPPER AND ZINC.

There are certain added chemicals which are found in many varieties of canned vegetables which are used not especially for the purpose of preserving them, but for adding to the attractiveness of their appearance. These are chiefly the use of copper and zinc salts to secure and preserve the green color of canned peas, beans, etc. The use of copper for this purpose is a very old one. Long ago it was observed that the cooking of peas, beans, and other green vegetables in imperfectly cleaned copper vessels would secure a deeper and more attractive green appearance for the cooked product. It did not take the observing cook long to discover that this improvement in appearance was due to the copper or zinc present in the copper or brass vessels. The same effect was found to be produced when these vegetables were cooked in ordinary vessels with the use of small quantities of copper or zinc salts. Upon the whole copper salts were found more convenient for this purpose, and hence at the present day an immense industry has grown up in the greening of canned vegetables by the use of copper and zinc, especially of the former, and it is found that a large part of such canned goods exposed for sale in this country has been greened by the addition of copper, and in some cases of zinc. For instance, the amount of copper found in peas of French origin was uniformly much greater than that found in American canned peas. Of 43 samples of American canned peas examined, 32·56 per cent were found to contain no copper, while 67·44 per cent were colored with copper. Of 36 samples of French peas, all were colored with copper except one, which was colored with zinc. In regard to the quantity of copper found, the following comparison will be of interest:

Amount of copper per kilogram.	American peas.	French peas.
	Per cent.	*Per cent.*
Less than 10 milligrams	30·23	0
Between 10 and 18 milligrams	11·63	5·74
Over 18 milligrams	25·58	94·29
Over 25 milligrams	16·28	88·57
Over 50 milligrams	6·98	60
Over 75 milligrams	0	31·43
Over 100 milligrams	0	11·43

The occasional use of a small quantity of a copper or zinc salt, it must be allowed, can be practiced without material injury to health. On the other hand, the continual and regular consumption of even the small quantities of these materials present in canned vegetables must be regarded as at least prejudicial to health. Therefore it is concluded that the public health will be sufficiently conserved, provided each can of vegetables which has been greened artificially in this way shall bear plainly marked upon the label the nature of the greening material and the amount thereof employed. The responsibility for the use of these vegetables will then be thrown upon the consumer, and he can exercise his own judgment with regard to the matter.

The question of the use of copper in canned goods has been agitated in France for nearly a quarter of a century. At first the committees appointed by the Government to investigate the matter reported uniformly against the use of copper for greening. While French packers were not allowed for some time to sell their copper-treated goods to French consumers, they were not prevented from using copper when the goods were intended for export. For instance, in 1875 some Bordeaux packers labeled their goods "Green peas (or beans) greened with sulphate of copper. Made especially for exportation to America and England, and not sold for French use." Copper was present in some of these samples to the extent of 40 milligrams per kilo. After this practice had gone on for some time the board of hygiene of the Gironde concluded to prohibit it, stating that no distinction should be made between goods destined for exportation and those intended for home consumption. Nevertheless, there was such a demand for goods of this kind that the exigencies of commerce gradually got the better of the hygienist, with the result that the French Government has finally permitted the use of copper in greening canned vegetables, requiring, however, that some definite mark shall be used in connection therewith. The canners, however, were shrewd enough to elude the necessity of marking their goods as having been greened with copper or zinc, and fulfill the letter of the law, if not the spirit, by marking them with some indefinite mark such as *à l'anglaise*. The result is that the purchaser of these goods has no intimation, as far as the label is concerned, of the nature of the material which is employed in greening, and the canners themselves claim that if they were compelled to mark their goods as having been greened with copper or zinc it would entirely destroy their sale. The question here is one of sight and not of taste or digestive value, and it seems that it would be wise to recommend to the consumer of canned goods to be content to use them, even if they are slightly pale or yellow, rather than to have them of a bright-green color at the possible expense of health and comfort.

VESSELS USED.

Another prominent feature of the work which we have conducted is found in the examination of the vessels containing the vegetables. In Germany the law requires that the tins employed for holding the canned goods shall not contain more than 1 per cent of lead. In this country there is no restriction whatever in regard to the character of the tin employed, and, as a result of this, the tin of some of the cans has been found to contain as high as 12 per cent of lead. There is no question whatever among physiologists in regard to the effect of lead salts upon the human system. The continual ingestion of even minute quantities of lead into the system is followed eventually by the most serious results. Painters' colic, lead palsy, and other serious diseases well known to physicians are the direct effects of the continual expos-

ure of the system to the influence of minute portions of lead salts. Therefore the greatest care should be exercised in the preparation of canned goods to exclude every possibility of the ingestion of lead. Even tin salts are poisonous, but not to the extent of lead, so that the presence of a minute portion of tin in canned vegetables, coming from the erosion of the cans containing them, is not a matter of such serious import as the presence of lead. Perhaps it would be quite impossible to exclude tin absolutely from canned goods when they are canned in tin, but it is possible to exclude the salts of lead. This can be done by requiring that the tin shall not contain more than, say, 1½ per cent of lead, and, in the second place, that the solder which is employed shall be as free from lead as possible. In Germany the solder employed in sealing the cans is not allowed to contain over 10 per cent of lead, while in this country the analyses of numerous samples of the solder employed show that it contains fully 50 per cent of lead. In addition to this there is no care taken to prevent the solder from coming into contact with the contents of the can. It is not a rare thing in carefully examining the contents of a can to find pellets of solder somewhere therein. Often on examining the inside of a can it is found that large surfaces of solder on the seams are exposed to the action of the acid contents of the can.

Another great source of danger from lead has been disclosed by the analytical work, viz, in the use of glass vessels closed with lead tops or with rubber pads, in which sulphate of lead is found to exist. As a sample of this, the goods of a manufacturer of Bordeaux may be mentioned. All the samples of his goods examined were put up in lead-topped glass bottles. All except one contained salicylic acid, and all of them save one contained copper. In one of these samples lead existed to the enormous amount of 35.2 milligrams per kilo; in another 15.6 milligrams per kilo were found, while in one sample the extraordinary quantity of 46 milligrams per kilo was discovered.

It is not difficult to see how goods covered with lead tops can be contaminated. It may be claimed that these goods should never be turned upside down, but the shippers pay little attention to such directions, and the result is that the goods may be kept for days or even weeks in such a position as to bring the contents of the can into contact with the lead tops or with the rubber pads containing lead. The constant consumer of such goods, therefore, must run some risk of being exposed to the insidious inroads of some of the diseases peculiar to the action of small quantities of lead upon the human organism. It is not too much to ask that the law should require the canners to exercise the utmost care to exclude all dangers of this kind.

The general result of the examination of the canned goods exposed for sale in this country leads to the rather unpleasant conclusion that in some cases the consumers thereof are exposed to greater or less dangers from poisoning from copper, zinc, tin, and lead. These dangers could be easily removed if the manufacturers of these goods were required to follow the dicta of a reasonable regard to public hygiene.

FOOD VALUE AND DIGESTIBILITY OF CANNED GOODS.

In regard to the food value and digestibility of canned goods interesting data have also been obtained. It is hardly necessary to call attention to the fact revealed by the examinations, that some of the canned vegetables, like the same kind of vegetables when green, are more a condiment than a food. This, however, does not constitute any argument for their exclusion.

The fact must not be lost sight of that the human being is not, like other animals, to be fed merely with a view to securing the most rapid development of the body and deposition of fat in proportion to the cost of food consumed. The great difference in the principles of human feeding as compared with cattle-feeding is found in the recognition of the property of taste. Any system of human feeding which rests solely upon the food value of what is consumed or the number of calories which such food will produce when burned is radically wrong. It is true that human beings should have nourishment, but this is only a very small portion of the cost of human food, and from an economical point of view the least important. The palatability of the food, its general attractiveness, its power of giving pleasure and promoting sociability are of more monetary importance in the human dietary than the bare necessity of preserving life. For this reason not only the rich, but even the laboring man in moderate circumstances is warranted in expending a large portion of the amount which he has to devote to the sustenance of himself and his family for those things which, while they may not be very nutritious, are palatable and inviting. The practice, therefore, of preserving vegetables during the season when they are most abundant, and thus providing them in a practically green state when they are least abundant and most expensive, is one which can not be too highly commended.

PURPOSES OF THE INVESTIGATION.

Many of the packers of canned goods have misunderstood the purpose of the investigation which has been made by the Department. There was no intention in this investigation to cast discredit upon any such process. It is true, we considered it our duty to report fully upon all the materials found in canned goods, and which, in our opinion, ought not to have been there, and which were prejudicial to health. We likewise considered it proper to point out the fact, in the special report issued on this subject, that the actual amount of nutritive material in canned goods was wholly disproportionate to the price paid therefor, and that a person purchasing thus an expensive luxury might also be securing a food which contained added bodies prejudicial to health. The object, however, in calling attention to these facts was to impress upon the canners and the public the necessity of preparing canned goods without these objectionable features. In fact, the position taken in the report was of such a conservative nature that it was not deemed advisable to utterly condemn the practice of adding salicylic acid, sulphurous acid, copper, zinc, etc., to canned goods, but simply to ask that in all cases where such additions had been practiced the label should call attention to the fact, leaving the responsibility for any injury which might accrue from the consumption of these goods to rest upon the purchaser and canner in common. In other words, if a consumer of canned goods purchase materials which are known to contain these preservatives and coloring matters, the responsibility rests largely upon himself, and the duty of the Department to the public has been fully discharged in calling attention to the possible dangers which may accrue from the use of these bodies and the necessity for requiring the persons who prepare them to plainly state upon the labels the character of the materials employed.

In the same way the purpose of the special report in calling attention to the enormously high price paid for the nutritive material in canned goods has been misunderstood. There are cases where the resources at the command of the consumer are so limited as to render it neces-

sary for the sustenance of life that he should secure as high a quantity of nutritious material as possible for the sum at his command. In these cases there is no choice left in regard to consulting the taste or the eye. It is a matter of necessity that life should be preserved. In such a case the expenditures for food should rest upon the same ground as in cattle-feeding. By pointing out in the special report the high price of the nutrient in such foods it was intended that this might prove of some advantage to the person temporarily, perhaps, in circumstances which rendered the maintenance of life the first object in the purchase of food. These ideas were incorporated in the special report in the following words:

A careful perusal of the data in the body of the report will not fail to convince every unbiased person that the use of canned vegetables is, upon the whole, an expensive luxury. It is not the purpose of this investigation to discourage the use of such bodies, but only to secure to the consumer as pure an article as possible. Nevertheless, these practical conclusions may prove of some help to the laboring man and the head of a family, when he finds himself in straightened circumstances, by assisting him in investing his money in a wiser and more economic way than in the purchase of canned vegetables. An expenditure of 10 or 15 cents for a good article of flour or meal will procure as much nutriment for a family as the investment of $3 or $4 in canned goods would.

PROTESTS OF PACKERS.

In many cases where the chemical examination disclosed the presence of preservatives in certain canned foods the packers have protested that a mistake in analysis had been made. It is not necessary to call attention to the fact that chemists are far from infallible, and that mistakes in analysis may be and are frequently made. In matters, however, of this kind extreme care is employed, and where an indication of preservative was found special corroborative tests were made. In all cases of doubt the foods were passed as being without added preservatives. Where, however, the chemical action was plain and unmistakable, there was but one course to pursue in making the report, viz, to state the facts as observed. Numerous protests have been received from packers in regard to this matter, and in many cases additional examinations have been made and in every instance with corroborative results. It is quite possible that imitations of the goods of packers with established reputations have been made by unprincipled parties. One packer acknowledged, in protesting that his goods had been misrepresented by the report, that his firm was in the habit of giving packages of labels to its customers, who complained in some cases that the labels as purchased had been soiled or torn. It is not difficult to surmise that in many such cases these labels may have been affixed to goods of a different quality from those put up by the original packer. In every instance we have been perfectly willing to thoroughly review any contested ground, and are anxious that all packers who feel that their goods have been misrepresented shall have a full and fair review of the work. We shall be only too glad to make any correction in case any mistake shall be found.

It is believed that the effect of the investigations will be of a most salutary kind. Canners will be more careful in the character of the tins which are used in the manufacture, in sterilization, and more particularly in the exclusion of all objectionable preserving reagents. There can be no possible objection, however, to the moderate use of common salt or sugar where the addition will tend either to improve the flavor or the keeping quality of the goods; nor, on the other hand, should there be any objection to the use of copper in greening, as, for instance, with canned peas, if the consumer be plainly informed of the fact.

In regard to the use of salicylic acid and other preservatives of this character, little can be said in addition to what has already been cited. There is a widespread belief among physicians and physiologists that the continued use of salicylic acid, even in small quantities, is injurious. There are some physicians and physiologists, however, who do not share this belief. In a case of doubt of this kind it is safe to go on the prohibition side. There is no doubt of the fact that vegetables can be well preserved without the use of salicylic acid. There is, therefore, no necessity for its employment, and it is hoped that packers in general will exclude it from the list of materials added to their preserved goods.

MISCELLANEOUS WORK.

The miscellaneous work of the division has been in the line of that usually practiced. It would not be profitable to recount here the various analyses which have been made under this head. Numerous samples of waters used for watering stock and for irrigation purposes, minerals supposed to contain phosphates, samples of marls, soils, and occasional samples of minerals containing precious metals have come under this head.

It may be well to state, for the information of those desiring work of this kind, that the Division of Chemistry no longer makes assays of minerals for the precious metals. The only furnaces we have which we could use for the purpose are those employed for incineration in the preparation of ash for analysis. As these incinerations are made in platinum dishes, the use of these furnaces for assays, introducing into them large quantities of oxide of lead, would render them dangerous to dishes of platinum.

It may be well, further, to call attention to the fact that miscellaneous requests for the analysis of fertilizers and soils are uniformly referred to the experimental stations of the States whence the requests come. There are so many local conditions necessary to be taken into account that soil analyses, with the labor and expense necessary, are of little profit when made on samples taken at random and without knowledge of the conditions necessary to make them typical and at a place remote from their location. It is far more profitable and proper that the farmers should apply to their State experiment stations, and not to the Department of Agriculture at Washington, for information of this kind.

The same remarks, to a limited extent, may be applied to the miscellaneous examination of fertilizers. Many of the States now have fertilizer-control laws for the protection of the farmer. Again, local considerations are of the greatest weight in determining the value of a fertilizer in any given case. The actual value for crop-producing purposes of any commercial fertilizer is not determined alone by the percentage of plant food it contains; the character of the soil to which the fertilizer is to be applied has much to do with its value as a crop producer; therefore any information which may be given in a miscellaneous way in regard to the value of a fertilizer can not be taken at its full worth without a knowledge of the character of the soil to which it is to be applied.

It is well again to call attention to the fact that it is not the function of the Division of Chemistry to make analyses of mineral and artesian waters for supposed medicinal qualities. If such waters, however, are to be used for agricultural purposes, they should be referred to the State experiment stations and not to the Department of Agriculture.