U. S. DEPARTMENT OF AGRICULTURE.

REPORT

OF THE

CHIEF OF THE DIVISION OF CHEMISTRY

FOR

1892.

BY

H. W. WILEY.

FROM THE REPORT OF THE SECRETARY OF AGRICULTURE FOR 1892.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
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CONTENTS.

REPORT OF THE CHEMIST. — 1892.

SIR: I have the honor to submit herewith a report of the work done in the Division of Chemistry of the U. S. Department of Agriculture during the past year.

Respectfully,

H. W. WILEY,
Chemist.

Hon. J. M. RUSK,
Secretary.

BLACK PEPSIN.

In the Report for 1891 was published a description of a preparation designed to increase the yield of butter. This preparation was sold at a high price and had the power of causing the incorporation of the casein, milk sugar, and other constituents of the milk with the butter fat. This was effected by producing a kind of an emulsion by which these bodies were held in suspension. The apparent result of the process was to double the yield of butter. It was pointed out at the time that this substance was pepsin and that the apparent increase in yield was in reality a delusion, as, of course, there is no method by which the actual content of butter fat in milk can be increased after the milk leaves the cow.

During the present year the Department has received numerous inquiries concerning the substance known and sold as black pepsin, which is used for the purpose described above. In reply to these inquiries the information has been of a uniform character, viz, that this substance has essentially the properties ascribed to it, but that its use in all cases must be regarded as a fraud and hence avoided.

One sample of the black pepsin above referred to has been examined by the Department and found to consist essentially of a mixture of crude pepsin with sugar. It is hoped that farmers will not be deceived by the claims of persons desiring to sell this compound, inasmuch as butter made in this way will soon spoil and is practically not butter but simply an incorporation of butter with about an equal weight of other substances. The making of such butter is also practically an adulteration of a food product and should be prohibited by law.

BANANA MEAL.

The Department has received during the past year numerous letters making inquiries respecting the use of banana meal as food. A sam-

ple of banana meal was furnished by Mr. Francis J. Geis, of New York, and a chemical analysis thereof was made. The results of the analysis are as follows:

	Per cent.	Per cent.
Moisture		11.44
Ether extract		0.39
Alcohol extract (80 per cent)		5.94
Of which { Reducing sugar	1.18	
Of which { Sucrose	0.08	
Cold-water extract		5.33
Fiber		1.11
Ash		3.04
Starch		59.35
Albuminoids		5.25
Digestible fiber and other undetermined carbohydrates		8.15
Total		100.00

Perhaps the most important result of the analysis is in showing the large percentage of starch which the banana meal contains. Evidently, as will be seen from the description following, the bananas were harvested for the purpose of making this meal while still quite unripe. otherwise the percentage of sugar would have been greater and the percentage of starch less. The amount of sugar present in the meal is quite insignificant, amounting in all to only 1.26 per cent, while the amount of material soluble in 80 per cent alcohol is much larger, showing probably a carbohydrate related to the sugars, and possibly of a sweetish taste, but not responding to the ordinary test for sugars. One important point to which attention should be called in the analysis is the fact that almost the whole of the material is digestible. The amount of indigestible fiber as determined by analysis is only a little over 1 per cent and the amount of ash a little over 3 per cent. According to the analytical data less than 5 per cent of the whole material is indigestible.

Practically, in this country, the only locality in which bananas can be sucessfully grown is found in the southern part of the Florida Peninsula. Bananas grow luxuriantly in South Florida, and have ample time for the maturation of their fruit. There are large areas south of a line drawn eastward from Tampa in which bananas could be successfully cultivated. The ease with which they grow, the little care which is required for their cultivation, and the magnitude of the harvest are points which demand for banana culture a respectful consideration. It is not possible to say with the data now at hand that banana culture in southern Florida will prove financially remunerative; that is a matter on which an expression of opinion is withheld. It is only desired to call attention to the data obtained for the purpose of further determining the possibilities of remunerative culture. What little is known of banana culture we have been compelled, of course, to take from foreign sources, and this is included essentially in what follows:

When only partially matured, in the milky state, these fruits contain a considerable portion of starch, and, roasted or boiled, form a very nourishing food, capable of being substituted for bread; when further matured they contain more sugar and are eaten as an accompaniment to meat, and when fully ripe the starch is largely changed into gum or sugar, and they are then eaten raw or sliced and cooked in the form of fritters.

As might be supposed with so important an article of food, many methods are adopted with a view of preserving the banana, as it quickly perishes after becoming ripe. Banana figs are preserved in a manner closely resembling that adopted with the ordinary fig. When fully ripe, the bunches of fruits are removed from the plants and exposed to the sun until they commence to wrinkle; the skin is then removed, for

if not peeled, a disagreeable flavor is imparted. They are still exposed to the sun until an efflorescence of sugar appears on the surface, when they are pressed into masses and wrapped with leaves of the plant or placed in boxes and kept dry. They have been kept in good condition in this way for many years. This method can only be adopted in climates that are very dry. In damp tropical regions they are prepared for drying by first rapidly boiling the ripe fruit for a short time in water that contains sulphate of lime; without this precaution, in moist climates, the fruit becomes damp instead of drying.

The farina of the banana, or plantain meal, is prepared by cutting off the fruit before it is ripe, and, while in its starchy condition, slicing it and drying in the sun. This, coarsely ground and sifted, forms a farina highly esteemed in South America; but as the quality of the flour depends chiefly upon the rapid drying of the cut slices, the preferable mode is to dry them in an oven. If knives are used in slicing the fruit, they should be nickel plated, as the acid acting upon steel or iron colors the fruit. When the drying process is thorough the slices are hard, brittle, translucid, and of a horny appearance, and when ground furnish a white, sweet meal, with a smell like fresh hay, and it is a very palatable and easily digested food. Macaroni made from it falls to pieces when put into warm water, and bread can be made only by adding some kind of meal that contains more gluten. The fresh pulp furnishes about 40 per cent of dry farina, and it is stated that the produce of bananas compared to that of wheat is as 133 to 1, and to that of potatoes as 44 to 1, and 1 acre of ground would furnish over 20,000 pounds of meal.

In some parts of South America the fruits are peeled, grated, and the moisture expelled by pressure; the mass is then baked in an oven and afterwards ground into a coarse kind of flour, which is inferior in nutritive properties to that obtained from the dried slices. Bananas baked in their skins, then peeled and boiled in water, are considered good for coughs and inflammation of the lungs. The Malays use a variety of this fruit, which possesses considerable tonic properties, to arrest diarrhea. The bananas are generally very astringent when half ripe and eaten raw, on account of the gallic acid which they contain. In the Antilles large quantities of potash are obtained from the ashes of the plant, which are used to wash linen.

Many spirituous drinks, as well as vinegar, are made from the banana. Banana wine is obtained in Cayenne by pressing the fruit through a sieve, after which it is made into cakes, dried in the sun, and dissolved in water when wanted for use. Bananas soaked in brandy impart to it a taste of the fruit. Vinegar is also made by suspending the fruit in baskets, where it liquefies and the juice, which is collected, soon becomes vinegar.

All of the species of Musa furnish fiber, and, since the stem, when the fruit has ripened, decays, or is cut down, the fibrous material is obtained without detracting from the food value of the plant.

When the stem is cut down, young suckers from the root take its place, which, in the course of a few months, attain a fruiting condition. In none of the varieties esteemed for their fruits are there any seeds discoverable, though at times minute black points may be observed in the pulp, disposed in longitudinal rows, which are probably the feeble traces of seeds not yet quite extinguished by cultivation, the black perisperm being the last to disappear.

In tropical countries where they are grown for the trade, they are planted in rich bottom lands and receive very little cultivation.

The number of bunches of bananas imported into the United States from Central America in the different years named below is as follows: In 1887, 5,914,472; 1889, 9,092,557; 1890, 12,582,550. The value of the imports of bananas into the United States during the year ended June 30, 1892, was $5,000,390.

FOOD ADULTERATION.

During the past year the work of the Department in the investigation of food adulteration has been directed chiefly to the examination of canned and preserved foods. An examination was not only made of the contents of the cans, but also of the materials of which the cans were composed and the solder employed in sealing them.

In European countries the character of the tin which is employed in making the cans is carefully observed under the statutes governing the matter. On account of the generally poisonous effect of lead salts it

is prescribed in some European countries that the tin used in canning must not contain over 1 per cent of lead. In this country there is no provision of law regulating such matters, and the result is that canners use tins without any regard at all to the composition of the tinning material. It is supposed by them, doubtless, that the tin used is practically pure; whereas it has been found by the investigations which have been made, that it sometimes contains over 12 per cent of lead. Several instances have come under our observation where the tin employed as a coating for the plate used in the manufacture of the cans contained over 10 per cent of lead. The danger which might arise from the use of this kind of material is manifest. The natural acids of fruits and vegetables, and even of meats, may act upon the lead as a solvent with the formation of lead salts highly injurious to health. As is well known, the solder of commerce contains usually from 40 to 60 per cent of lead. It is, therefore, highly important that this solder should not come into contact with the contents of the can. Nevertheless, it is a very common occurrence to find nodules of the solder in the can, no care whatever being exercised to prevent the melted solder from running into the contents of the can. This is a matter which should also be carefully observed, and the solder should be so employed as to be entirely out of contact, or practically so, with the contents of the package.

Canned meats have also been carefully examined for the detection of ptomaines, or, in other words, nitrogenous bases, which are formed during the decomposition of flesh. No such bases have yet been found, although they doubtless sometimes exist. It is probable, however, that such bases are formed in the most part subsequent to the opening of the can, and therefore there would be more danger in eating canned meats which had been open for some time than those which had been freshly opened. The microörganisms which are active in the formation of such nitrogenous bases would naturally not be in action in the contents of the can, inasmuch as such contents are presumably sterilized after the air is excluded. On opening the canned goods, however, and the exposure of the contents to the air, microörganisms would be at once seeded, and their development might go on with astonishing rapidity. Canned goods, therefore, should not be preserved for any great length of time after opening before their consumption.

Careful examination was also made for preservatives used in canned goods. In some forms of canned goods, such as condensed milk, it is customary to add large quantities of sugar; in fact, sugar may be added to many of the canned substances. The addition of a preservative of this kind can not be regarded with distrust unless it be added in such quantities to a very expensive material as to materially diminish its cost. When, however, the question of such preservatives as salicylic, benzoic, or boric acid, hydronaphthol, and bodies of this class, and especially sulphites and saccharin, is considered, the matter is quite different. All these bodies, with the possible exception of saccharin, are certainly injurious to health when taken even in small quantities for a long time, and they should be rigidly excluded from canned materials. Some of these preservatives have been found in many instances, although they do not exist in a very large percentage of canned goods.

Particular attention has been paid to the examination of green-colored peas, beans, and other vegetables, for copper. It is a common custom to use some kind of a copper salt, presumably the sulphate, in canning such materials for the purpose of preserving or intensifying their green

color. The consumer may be certain when he is eating very green canned peas, beans, or anything of that kind, that he is consuming large quantities of copper. We have uniformly found large quantities of copper in all such goods, and have recovered it in every instance, where the attempt has been made to do so, in the metallic state. While the use of copper adds greatly to the appearance and attractiveness of such canned materials, it must be condemned on hygienic grounds, as the frequent consumption of canned goods which have been colored with copper might be very prejudicial to health. These remarks are made with the full understanding that the occasional consumption of a small quantity of copper, or even of lead, tin, or a preservative such as those mentioned above, may occasion no ill effects whatever; it is only when such substances are consumed constantly and for long periods of time that they may become dangerous from the cumulative effect which they may produce.

The amount of analytical work which has been bestowed upon this class of foods is very great indeed, and laborious researches have been undertaken, not only for the purpose of determining and detecting the different forms of adulteration which may exist, but also of showing in what way such adulterations can best be detected. The data in detail of this work will soon be published as Part 8 of Bulletin 13, on "Food and Food Adulterants."

ADULTERATION OF HONEY.

Since the publication of the special report on honey adulteration in Part 6 of Bulletin 13, a large additional amount of work has been done on this subject in conjunction with Prof. A. J. Cook, of the Agricultural College of Michigan.

Some question arose among dealers in honey in regard to the accuracy of the methods employed in determining honey adulteration, and the object of the work alluded to above was to determine in a measure the reliability of the methods employed. The investigation, however, did not stop at this point, but was carried considerably further, with the intention of determining, if possible, a method by means of which honey derived from the plant-louse, or the exudations therefrom, might be distinguished from that from pure floral honey. To this end fifty-six samples of honey were collected by Prof. Cook and forwarded by number to the Department for chemical examination. No description whatever accompanied these samples, and they were examined without knowledge of their origin or nature.

The examination consisted in the determination of water, ash, percentage of invert sugar, percentage of sucrose, and polarization at different temperatures. In every instance abnormal honeys—that is, those not derived from pure floral exudation—were detected. In one or two cases, however, a genuine floral honey was included in the list of suspicious honeys. On inquiry it was found that such honeys had been rapidly gathered, and were deemed suspicious on account of containing more than 5 per cent of sucrose.

The general results of the investigation serve to confirm the conclusions of previous work, viz, that a pure floral honey gathered and stored by bees always shows a left-handed polarization at ordinary temperatures. Such honey contains an average of about 17 per cent of water, 72 per cent of invert sugar, and from 1 to 2 per cent of sucrose. Occasionally the percentage of sucrose rises above these figures, but the figures given are the average.

When honey has been mixed with glucose the percentage of invert sugar is at once diminished, due to the fact that glucose consists largely of maltose and dextrin, maltose furnishing a smaller percentage of reducing sugar and dextrin none at all. Such honeys, moreover, are always strongly right-handed at ordinary temperatures and remain so after inversion. On the other hand, a honey which contains an abnormal proportion of sucrose may have a right-handed polarization at ordinary temperatures, but after inversion it becomes strongly left-handed, showing the nature of the adulterant.

Honeys which are derived from the plant-louse are, in general, slightly right-handed. In one instance it was found to be strongly so, and this right-handed polarization continues after inversion. Such honeys also have an abnormally low percentage of invert sugar and, as has been observed in the few cases which have been examined, an abnormally high percentage of ash.

As a result of the work so far, the following may be regarded as a temporary criterion for judging a honey derived from the plant-louse, as distinguished from a pure floral honey: The plant-louse honey will have an abnormally high percentage of ash, an abnormally low percentage of invert sugar, and a polarization near zero at ordinary temperatures, or slightly right-handed and persisting after inversion.

It is well known that pure invert sugar at a temperature of 88° C. is without effect upon the plane of polarized light. Hence a solution of pure invert sugar polarized at that temperature would indicate zero on the scale of the polariscope. Advantage was taken of this fact to determine the residue of right-handed bodies in the honeys examined at a temperature of 88°. Forty-two of the samples mentioned above were polarized at 88°, and with the uniform result, with two exceptions, of a right-handed polarization. The degree of right-handed polarization, however, varies widely, being smallest for pure floral honeys, largest for honeys adulterated with glucose, and a medium polarization for honeys of plant-louse origin. The highest right-handed polarization at 88° obtained was 53.53°. This was of a sample which was strongly adulterated with glucose. One sample polarized zero at 88°, and was therefore presumably a pure solution of invert sugar. Two samples showed a left-handed polarization at 88°, indicating that they contained an excess of levulose. They were probably made by draining a granulated honey, leaving the dextrose undissolved.

The general result of this work establishes the fact that the chemist can in almost every instance distinguish a pure floral honey from any sophistication of any kind, with the possible exception of adulteration with pure inverted sugar.

Work on this line of investigation will be continued with the object of discovering some method by means of which the last form of adulteration may be also detected with certainty.

EXPERIMENTS WITH SUGAR BEETS.

The experimental work with sugar beets begun in previous years was continued during the past year in the same general lines as those already pursued. The work of the Department was divided into two main divisions: The first division consisted in the continuation of the experimental work at the station of the Department at Schuyler, Nebr.; the second consisted in the distribution of high-grade beet seed to farmers who had applied therefor, accompanied with instructions for

planting, cultivating, and harvesting the beets, and taking samples for transmission to the chemical laboratory at Washington.

The work at the experiment station consisted of two distinct lines of investigation. The first of these referred to the production of sugar-beet seed from a crop of mother beets saved from last year, and the second was devoted to the cultivation of the different varieties of sugar-beets in plats of appropriate size, with the determination of their sugar content at various periods of maturity, and the total weight of beets produced. In connection with these, an interesting experiment was undertaken in determining the actual cost of the production of a single acre of beets, the data of which will be found farther on.

THE PRODUCTION OF SEED.

The beets which were used for the production of seed were preserved from the crop of 1891 in carefully constructed silos. Beets of normal form and a weight of a pound or a little more were those which were selected for preservation. At the time the beets were placed in the silo a given number representing the average of each variety was taken and analyzed. The weight of the beets was also determined. The object of this work was to determine as nearly as possible any loss in sugar or in weight which might take place during the winter.

On the 26th of March, 1892, the silos were opened and the work of examining the mother beets was commenced. When the silos were opened, the beets were found in an excellent state of preservation. The varieties which were preserved were the following: (1) Vilmorin's Improved; (2) Dippe's Kleinwanzlebener; (3) Desprez; (4) Lemaire; (5) Ferdinand Knauer; (6) Kleinwanzlebener Elite.

A comparative analysis of the beets at the time the silos were opened showed that they had lost during the winter an average of 2.85 per cent of sugar. In the analysis of the beets, therefore, 2.85 per cent of sugar was added to each determination in order to make the comparison directly with the beets as they were stored. In all, 4,455 mother beets were analyzed by boring a hole about three-fourths of an inch in diameter diagonally through the beet and taking the pulp thus obtained for the analysis.

The beets were then divided into various classes according to the percentage of sugar which they contained. The classification of the different varieties according to this method is given in the following table:

Number of beets of each variety containing the given percentage of sugar.

Variety.	11 per cent.	12 per cent.	13 per cent.	14 per cent.	15 per cent.	16 per cent.	17 per cent.	18 per cent.	19 per cent.	Total.
Vilmorin	38	161	268	295	170	50	4	.....	.....	986
Kleinwanzlebener	37	115	196	245	211	53	8	1	.....	886
Desprez	144	337	331	243	78	10	3	.....	.....	1,146
Lemaire	44	93	127	99	59	8	3	1	.....	434
Knauer	58	166	169	128	79	32	4	2	.....	838
Elite	32	72	93	76	50	30	8	3	1	365
Total	.....	.....	.....	.....	.....	.....	.....	.....	.....	4,455

All beets which fell below 11 per cent of sugar were rejected and not used for the propagation of seed.

All the beets which were preserved for seed were then divided into three classes. The first or extra quality consisted of those beets showing a content of 17 per cent of sugar and above; the second class,

grade No. 1, consisted of all those beets having a sugar content varying between 15 and 17 per cent; the third class, grade No. 2, consisted of all those beets having a sugar content of from 11 per cent to 15 per cent. The seeds were harvested early in August and with the following results:

Variety.	Area planted.	Seeds collected.	Calculated yield per acre.
	Rods.	*Pounds.*	*Pounds.*
Vilmorin	20.0	117	936
Dippe's Kleinwanzlebener	20.0	128	1024
Desprez	24.0	92	613
Lemaire	10.3	66	1056
Knauer	15.0	126	1344
Elite Kleinwanzlebener	9.0	66	1173
Total	98.3	595	Mean...1025

Actual value of seed produced (595 pounds at 15 cents) $89.25

The Department has reason to be satisfied with this first attempt in this country to produce graded beet seed, such as has been produced for so many years and with such happy results on the beet-seed farms of Europe. All the seed of the extra quality, of course, is saved solely for the purpose of producing mother beets for further seed production. The seed of the first and second grades will be used for general planting for the production of the two grades of sugar beets.

On account of the newness of the work and the difficulty of securing skilled labor therefor, no attempt was made to determine the actual cost of the production of the seed. Its value, however, at the rate of 15 cents per pound, shows that an acre of ground may be made to yield a large sum of money when planted to mother beets.

Aside from the importance of the production of beet seed as an economical measure, it must not be forgotten that there is also much to be expected from the acclimatization of the beet to the conditions of the seasons in different parts of the country. It is only reasonable to expect that beet seed which is produced for a number of years, for instance in the vicinity of Schuyler, will be able to produce a beet better adapted to the climatic conditions of that locality than beet seeds imported from Europe. By the careful selection of high-grade beets and the propagation of seed therefrom, it is to be expected that the average content of sugar in the field beets will be more firmly established and increased. At the present time, with the imported seed and at the period of perfect maturity, we have been able to produce beets with an average content of about 14 per cent of sugar. With seed produced on the spot in the manner indicated, it is not too much to expect that this content of sugar may be increased fully 1 per cent in the field as a whole.

During the season which has just passed, a much larger number of mother beets has been selected, and it is proposed during the coming spring and summer to produce beet seed on a larger and more elaborate scale than that which is indicated briefly in the report above.

CULTURE WORK.

The cultivation of the different plats in beets was conducted on the principle of rotation, the plats which were in beets last year having been seeded to cereals, and all the plats of the station so adjusted as to bring each one in beets once in four years.

The first planting was made on April 30, it having been delayed until

that day by the cold and wet spring. The month of May was extremely wet and cold and quite unfavorable for the vigorous growth of the young beets. June was favorable to rapid growth, which continued until the middle of July. After the middle of July and until the harvesting time the meteorological conditions were of an extreme character. The temperature for the latter half of July and the whole of August was very high, and during this time there was very little rainfall. The mean temperature for July and August for 1891 was 70.05° F. For the same period during 1892 it was 74° F. The rainfall from May 1 to November 1, 1891, was 26.6 inches; for the same period in 1892, 14.1 inches. Thus it is seen that the season of 1892 was much warmer and drier than the season of 1891, and therefore more unfavorable to the development of the beet.

The beets also suffered from an insect pest during the season of 1892, which produced serious ravages. The insect—a caterpillar (*Eurycreon sticticalis*)—attacked the beets during the latter half of July. By the use of arsenical insecticides the ravages were checked, but not until great damage had been done and many caterpillars had transformed. A second generation was thus produced and attacked the crop at a later date. During the second attack the whole of the foliage of the beets attacked was consumed by the caterpillars. The growth of the beets was therefore checked and kept at rest until time for the development of a new crop of foliage, which latter was of course developed at the expense of the original beet.

YIELD.

As a result of all these unfavorable conditions the yield of beets per acre was much less in the season of 1892 than in the season of 1891. The yield of each variety per acre and the maximum percentage of sugar in the juice is given in the following table:

	Tons per acre.	Sugar in juice.	Sugar per acre.
		Per cent.	*Pounds.*
Vilmorin	12.5	15.6	3,900
Dippe's Kleinwanzlebener	15.0	16.0	4,800
Desprez	16.8	13.0	4,368
Lemaire	15.8	14.6	4,614
Elite Kleinwanzlebener	16.0	15.2	5,120
Original Kleinwanzlebener	18.6	16.1	5,989

In explanation of the above table, it is necessary to say that the maximum content of sugar in the juice is taken from the series of analyses which yielded the highest results during the analytical season; therefore the table shows what the variety would have yielded in sugar if harvested at the most opportune time. Of course, in a manufacturing campaign it is not possible to harvest each variety of beets at the time of its greatest content of sugar, and therefore the yield of sugar as given in the above table is much larger than would actually be obtained in practice.

In regard to the percentage of sugar in the beet, the content was fairly comparable with the season of 1891. The yield in tons per acre is decidedly less. A comparison of all the varieties of the two seasons is given in the following table:

	1891.	1892.
Weight of beets per acre ..... tons..	21.77	15.8
Yield of sugar per acre ..... pounds..	6,060	4,800

COST OF THE PRODUCTION OF ONE ACRE OF BEETS.

In the data which follow is given the total expense of the production of a single measured acre of beets, in which an accurate account of every expense attendant upon the planting, culture, harvesting, and delivering of the beets was kept. The result, while not particularly encouraging, must be interpreted in the light of the fact that it is not possible to produce a single acre of any crop with as much economy as a larger area could be produced proportionately. Further than this, attention must be called to the fact that no preparation had been made at the station for harvesting the beets by means of a mechanical lifter. Inasmuch as the rest of the work was done on small plats and had to be done carefully by hand, no provision had been made for harvesting after the manner employed in large fields. The cost of harvesting, therefore, as given in the itemized account, is fully double what it would be in ordinary beet culture. The itemized cost of the production of one acre of beets is as follows:

1891:		
Oct. 1.	Light plowing of ground	$1.68
Oct. 25.	Deep plowing of ground	2.00
Oct. 25.	Subsoiling of ground	2.00
1892:		
April 28.	Disk harrowing of ground	.38
April 29.	Twice harrowing, at 17 cents	.34
April 30.	Rolling	.17
April 30.	Cost of seed (17 lbs., at 15 cts.)	2.55
April 30.	Drilling seed	.52
April 30.	Rolling after drill	.17
June 2.	Horse hoeing	.62
June 8-10.	Thinning out (65 hours, at 12½ cents per hour)	8.12
June 17.	Hoeing by hand (50 hours, at 12½ cents)	6.25
1892:		
June 21.	Horse hoeing	$0.62
June 27.	Horse hoeing	.62
June 30.	Horse hoeing	.62
July 7.	Soiling up the beets (29 hours, at 12½ cents per hour)	3.62
	Total cost of production	30.28
	Harvesting by hand	13.50
	Transporting 12½ tons beets 3 miles, at 50 cents per ton	6.00
	Rent of land, at $2.50 per acre	2.50
	Total cost of planting, cultivating, harvesting, and delivering to factory one acre of beets	52.28

In so far as the actual cost of the production of the beets is concerned, the figure given above, of $52.28, may be taken as the maximum cost of the production of 1 acre of beets by the most careful and approved methods. There is, of course, no doubt of the fact that in field culture where such great care is not exercised the cost may be materially diminished. As has already been mentioned, this is especially the case with the item of harvesting, from which at least one-half may be deducted as indicated above. Nevertheless the actual figures are given just as the expense account was paid at the station. Included, of course, in the cost of harvesting is the cost of topping the beets, which might not be inferred simply from the item as given. The cost of transporting the beets to the distance of 3 miles includes the loading of the beets into the wagons, hauling the distance, and unloading by means of a shovel into a car. Where beets are dumped directly at the door of a factory this cost may be materially diminished.

The price received for the beets was $4 per ton, making the total price received $50. This deducted from the cost of production shows an apparent net loss of $2.28 per acre. When, however, the fact is considered that if the farmer had done this work himself and paid himself and his team the liberal wages allowed, it is seen that he would have come out very well considering the outlay.

It was, of course, a great source of regret to us that the very acre of beets which we had selected as a test of cost of production should happen to be the one which was most seriously damaged by the caterpillars. The foliage of the beets on this acre was completely destroyed by the caterpillars during their first and second attacks; otherwise there is no doubt of the fact that the yield per acre would have been

at least 6 tons more and shown a handsome profit instead of loss per acre. These, however, are accidents which must be allowed for, and it is useless to try to deceive the public by the statement that every farmer who practices beet-growing will make a profit per acre. The business is just like that of any other farming occupation—sometimes it will prove highly remunerative and at other times it will be practiced at a loss.

This Department has no desire to induce farmers to enter into the culture of the sugar beet by any high coloring of the returns which they will receive or any diminution of the labors which the farmer will have to undergo. With the most careful culture and with attention to every detail the farmer may as well acknowledge the fact that it will cost him, in round numbers, in the neighborhood of $50 to produce a single acre of beets and deliver it a distance of 3 miles to a factory. Where he farms on a larger scale, and especially after a year or two of experience, there is no doubt of the fact that this expense can be reduced to $40 per acre or perhaps lower. More than this can not now be promised as regards the economy and cheapness of beet production.

Taking all the plats of the experimental station for the season, it is found that the mean yield per acre was 15.8 tons, which, at $4 per ton, would amount to $63.20 per acre. The cost of production for the yield of 15.8 tons would have been no greater than for the yield given, viz, 12.5 tons per acre, that is, $30.28. The cost of harvesting and delivering to the railroad station would have been greater, viz: for transportation, $1.50 extra, and for harvesting and topping, $2.50 extra, making the total extra cost for the increased yield $4. This, added to the $52.28, would make the total cost $56.28, which, deducted from the price of the beets, $63.20, would leave a net profit per acre for the whole station of $6.92. To avoid any misconception on the part of the reader, let it be said that this does not, of course, represent the actual cost of the small plats which were grown upon the station, which was very much greater than the amount mentioned above. The illustration is given only to show what the financial result would have been had the whole station been cultivated for factory purposes as the 1 acre was. A profit of $6.92 would be at the rate of nearly 20 per cent on a valuation of the land at $40 per acre. This is certainly a profit which would be satisfactory to most persons.

It is seen, however, from the above how rapidly the profits of a farmer will diminish if he allows the yield per acre to fall below 15 tons. On the contrary, it must be granted that when the yield does fall below 15 tons it is due to lack of care and experience in culture, and thus the actual cost of production is diminished to avoid expense. Nevertheless it seems certain that farmers who conduct the culture of their beet fields in such a way as to secure only 5 or 6 tons per acre must necessarily operate at a loss.

In regard to the price obtained, it may be well to say that the beets not used for mothers were sold to the beet-sugar factory at Grand Island, where the price paid for beets is $4 per ton for beets polarizing from 12 to 15 per cent. The beets delivered by us to the factory polarized nearly 15 per cent, and so were very little inferior to those which would have fetched $4.35 per ton.

On the whole, the culture experiments for the season must be regarded as quite satisfactory when all the adverse circumstances are taken into consideration. The data given at least represent with absolute accuracy the operations which were performed and are therefore extremely valuable to the farmer and the manufacturer as a basis

for estimating the probable cost and profit or loss of engaging in beet-sugar culture. The full data of the culture experiments were published in Bulletin 36 of the Division of Chemistry, which was issued in March, 1893.

GENERAL DISTRIBUTION OF SEED BY THE DEPARTMENT.

During the late winter and early spring of 1892, 4,000 pounds of imported beet seed were distributed by the Department to various parts of the United States, to the addresses of those who had made written application for such seed during the previous year. The varieties distributed were Vilmorin's Improved and Kleinwanzlebener. In all, 8,159 packages of 7.8 ounces each were sent out to 2,316 addresses. Accompanying each package were printed directions for preparing the land, planting the seed and cultivating it, and for taking samples for transmission to the Department for analysis.

Attention was called in the last annual report to the unsatisfactory results attending this method of experiment. It was difficult to obtain control on the part of the farmers of the experimental conditions, and the reports which have been received are as a rule fragmentary and unsatisfactory. In addition to this, inasmuch as a considerable time must necessarily elapse between the harvesting of the beets and their reception at the laboratory for analysis, more or less change will take place in the constitution of the beets. This change consists essentially in the loss of water by evaporation during transportation in the mails; so when the beet is received it is often shriveled, and by experiment it has been demonstrated that it may lose as much as 15 to 20 per cent of water in extreme cases. The result of this loss of water is to increase the apparent content of sugar in the juice of the beet and thus give rise to misleading results. In the interpretation, therefore, of the analytical results obtained from the analysis of these beets, the above fact must be borne in mind. In general, the more distant the locality the greater the loss by evaporation would be. Nevertheless the results may be regarded as in a measure comparable and indicating in a general way the possibilities of beet culture in the various localities of the country. The value of the work, however, appears to be so small from a practical point of view that it is recommended that further experiment in this direction be discontinued.

Results of the work by States.

State.	Number of samples.	Average content of sugar.	State.	Number of samples.	Average content of sugar.
		Per cent.			*Per cent.*
Arkansas	3	9.41	New Mexico	11	15.34
California	4	14.72	New York	4	15.43
Colorado	129	14.82	North Carolina	1	8.99
Idaho	1	14.65	North Dakota	6	12.86
Illinois	18	10.93	Ohio	42	11.62
Indiana	18	11.23	Oregon	8	14.24
Iowa	11	10.93	Pennsylvania	2	10.75
Kansas	18	11.07	South Dakota	30	13.12
Kentucky	2	8.86	Tennessee	1	9.42
Michigan	37	14.11	Virginia	6	11.95
Minnesota	22	12.17	Washington	14	14.52
Missouri	2	8.09	West Virginia	2	11.29
Montana	1	10.93	Wisconsin	12	12.72
Nebraska	15	14.15	Wyoming	3	15.20
Nevada	9	15.92			

Some interesting suggestions may be derived from the study of the data which are given above. In general, the data confirm the previous publications of the Department relating to the area in which sugar beets can be successfully cultivated. This area, however, appears to be gradually extending. The most remarkable extension of it which is indicated is in the so-called arid regions. Beets which have been grown upon irrigated land in Wyoming, Idaho, Colorado, and New Mexico are uniformly of high character and rich in sugar. It is evident that there is perhaps no crop which can be so successfully cultivated upon irrigated land as sugar beets. The cost of irrigated land makes it necessary that some crop should be grown which will yield a large return. Land which it has cost from $50 to $100 per acre to irrigate can not be seeded with financial success to such crops as will yield a net profit of only $4 to $5 per acre. Such land should be made to yield at least a net profit of from $10 to $15 per acre in order to pay a proper interest on the first cost of the soil. There is no crop yet which has been introduced into the arid regions which gives such promise of producing the above result as the sugar beet. The market for sugar can not be overstocked, hence there is no danger of blocking the market in case all the lands which have now been recovered by irrigation should be planted in beets. It would be quite different if they were planted with potatoes or some similar crop, whose overproduction might glut the market. It is no wonder that capitalists are looking with interest to this new opening for investment.

Climatic conditions, as has already been stated in previous publications of the Department relating to sugar beets, are of the utmost importance not only in the growing of the crop, but in the harvesting thereof. In the irrigated lands of our arid regions we have a complete control of climatic conditions. In the first place, there is during the growing season almost unbroken sunshine, a condition essentially favorable to the production and storage of large quantities of sugar. In the second place, the high altitude of the plateaus of the arid regions gives a summer which is not too warm for the proper growth of sugar beets. In the third place, the control of the water for irrigating purposes renders it possible to stimulate the growth of the beets during the earlier periods of the summer, while the withdrawal of the water prevents any second growth after the beets have matured in the autumn. In the fourth place, the dry autumnal weather is most favorable to harvesting the crop, and the period of frosts is so well known as to permit of the entire harvest being made before any danger of freezing occurs. It is believed that in no other place in the world can be found such a favorable agreement of climatic conditions for the production of not only large crops of beets per acre, but also of beets rich in sugar and of high purity.

Another fact which is worthy of notice is the continued success of beet culture upon the Pacific coast. The few samples received from the Pacific coast continue to sustain the high character of that locality for the production of sugar beets. Fortunately this experimental evidence has been thoroughly proved by the results of practical work. The beet-sugar factories during the present year have scored a phenomenal success. From the incomplete records on file in the Office of Internal Revenue, it is evident that the State of California alone during the present season has made over 20,000,000 pounds of beet sugar in three factories. Such a result is well calculated to encourage further investment of capital in the production of beet sugar.

A further study of the data reveals the fact that the Northern, Cen-

tral and Eastern States of the country are also well suited for the production of sugar from the sugar beet. From New York to the Dakotas the results are strikingly favorable.

The work of the Department, now extending over a period of three years, in testing in the manner described the possibilities of beet culture in the United States is now so complete as to leave the matter practically in the hands of investors. The Department can do no more than has been done to show the course which capital should pursue. It remains for the business men of our country to take hold of the matter of the production of our own sugar in such a way as to insure its speedy success. As far as can be seen there is no longer any reason to hesitate. The experimental ground has been thoroughly worked out both at the experimental station of the Department and by the State experiment stations, and by the general work of the Department in distributing beet seed to farmers in all localities. The case has been well made out. Numerous failures, it is true, have shown that there is always danger of disaster, but the uniform preponderance of successful effort shows conclusively that, with properly directed effort, and with properly invested capital and properly conducted operations, success is as reasonably certain in this business as in any other legitimate business in this country.

EXPERIMENTS WITH SORGHUM.

The work of the Department in continuation of the experiments for the improvement of sorghum as a sugar-producing plant was continued during the past year in Kansas at Sterling and Medicine Lodge.

At the Sterling Station 175 acres of land were leased for the culture work. The object of getting so large an area of land was to enable the different plats to be planted at a sufficient distance apart to prevent crossing when it was not desired. The land was plowed from 4 to 5 inches deep, harrowed once and in some instances twice.

Planting was commenced on the 8th of April and ended on the 30th of June, thus continuing over a period of eighty-three days. Two hundred and eighty-seven small plats were planted; most of them with seeds from selected seed heads of greatly superior quality. One hundred and nine large areas were planted with mixed seed from high-grade cane. The small plats were planted by hand while the larger were planted by drill. An average of 2 pounds of seed was planted per acre. Some replanting was necessary. The ordinary cultivation was given, the hoe being used on some plats to reduce the plants to a proper number per acre.

The season was rather favorable to the production of cane, and the best crop which has been secured by the Department at Sterling was grown. The quality of the canes was also satisfactory. The experience of the work shows that earlier plantings require a longer period to reach maturity than the later ones, which might be inferred from the character of the season.

The main object of the year's work was to reduce the number of varieties by selecting a few superior ones. The so-called varieties of sorghum are based upon very small botanical differences, not sufficient to distinguish them botanically but simply agriculturally; hence a very great many varieties may be produced, but they are so nearly alike that it does not seem necessary to establish them by long years of careful selection. The few superior varieties already established, which are quite distinct in their nature, offer all the inducements necessary for the continued propagation of a high-grade sorghum cane.

In general the experience of the work at the station has shown that hand-planting gives a much more uneven and irregular stand of cane than machine-planting; but there is no other way of planting selected seed heads except by hand, as it would be too much trouble to put so small a quantity of seed into a drill for planting purposes. It is in general advised to roll the land as soon as the canes appear, as it makes it possible to cultivate closer and thus diminish the amount of hand labor required.

TESTS OF VARIETIES.

As a general result of the work four varieties have been selected, out of all which have been investigated, for the continuation of improvement work in the future. These varieties are Folger, Collier, McLean, and Colman.

Folger is the best early maturing variety. It undoubtedly originated in a cross of Amber and Link, as reversions may be found in its canes to both these varieties, but the general type of the variety is now firmly established. It has all the advantages of early maturation of the Amber cane and is superior to it in every respect—in yield per acre, sugar content, and general sugar-making qualities.

The Collier variety is recommended as the best variety for the more northern latitudes in which sorghum is grown for sugar. It has an abundance of foliage which is quite persistent and very resistant to frosts. The canes are quite slender, yet it always stands up well, because the seed heads are light. It has a high content of sucrose and a fair purity. It ripens reasonably early and can be planted as late as June 15, in favorable localities.

The McLean variety has been grown at the Sterling Station for three years. It gives quite large canes and grows very tall. It seems well suited to the climate of Kansas and has always since its introduction shown a high percentage of sugar. The type is not yet firmly established, inasmuch as when the seed was originally received from Australia it consisted of two distinct types, and the pure McLean type has not yet been as firmly established as could be desired.

The Colman variety was originated at the station in 1888 by a cross between Amber and Kansas Orange. At first the type was very variable, but now it has become firmly established, and there is no variety of sorghum which has been grown which gives as good results in the sugar-house as the Colman.

The analytical work at Sterling embraced the analysis of average samples from the different plats to determine their value for sugar production, together with the usual analysis to determine the selection of seed heads by the character of the juice of the cane bearing them. The analytical results have been collected into tables showing the various properties of the different plats which were in cultivation.

The number of days required from the time of planting until the standard varieties reached 11 per cent of sugar is as follows:

	Days.
Colman	135.
McLean	135.
Collier	140.
Folger	142.

The dates on which the leading varieties reached 11 per cent of sucrose are as follows:

Folger	Aug. 29.
McLean	Aug. 30.
Collier	Sept. 5.
Colman	Sept. 7.

The number of days required for each of the leading varieties to attain a purity of 70 per cent is as follows:

	Days.
Colman	135
McLean	139
Collier	144
Folger	149

The dates on which the leading varieties attained a purity of 70 per cent are as follows:

McLean	Sept. 4
Colman	Sept. 7
Collier	Sept. 9
Folger	Sept. 12

The relative position of the leading varieties, based on analysis of average samples, for the maximum per cent of sucrose is as follows:

	Per cent sucrose in juice.
Collier	18.50
McLean	17.24
Colman	16.93
Folger	15.57

The dates on which the leading varieties reached their maximum percentage of sucrose, as based on the analysis of average samples, are as follows:

Folger	Sept. 26
McLean	Sept. 28
Colman	Sept. 29
Collier	Sept. 30

The relative rank of the leading varieties in respect of minimum glucose, based on the analysis of average samples, is as follows:

	Per cent reducing sugar in juice.
McLean	0.44
Collier	0.49
Colman	0.50
Folger	0.91

The dates on which the leading varieties showed their minimum percentage of reducing sugar, as determined by the analysis of average samples, are as follows:

Colman	Sept. 25
McLean	Sept. 26
Folger	Sept. 27
Collier	Sept. 28

The relative position of the leading varieties in respect of the maximum purity, based on the analysis of average samples, is as follows:

	Purity.
Collier	78.19
Colman	77.95
McLean	76.80
Folger	74.75

The dates on which the leading varieties reached their maximum purity, based on the analysis of average samples, are as follows:

McLean	Sept. 22
Collier	Sept. 27
Folger	Sept 27
Colman	Sept. 27

The relative position of the leading varieties, based on their mean percentage of sucrose, from the analysis of average samples, is as follows:

	Mean percentage of sucrose.
Collier	18.43
Colman	17.79
McLean	16.92
Folger	14.87

The relative position of the leading varieties as determined by their mean purity, from the analysis of average samples, is as follows:

	Mean purity.
Colman	77.99
McLean	77.47
Collier	76.02
Folger	72.88

The mean value of the leading varieties in respect of maximum sucrose, for five years' experiment, is as follows:

McLean	Rank 1
Colman	Rank 2
Collier	Rank 3
Folger	Rank 4

The relative rank of the leading varieties for five years, based on the means of their minimum glucose, is as follows:

McLean	Rank 1
Collier	Rank 2
Colman	Rank 3
Folger	Rank 4

The relative rank of the leading varieties for five years, based on the mean of their maximum purities, is as follows:

McLean	Rank 1
Colman	Rank 2
Collier	Rank 3
Folger	Rank 4

From the total number of seed heads selected for propagation from the leading varieties, during the season of 1892, the following data are taken:

Percentage of total number falling within the limits given below.

[Percentage of sucrose in juice.]

Variety.	Below 11 per cent.	11 per cent.	12 per cent.	13 per cent.	14 per cent.	15 per cent.	16 per cent.	17 per cent.	18 per cent.	19 per cent.	20 per cent.	21 per cent.	Number of selections.
Colman	1.26	0.74	1.39	3.81	6.68	11.28	29.41	32.09	10.59	1.65	0.79	0	8,773
Collier	0.01	0.05	0.15	0.80	1.93	7.13	17.00	28.83	29.98	12.85	1.20	0.01	5,316
McLean	0.10	0.24	1.29	6.05	15.31	21.48	23.71	22.74	8.23	0.69	0	0	3,711
Folger	0.87	2.42	11.73	32.35	38.50	13.52	0.55	0.02	0	0	0	0	11,467

Percentage of total number falling within the limits given below.

[Purity coefficient in juice.]

Variety.	Below 70 per cent.	70 per cent.	71 per cent.	72 per cent.	73 per cent.	74 per cent.	75 per cent.	76 per cent.	77 per cent.	78 per cent.	79 per cent.
Colman	15.21	2.67	3.87	4.73	5.92	7.94	10.90	13.47	14.10	11.81	5.47
Collier	10.69	2.99	4.62	5.43	8.70	12.49	15.29	14.27	12.00	7.11	3.19
McLean	6.57	3.28	4.92	7.61	11.03	15.10	15.96	14.66	10.79	6.27	1.99
Folger	53.58	5.96	11.11	7.76	4.59	2.24	0.90	0.48	0.21	0.06	0.05

Variety.	80 per cent.	81 per cent.	82 per cent.	83 per cent.	84 per cent.	85 per cent.	86 per cent.	87 per cent.	88 per cent.	89 per cent.	90 per cent.
Colman	2.21	1.09	0.33	0.14	0.03	0.04	0.02	0.02	.....	0.01	0.02
Collier	1.29	1.50	0.11	0.18	0.05	0.09	.....	.....	.....	.....	.....
McLean	0.86	0.40	0.43	0.13	.....	.....	.....	.....	.....	.....	.....
Folger	0.02	0.01	0.01	.....	0.01	.....	0.01	.....	.....	.....	.....

Experiments were also made to determine the relative keeping qualities of the different varieties. They were cut and placed in small piles in a shady place, covered with trash, and this trash was kept moist.

Table showing the keeping qualities of the different varieties.

Variety.	Date.	Sucrose.	Glucose.	Purity.
		Per cent.	*Per cent.*	*Per cent.*
McLean	Oct. 6	19.20	0.51	78.40
	Oct. 29	15.45	7.10	62.90
Collier	Oct. 6	20.10	0.31	76.80
	Oct. 29	17.21	6.92	66.04
Colman	Oct. 6	18.70	0.62	79.20
	Oct. 29	17.81	4.00	74.30
Folger	Oct. 6	17.70	1.03	76.70
	Oct. 29	15.28	4.23	76.17

From the above table it is seen that it is not always safe to depend upon the deterioration of the sucrose alone in regard to observing the qualities of the cane. In each instance it is seen that there was, while not a great loss of sucrose, yet a tremendous increase in glucose and decrease in purity. The natural drying out of the cane would maintain the sucrose content up near the normal, while the sugar-producing quality of the cane was greatly deteriorated.

The following is a statement of the average analysis of the different varieties of cane from the time they were first grown by the Department up to the present. The great increase in the sugar content and the purity for the year 1892 must be regarded as due largely to climatic conditions, and it is not probable that this high character of the cane will be preserved.

Variety.	1888.			1889.			1890.			1891.			1892.		
	Mean percentage.		Mean purity.	Mean percentage.		Mean purity.	Mean percentage.		Mean purity.	Mean percentage.		Mean purity.	Mean percentage.		Mean purity.
	Sucrose.	Glucose.		Sucrose.	Glucose.		Sucrose.	Glucose.		Sucrose.	Glucose.		Sucrose.	Glucose.	
Collier	12.31	0.73	71.69	14.91	0.75	76.95	15.95	0.59	74.77	14.80	0.90	73.80	18.50	0.49	78.19
Colman	.....	.....	.....	14.58	1.15	75.55	14.88	0.84	76.38	15.60	0.73	76.30	16.93	0.50	77.95
Folger	.....	.....	.....	14.08	2.03	76.54	14.12	1.75	74.91	14.60	1.35	73.30	15.57	0.91	74.75
McLean	.....	.....	.....	.....	.....	.....	15.22	0.52	76.00	16.40	0.55	77.40	17.24	0.47	76.80

The above data, while they show variations and occasional reversions and retrogradations, yet indicate most clearly a gradual, and in some cases rapid, improvement in the character of the variety. There is a tendency to the production of a larger quantity of sucrose, a smaller quantity of glucose, and a higher purity. This is due solely to the principle of selection, by means of which an attempt is made to propagate only such individual samples of any given variety as have in a high degree the characteristics necessary for successful sugar-growing.

The amount of analytical work which was accomplished at Sterling is only faintly indicated by the above selections from the work. The analytical work was commenced on the 20th of August and continued until the 1st of October. The working force in the laboratory consisted of twenty-seven men. In all, 37,403 seed selections were made, and 1,772 analyses of average samples. The average number of analyses made per day was 1,399. Only about 25 per cent of the total number of canes brought in for selection passed the first test of specific gravity, and the total number of canes which were milled separately and the specific gravity test taken was 156,700.

EXPERIMENTS IN MOLASSES-MAKING.

In addition to the experiments in the improvement of the sorghum cane carried on at Sterling, considerable work was done in determining the varieties best suited to the manufacture of molasses, and the best methods of manufacture from the farmer's point of view. While this work was not intimately connected with sugar production, yet it will prove of some interest to the small farmer who grows only a small area of cane solely for the purpose of supplying himself or his neighbor with molasses. The results of chemical analysis alone would be sufficient to show that some varieties of sorghum are much better suited to sirup-making than others. The development of varieties of cane especially for sugar production would, in some respects, unfit it for the manufacture of molasses alone, for the reason that the certain granulation which would ensue after the molasses is boiled to the proper density would render it unfit, commercially, for table use. In all, about 4,000 gallons of sirup were made during the experiments, and the quality of much of it was equal to the molasses made from sugar cane by the open-kettle process. Unfortunately, all of the molasses made showed a tendency to crystallize and some became converted entirely into mush sugar. This fault could easily be foretold from the character of the cane worked.

Different methods of clarification were tried for the purpose of making a high grade of molasses. Among these were clarification with lime, clarification with lime and clay, clarification with lime and tannin, clarification with lime and some acid, and cold clarification with acid.

First, in regard to the lime process, it may be stated that when lime is employed it is not used to saturation, but the juice is left distinctly acid so that the bright color of the molasses may be preserved. The clarification made in this way must, therefore, be imperfect as far as any good effect of the lime is concerned. Lime always tends to darken the resulting product, and therefore its use in the manufacture of molasses must be generally condemned.

Experiments were also made, as indicated above, with the combination of lime and clay. In this case about 1 per cent of bisulphite of lime solution is added to the fresh juice as it comes from the mill. A thick creamy mixture of lime and clay is added to the boiling juice. The addition of clay is necessary to secure a rapid subsidence of the flocculent matter. The resulting molasses is usually of fine flavor and color.

The lime and tannin process is one which has been long in use, having been described as long ago as 1847. It consists in the use of tannic acid in some form added to the fresh juice before any other clarifying agent is used. Clarification with the use of tannic acid has also been tried in the Louisiana Sugar Experiment Station, and in general the results are regarded as favorable. In this process it appears that lime removes one class of impurities, the tannic acid removes another class, and the resulting juice is clear and bright.

The process which rests on the combination of lime with an acid has been practiced also for many years. Phosphoric acid is the one which is preferred on account of the perfect precipitation of the added lime which is secured. This process secures a sirup of bright color and fine flavor. This process has been tried in all sugar-producing countries and gives apparently good results; yet it has not come into general use, inasmuch as in sugar-producing countries it is no longer an object to secure a light-colored product, but a large yield without reference to color.

The method of combining lime with carbonic acid has been thoroughly worked out by the Department, and with excellent results in so far as the yield of sugar is concerned. There is probably no known method by which so large a yield of sugar can be obtained from a given quantity of juice as by the application of the treatment employed in beet-sugar factories known as carbonatation or saturation, namely, the addition of a large excess of lime and its subsequent precipitation by means of a current of carbonic acid.

With sorghum juice, cold clarification has some decided advantages. Especially when these juices have been expressed by a mill, the starch grains, which they contain, will have opportunity to subside during cold clarification. If hot clarification be employed, the starch grains will soften and be distributed in a pasty mass uniformly throughout the whole of the juice. The addition of clay, of course, hastens the precipitation of all suspended bodies mechanically. It is doubtful whether the clay has any specific effect upon the clarification itself, but it acts simply as a mechanical carrier by means of which the subsidence of the flocculent matters is hastened. The fact that clay added to cold juice, which has been properly limed, gives a better separation of the impurities, a brighter, clearer liquid, which is more easily filtered and which gives less scum during evaporation, may be easily verified by laboratory experiments and also by work in a factory.

The process which gave the best results during the experimental work consisted in liming the cold juice until a good clarification was secured, adding lime when necessary until the juice was decidedly alkaline and the color red, the criterion being the proper clarification and not the color. This was followed by the addition of clay mixed to the consistency of a batter in sufficient quantity to increase the density of the well-stirred liquid about one degree Baumé or two degrees Brix. The whole mass was then allowed to settle, the time required being from one to two hours. The clear liquid was then drawn off from the surface by a swing valve, proper care being taken to leave all the settlings in the tank. The clear liquid was run into a clarifying tank; phosphoric acid was then added until the liquor was slightly acid, as determined by litmus paper. It was then heated nearly to the boiling point and the scums thoroughly removed. The juice was again allowed to settle for half an hour to an hour and drawn off again from the surface downward by a swing valve, care being taken not to remove any of the settlings. The light-colored and bright juice is then filtered. With

such a clear liquid filtering seems unnecessary, yet it gives increased brightness to the molasses. No pressure was used in the filter-press and the cloths did not require frequent changing. The clarified liquid was then sent to the evaporating tank and reduced to the consistency of molasses.

This method gives a good product, but of course there is a great waste, inasmuch as the settlings could not be filtered, but had to be thrown away. When the object is to secure a high-grade molasses for household use, without reference to the economy of manufacture, the process could doubtless be used to good advantage. The cost of the phosphoric acid, it was estimated, was not over one-third of a cent per gallon.

The process of liming the juice may be more minutely described for the benefit of those who are not accustomed to it.

Cream of lime is prepared by mixing a well slaked lime with water to the consistency of a cream and filtering it through a fine sieve to remove all large particles. It is highly important that no large particles of undissolved lime be present in the cream. This cream of lime is added slowly to the cold juice as it comes from the mill and thoroughly mixed. Blue litmus paper, which has been made red by dropping it in the fresh juice, should be immersed in the lime juice. When the reddened litmus paper shows a slightly blue tinge of color it indicates that the juice is slightly alkaline. If this is not the case more lime should be added until the juice becomes alkaline. A test-tube should now be filled with the limed juice, placed in the light, and allowed to remain at rest for five minutes. The liquor as seen in the test-tube should be bright, clear, and transparent. If it is not, more lime should be added to the juice and the test should be repeated. With some juice it is necessary to add lime until it becomes strongly alkaline and reddish in color; while other juices liming to the neutral point or to slight alkalinity gives a proper result. In all cases cream of lime must be added until the juice becomes clear and bright in order that a good clarification may be secured.

Two points should always be borne in mind: If too little lime be used the juice will not be well clarified, and if an unnecessary amount of lime be used it will require excessive use of phosphoric acid to remove it. Practice will soon determine very nearly the amount of lime required, but the exact proportion should always be finally determined by the appearance of the limed juice in the test-tube.

Experiments show that the yellow or red clays are best suited for this purpose. They should be well mixed to a uniform batter with water and strained to remove all coarse particles. Enough of the clay should be added to the limed juice to increase its density sufficiently to cause a rapid settlement of the particles. The amount of clay depends upon many factors and can easily be determined by a few experiments. In general, from 1 to 2 pounds of clay to 100 pounds of juice are found sufficient. As soon as the juice has been limed and clayed and well mixed, it can be tested by means of the test-glass as indicated for the liming, and if it does not settle with sufficient rapidity an additional amount of clay can be added. A tank 36 inches deep filled with cold limed and clayed juice should give about 30 inches of clear juice and 6 inches of settlings in from one to two hours. The time depends upon the temperature, the density of the juice, and the quantity of the clay. When the clear juice has been drawn from the settling tank, leaving the impurities with the clay, the lime, having done its work, should be entirely removed from the juice by the addition of phosphoric

acid. One hundred and eight gallons of the acid phosphate of calcium, sometimes called superphosphate of lime, were used in the experiments. A preparation of phosphoric acid known as clariphos, essentially an acid calcium phosphate, may also be used. About 1 gallon of acid phosphate to 400 or 500 gallons of juice should be employed. The amount of acid required depends upon the quantity of lime which was used in the clarification, and for this reason it is desirable to use no more lime than is necessary to secure the desired results. The phosphoric acid combines with the lime, forming tri-calcium phosphate, which is insoluble, and is at once precipitated, thus removing both the lime and the acid present in the juice. The natural organic acids which were originally present in the juice are thus set free and produce the required acidity for the production of a light-colored and highly flavored product. It is important that both the phosphoric acid and the lime should be entirely removed, and for this reason no excess of acid phosphate should be employed. The proper method of determining this is also in a test-tube, in which it can be determined whether or not the precipitation is incomplete. Time should now be given for the phosphate of lime which is formed to settle, and this is easily accomplished in much less time than was required for the original clarification. A tank 36 inches deep gives about 34 inches of clear juice and 2 inches of settlings in about one hour. Attempts to filter the settlings or sediments were unsuccessful. The settlings from the lime and clay clarification, together with the settlings from the acid phosphate clarification, should be run into a sirup tank, diluted with an equal volume of water, and again allowed to settle and the clear liquor drawn off, by which means much of the waste which would otherwise occur can be avoided. By a proper arrangement of the swing-valve the liquor can all be drawn off from the surface downward and thus secure a complete separation of the settlings from the clear liquor. The clarified liquor can be easily filtered through fine cloths without pressure. Though filtering is not as necessary with clear and bright juice as it is with cloudy juice, yet it gives greater brightness to the molasses by removing all the fine particles which escape subsidence in the ordinary way.

The clarified juice prepared in the manner above can be evaporated in any convenient way which the farmer and small manufacturer have at hand. It is only important that the evaporation should be rapid and is best conducted in a thin film and in pans with several compartments with a continuous flow. An example of the method of the work may be seen from the following data:

September 29, tank No. 1 contained 480 gallons sorghum juice which showed a total solid, by means of a Brix spindle, of 21 per cent. The juice was limed to slight alkalinity and clay batter added until the total solids as indicated by the spindle amounted to 22.5 per cent. The liquor was then allowed to settle for one hour, ten minutes after which 440 gallons of clear juice were drawn off, and to this clear juice one gallon of acid phosphate of calcium was added, the temperature raised to the boiling point, and the mass skimmed. The whole was then allowed to settle for forty minutes, after which the clear juice was drawn off and filtered. The settling of the sediments required one hour. The skimmings were then mixed and diluted with water and resettled, giving a clear juice showing 9 per cent total solids. The clear juice was then evaporated to molasses, giving a light colored and fine flavored product.

EXPERIMENTS AT MEDICINE LODGE.

Experiments in the culture of sorghum were continued at Medicine Lodge, Kans., during the season of 1892.

The spring was very cold and wet, followed by an excessively hot and dry summer. The rainfall for April was only .49 inch; May, 4.65 inches; June, 2.85 inches; July .76 inch; August, 2.42 inches; September, .84 inch; October, 3.44 inches. The first killing frost was very early, having fallen on the 8th of October. The summer was excessively hot, and this, conjoined with the small rainfall, caused the crop to suffer severely from drought.

The alternate plats of the experimental station were planted with the different varieties of cane, the others being left in fallow. In addition to the acreage thus secured on the land leased by the Department, 50 acres of land were leased from neighboring farmers, who agreed to plant the varieties of cane furnished them, according to the directions of the superintendent, for a stipulated sum. It was also agreed that no variety of sorghum should be cultivated within 300 yards of any other variety. In this way all accidental mixing of varieties was avoided. The seed bed of the land upon the station was prepared by soiling and subsoiling—a thorough preparation of the surface for planting.

The planting was done chiefly with individual seed heads grown at Sterling during the year 1891. This kind of planting was of course accomplished by hand. In some blocks the planting was done with a hand-drill from mixed seeds of high-grade cane grown at Sterling during the previous year. The cultivation was careful and thorough and of the usual character. Hand thinning and hoeing was practiced once early in the season, the rest of the cultivation being by horse power. Owing to the heavy rains of May some of the first plantings did not come up and replantings were made necessary. The planting of the cane commenced in April and continued until June. The agricultural results obtained on the plats at the station were as follows:

On block 5, Folger was planted April 20. It was cultivated eight times by horse power and gone over five times with the hoe. It made a good and vigorous growth from start to maturity. It was harvested and delivered to the mill from September 8 to 10. The total tonnage of topped cane—that is, the canes with the seed tops removed—from the block was 21.5, showing a yield of 10.75 tons per acre. From this plat 2,255 seed heads were saved by selection for subsequent planting.

On block 35 of the station Folger was also planted. The method of preparation of the soil and cultivation were as given above. It was planted on the 27th of April and harvested from October 17 to 20. The total weight of cane obtained was 15 tons, showing a yield of 7.5 tons per acre. No seeds selections were made from this block.

Block 17 was planted with Collier cane on the 22d of April. It received the same cultivation as above. It was harvested October 7 to 12, yielding a total tonnage of topped cane of 16, or 8 tons per acre; 2,405 seed selections were made from this plot.

Block 47 of the station was also planted with Collier cane on the 2d and 3d of May. It was harvested October 11 to 13, yielding 25 tons of topped cane, or 12.5 tons per acre; 3,110 seed selections were made from this plot.

Block 29 of the station was planted in McLean cane on the 24th of April. It was harvested October 16 and 17, yielding 12.25 tons of topped cane, or 6.13 tons per acre; 217 seed selections were made from this plot.

Block 11 of the station was planted with Colman cane on the 21st of April. It was harvested from the 14th to the 16th of September, yielding 20.75 tons of cane, or 10.38 tons per acre; 2,379 seed selections were made from this plat.

Block 41 of the station was planted also with Colman cane on the 30th of April. It was harvested from September 20 to 30, yielding 19.5 tons of cane, or 9.75 tons per acre; 2,374 seed selections were made from this plat.

Block 23 of the station was planted with Link on the 23d of April. It was harvested October 6 and 7, yielding 14.50 tons of topped cane, or 7.25 tons per acre; 1,343 seed selections were made from this plat.

The agricultural details of the 50 acres grown by different farmers will be given in Bulletin No. 37, published April, 1893.

In general, it may be said that the agricultural data were satisfactory, considering the extreme drought of the season. The corn crop in the vicinity of Medicine Lodge was almost a complete failure. The sorghum crop, while not equal to that of previous years, gave fairly good returns to the farmer.

The excess of cane not used for experimental purposes was delivered to the sugar mill at the standard rates per ton. The price per ton paid for topped cane by the factory was based upon the average polarization of each load. After each load of cane was weighed sample canes were taken at random from different parts of the load, passed through a small mill, and the juices of the mixed canes polarized. The rates paid were as follows:

	Per ton.
Under 10 and not over 11 per cent	$1.50
Under 11 and over 10 per cent	1.50
Under 12 and over 11 per cent	1.70
Under 13 and over 12 per cent	2.00
Under 14 and over 13 per cent	2.10
Under 15 and over 14 per cent	2.20
Over 15 per cent	2.30

The actual data as gathered from the sales at the mill are given in the following table:

Money value of varieties.

Variety.	Average tonnage.	Average sucrose.	Average price per ton.	Average revenue per acre.
Orange	13	14.1	$2.20	$28.60
Colman	9.02	15	2.30	20.75
Variety No. 160	9	15.6	2.30	20.70
Folger	8.72	13.9	2.10	18.31
Amber	8.50	13.6	2.10	17.85
Collier	7.11	15.1	2.30	16.35
Link	6.98	15.7	2.30	16.05
No. 161	6.63	16.3	2.30	15.25
No. 112	6.50	16.8	2.30	14.95
India and Orange	6.11	15.6	2.30	14.05
African	6.83	12.5	2.00	13.66
Planter	6.06	14.2	2.20	13.30
McLean	6.01	14.4	2.20	13.22
Average	7.52	14.2	2.20	16.53

The mean tonnage per acre, as shown by this table as delivered to the mill, was 7.52. This may be regarded as two-thirds of a normal crop, and shows that, even under the disadvantages of a very dry season, good farming applied to sorghum in the vicinity of Medicine Lodge can be made to pay a remunerative return.

SEED SELECTION WORK AT MEDICINE LODGE.

The work of seed selection at Medicine Lodge was carried on essentially as has already been described for Sterling. Samples for selection were taken in the following way: Each plat at the time of sampling was visited by the sampler, who took with him a wagon and team, and driver. Passing through the field the sampler would cut at random those stalks which gave the best appearance as judged externally. The stalks taken represented those which were healthy looking, of full normal growth, and in general possessing, as far as could be judged by the eye, the best qualities. The smaller and less developed stalks were purposely omitted from all selections, although it is well known that such small growths often contain the highest percentage of sugar in the juice. The object, however, of a seed selection of sorghum for sugar-producing purposes is not alone to secure a juice rich in sucrose but also to develop a strong, healthy, and vigorous plant capable of resisting high winds, prolonged drought, and other seasonal dangers. It is also important that the plants developed for sugar-making purposes be of rather a large size, so that the expense of growing and handling may be diminished and the tonnage per acre be increased.

The samples which were to be analyzed in the morning run were taken late in the afternoon, so that they might be brought to the laboratory by 7 or 8 o'clock in the evening. The samples which were to be examined during the afternoon were cut after the dew had entirely dried out in the morning, usually between 9 and 10 o'clock, so that the load of samples might reach the laboratory by 1 o'clock.

As the stalks from each particular seed head were selected they were placed in a pile and a label attached thereto by the attendant, and this bundle of stalks was then placed in the wagon. In this way the progeny of each particular seed head selected for propagation was brought to the laboratory separately.

The method of preparing the samples for examination was simple and effective. The stalks were stripped of their leaves and were then brought to the attendants of four small Pioneer mills driven by a shaft from a common horse power. Each stalk was run through the mill separately. In order to hasten the time of passing through, the butt of the stalk was first presented to the rolls. As soon as it was caught and was passing through the attendant cut the stalk into three pieces, putting each piece in separately, and preserving the seed head with about 18 inches of stalk attached thereto.

The juice from the mill was collected in a tin vessel holding about a quart. This was removed from underneath the mill, the seed head laid across its top, and it was passed on to the desk, where the specific gravities were taken roughly by means of a Brix spindle. The standard of each variety having been fixed at a certain percentage of total solids this percentage was roughly determined by means of a spindle, and the samples falling below this standard were rejected and the seed heads belonging thereto thrown away. When the sample reached, or went above, the standard fixed, it was passed on to the tagger, who attached to the vessel containing the juice a gum label with a given number, and tied to the seed head a shipping tag bearing the same number.

The samples of juice were then passed to the total-solids table, where the total solids were determined with accuracy by calibrated Brix spindles, and the temperature at which the total solids were determined was noted. The seed heads thus preserved were collected together in bundles and hung from the rafters of the building.

The juices were then passed to the laboratory, where they were prepared for polarization and polarized in the usual way.

The analyses of average samples—that is, of considerable quantities of cane cut from a given plat, taking every stalk within the space harvested—were carried on in the same way, with the exception that, in addition to the total solids and sucrose, as determined by the polariscope, the percentage of reducing sugar was also determined.

The number of analyses per day averaged about 1,600, and the number of stalks ground per day was about 5,000, practically two-thirds of the stalks on an average being rejected as not coming up to the standard fixed.

The total number of seed heads selected for the reproduction of high-grade cane was 49,912. Of this 32,849 were selected from plants having a distinct pedigree—that is, from plants whose pedigrees could be traced back through individual seed heads for several years.

Seventeen thousand and sixty-three seed heads were selected from plants whose pedigree was not distinct, but in general derived from mothers of high sugar-producing qualities.

The average percentage of sugar in the juice of the selected seed heads from pedigreed seed (32,849 in number) was 17.22 and the average purity from these samples 76.5.

The following are some of the data obtained with the four varieties which were discussed in the data from Sterling.

Variety.	Number of selections.	Average percentage of sucrose.	Average purity.
Collier	5,506	18.99	77.13
McLean	2,193	18.42	77.99
Colman	6,553	15.79	72.10
Folger	2,255	15.53	72.20

The relative rank of the different varieties, as determined by the mean of the maximum sucroses and purities of average samples, has also been calculated from the analytical data. Of course this relative standing must not be taken as absolutely fixed, on account of the fact that some of the varieties furnished a larger number of samples for selection than others, and therefore a strict comparison can not be made among them from the data obtained. In general, however, the value of the different varieties may be quite accurately approximated from a study of the analyses.

According to the data obtained the first rank in maximum sucrose is held by the Collier cane, the second by the McLean, the third by the Colman, and the fourth by Folger.

In respect of maximum purity the first rank is again taken by Collier, the second by McLean, the third by Colman, and the fourth by Folger. Thus it is seen that whether determined by maximum sucrose or maximum purity the relative standing of the four varieties is as given above.

Interesting data were also obtained in contrasting the qualities of the parent plant, and the progeny of each variety planted from special pedigreed seed traceable through several years.

In the work of seed selection an indefinite number of canes is selected in the field, and, as has already been said, only those are taken for seed selection whose juices exceed a certain arbitrary density. Such canes may be regarded as of superior characteristics and are

selected because of the tendency of plants, as well as animals, to transmit their peculiarities to their progeny.

In the case of Folger, 106 parent canes, grown at Sterling in 1891, were compared with 1,879 of the progeny of these canes grown in Medcine Lodge in 1892. The average percentage of sucrose in the parent canes was 15.31, and in the progeny 15.53. The average purity of the juices of the parent canes was 73.14, and of the progeny 72.2.

Of the Collier cane forty-nine parents were compared with 1,993 of their progeny. The results were as follows:

Parent canes.		*Progeny.*	
Average sucrose, per cent	17.17	Average sucrose, per cent	20.00
Average purity	75.50	Average purity	78.50

Of the Colman cane fifty-one parents were compared with 1,781 progeny.

Parent canes.		*Progeny.*	
Average sucrose, per cent	15.80	Average sucrose, per cent	16.07
Average purity	75.92	Average purity	71.04

Of the McLean cane forty parents were compared with 793 progeny.

Parent canes.		*Progeny.*	
Average sucrose, per cent	17.5	Average sucrose, per cent	18.73
Average purity	76.0	Average purity	78.50

Taking all the varieties examined, including the four varieties mentioned above, 730 parents were compared with 19,301 progeny. The mean result for all the samples was the following:

Parent canes.		*Progeny.*	
Average sucrose, per cent	16.08	Average sucrose, per cent	17.03
Average purity	75.70	Average purity	74.02

From the whole number of seed selections a certain number was selected for special propagation at the station the coming year. These selections were made from those canes showing the best qualities for sugar production of the whole number examined. For the four varieties which have been mentioned the data are as follows:

Variety.	Total number of heads selected for propagation.	Average sucrose.	Average purity.
		Per cent.	
Collier	330	20.06	82.5
McLean	391	19.2	81.7
Colman	273	17.12	80.9
Folger	516	16.18	77.4

The selections for propagation, including those mentioned above, numbered 2,520; the average percentage of sucrose being 17.88, and the average purity 80.48.

The other selections, although not of the highest grade, are considered suitable for planting for general commercial purposes, while the 2,520 mentioned above, are those which would be selected for the continued intensive culture of cane, looking to the development of high sugar-producing qualities. When it is remembered that forty seed heads on an average will plant 1 acre, it is seen that the area

which could be planted with the seed heads selected for propagation would be a little over 63 acres. Of course, it will be understood at once that the Department itself would not think of planting any such area, but would select from those seed heads put aside for special propagation, the very best for the special work in the improvement of the cane.

The amount of analytical work which was done in connection with the selections above mentioned can be seen from the following summary:

Total number of polarizations made	50,720
Total number of single stalks ground	150,000
Total number of glucose determinations made	923

The amount of work which was done by the Department during the past year in the development of the sorghum cane is far greater than that of any other previous year, owing to the fact of the operation of two separate stations instead of one. In addition to this, each of the stations did a much larger amount of work than has ever before been done by a single one. It is not believed that it is necessary that the work should be continued in more than one station. Nevertheless the attention of the different State experiment stations should be called to the fact that the Department has secured this large number of specially selected and pedigreed seed heads for propagation, and it would be well for all those States whose climate and soil are suitable to the culture of the sorghum to continue the work on the lines indicated by the results obtained by the Department. In this way a variety of cane, or varieties of cane, might be secured which would be especially suitable to the locality where grown.

The U. S. Department of Agriculture has gone to the expense and labor of not only indicating the method by which such work should be accomplished, but by doing it on a scale which has never been equaled by any similar undertaking anywhere in the world, not even excepting the beet-sugar seed production farms of Europe.

EXPERIMENTS IN THE CULTURE OF SUGAR CANE.

Experiments in the culture of sugar cane were carried on by the Department at Runnymede, Narcoossee post-office, Florida.

The station at Runnymede has only just been commenced, and as a result the work done is only of a preliminary character. The object of the work is to determine the variety of cane which is best suited to the different soils which are found in the Florida peninsula, and also in the improvement of those promising varieties which are found adapted to growth in that locality.

Two kinds of soil are used for the experimental work, namely, the vegetable mold or muck soils from the reclaimed swamp lands or lake borders, and the upland or sandy soil, which is the prevailing soil of the peninsula.

Attempts were made to secure the proper ditching and drainage of the vegetable mold in order to secure a good crop on the first year, but the results were not satisfactory. The small area of cane which was grown on the vegetable mold was very poor in quality and the results were not at all promising. It is hoped that much better results may be obtained after a more thorough drainage and culture of the soil are secured.

The cane which was grown on the upland or sandy soil was, however, much more successful and promising. The cane which was grown on the upland or sandy soil, while it does not yield a large tonnage per acre, is exceedingly rich in sugar, and by reason of the fact that it lives entirely through the winter without danger of freezing, it is permitted to mature and thoroughly develop its normal content of sugar. Canes which are left growing upon the sandy soil during the winter almost invariably tassel before the opening of the spring, and for this reason reach a complete state of maturity and develop a maximum percentage of sucrose. In one variety of ribbon cane grown upon the sand and cut after eleven months from the time of the last harvest, it was found that the percentage of sucrose was 15.41 with only .28 per cent of reducing sugar, and the juice showed a purity of 93.4. Such a cane as this when manufactured by the best modern processes would yield fully 250 pounds or perhaps 260 pounds of sugar per ton.

In all about eighty varieties of sugar cane have been planted on the station. Most of these were procured from the Louisiana Sugar Experiment Station through Dr. W. C. Stubbs, they having been originally secured by the U. S. Department of Agriculture for him through our consular agents in tropical countries. Very few of these varieties have shown promising results upon the station. Among those most promising may be mentioned the Betran or Panaché variety, which showed a sugar content of 12.98 and a purity of 82.2. The Papua variety showed a sugar content of 13.03 and a purity of 84.1, and the Green or Otaheite variety showed a sugar content of 13.46 and a purity of 84.7.

The soil of the station is now better prepared for culture, and during the coming season more extensive experiments will be made in the growing of the different varieties for sugar-making purposes.

In addition to the experiments with sugar cane other experiments have also been made on the different kinds of soil looking to the production of a forage crop suitable for stock, and to the growth of other tropical and semitropical products. Among the crops which have been tried with promise are tobacco, pineapples, and cassava.

Especial attention has been given to experiments with cassava in the vegetable mold, inasmuch as it has not heretofore, to my knowledge, been grown upon such a soil. The first year's results are promising, although it is not possible to say yet that the cassava plant will do as well in the vegetable mold as it will in the sand. Particular attention is called to the possibilities of the culture of the cassava plant, both as a source of food for animals and as a possible source of starch or glucose. It grows in great luxuriance in almost pure sand and seems certain to make a crop in almost any kind of a season, whether it be wet or dry. Additional attention will be paid to this plant during the coming season.

Experiments are also in progress in the growth of olive and peach trees, and in the culture of oranges and other citrous fruits. It is believed that a continuation of the work at the station will result in great benefit to the people of Florida and other semitropical portions of the United States.

MISCELLANEOUS WORK.

The miscellaneous work of the Division of Chemistry has decreased considerably in the past few years on account of the fact that it was impossible to do all the work of this kind which was presented. Most of the miscellaneous work is upon subjects which do not relate in any

way to agriculture. Chief among these may be cited the requests for the assay of ores for the precious metals and for the analysis of mineral waters which are supposed to possess medicinal properties. The Division of Chemistry is not furnished with a complete assay outfit, and hence the work attending an attempt at an assay is a matter of no mean importance. It would be well for those interested in the matter to take note of this and thus avoid the expense of sending mineral substances for assay. It is the uniform practice of the division, however, to examine the minerals sent, and if they can be determined by inspection or a simple qualitative analysis, this is always done, and the results communicated to those interested. When a complete quantitative chemical analysis, however, is required, it is the uniform custom of the division to decline work of this kind, as it is in no sense germane to agriculture.

Only a few exceptions are made to this rule, namely, in the analysis of minerals which by their decomposition afford valuable ingredients to soils, and the examination of mineral waters which in any way affect the practice of agriculture, either when used for irrigation or for live stock. Matters of this kind fall properly within the domain of agricultural research. In general, however, those who seek information of this kind are referred to the agricultural experiment stations of the several States, which are in a far better position to judge of the importance of the work and its value to the farming interests than can possibly be done here.

There is another class of miscellaneous work which is of a different character, namely, that relating to the investigation of natural and artificial fertilizers. A considerable quantity of this kind of work has been done for persons who are not in a position to secure it otherwise, and in cases where the completion of the work gives promise of some benefit to agriculture. Especially is this the case where samples are sent by farmers who are in rather straitened circumstances and who may be made the victims of fraud in the purchase of artificial fertilizers. When convenient such work, of course, is referred to the several State stations, but in many instances exceptions are made in the case of farmers when it is difficult for them to secure work of this kind in their own States. The amount of work in this direction must be limited, as otherwise the capacity of the division would be exceeded.