EXPERIMENT STATION

OF THE

KANSAS STATE AGRICULTURAL COLLEGE,

MANHATTAN.

BULLETIN NO. 36—DECEMBER, 1892.

CHEMICAL DEPARTMENT.

G. H. FAILYER, M. Sc., CHEMIST.

J. T. WILLARD, M. Sc., ASSISTANT CHEMIST.

EXPERIMENTS WITH SORGHUM.

It is now five years since this Department began work on sorghum. At first our attention was principally confined to a comparison of varieties. Every possible sort of seed that could be obtained was grown. As was very natural, numerous varieties were grown in various sections of the country without much knowledge of their relative merits. In growing many of these together, it was found that the same sort in some cases had more than one name, and that the same name was sometimes applied to more than one kind. This was to have been expected; as many of the names are local and no descriptions of varieties have been available to correct the use of names. Many kinds of sorghum have been introduced into the United States in recent years, in the hope of discovering valuable sorts. These came from various tropical countries—Central America, Africa, and India. We grew several hundred of these. Many of them were non-saccharine and were certainly grown in their native home only as grain plants, as were doubtless many or most of those whose juice is sweet. A few of these recently-imported sorts are really valuable—one at least, Undendebule. being superior to any other known sorghum. This comparison of varieties has been less

prominent in our work in recent years. We have gradually dropped from our long list the less promising ones, until only about a dozen are retained. These best kinds include some of the old and well-known varieties, some of the very recent importations, and some crosses.

As comparisons of varieties have assumed less prominence in our work, increased attention has been given to the improvement of the quality of the better sorts, until this work has practically monopolized our efforts with sorghum. Good cultivation has been given the crop, with the view of securing such effect as it may produce; but the main efforts on improvement of the sugar content of sorghum have been by seed selections. The course pursued has been explained in our previous bulletins, but to make this one complete in itself it will be briefly repeated here.

A number of stalks of the variety under trial, including various sizes but none that are very small, are run through the one-horse three-roller mill, and the juice of each stalk collected in a bottle. The head, with the stem cut short, is placed in the bottle. Thus the grinding may be continued without danger of misplacing the juice and the heads, and the trouble of labeling is saved. From time to time the specific gravity of the juice is taken by means of a hydrometer, and the juice and heads of all that are exceptionally high in gravity are saved together for further analysis of the juice. The heads corresponding to the best juice, as demonstrated by this more complete examination, are distinctly and fully labeled, and preserved for next year's planting. So all the varieties are treated. The crop of the next year from this selected seed is treated in like manner, and so on.

Small stalks are rejected in this work for two reasons. In so far as it indicates a tendency of the variety, it is a disadvantage, as good-sized stalks are essential to a heavy tonnage. But a more important reason rests upon the fact that small stalks have a higher percentage of sugar in their juice than do the large or medium stalks in the same row, and, hence, produced from the same kind of seed. (See Annual Report for 1889, p. 102.) The smaller size is an accident of growth, depending on thickness of stand largely, and there is no evidence leading one to believe that the crop grown from seed of such stalks would be superior to the average of all sizes the year before. To perfectly compare individual stalks, they should be of the same size. However, if we find a large stalk, which is at the same time superior to all others in sugar content, we may be sure that it is the best one, as large stalks average poorest in sugar. This influence of small size was excellently shown this year in the variety Undendebule No. 1, or Collier, by a trial in which 8 or 10 small stalks were taken singly, and all of them yielded juice which ran higher in specific gravity than the larger canes of the same variety. Only one of these canes was fully analyzed. It is the first one in the list of single stalks of that variety, and its juice contained the highest percentage of sugar observed in that variety, viz., 20.49. It must not be inferred that thick planting for the

purpose of producing sweet stalks is advisable. The small stalks yield a smaller percentage of juice, so that, while their juice is richer, the sugar obtained from a ton of cane would actually be less. Moreover, it is possible that close planting may be carried so far as to produce canes of poor juice. Results at Sterling, Kas., indicate this. A reason for the less yield of juice may be found in the fact that the hard, juiceless shell of the stalk makes a larger percentage in small stalks than it does in large ones.

Our work on the improvement of sorghum by seed selection began in 1888 on a few varieties. As the number of our good sorts has increased we have included them in our work of improvement. In 1888, when we took up this work, we, as well as others who began the same line of work near the same time, were in the dark as to probable results of this seed selection. We published our results year after year, showing an *apparent* improvement, but we were very cautious about asserting that there was an *actual* improvement, much less to attribute the result certainly to selected seed. But a continuous increase in sugar content for five years and a constant superiority of cane from selected seed over that from common seed afford ground for more assurance. But the details of this will appear in our analytical results, and further comment is reserved until after they are given.

In this region the season of 1892 was a very peculiar one from an agricultural point of view. It is difficult to say whether it was favorable or unfavorable on the whole, for the sorghum crop. It was excessively wet all through April and May. We put our sorghum ground in excellent condition by plowing it very deep. Immediately after it was plowed heavy rains put a stop to further operations for a time. The ground hardened on the surface and it seemed unsuited to receive the seed. However, the planting of the experimental sorghum was completed on the twenty-first day of May. The seed germinated well notwithstanding the extreme wet, and the plants grew well until checked by the drought, extending from the early part of June until after the middle of July. Occasional rains after this time caused renewed growth, but the plants did not fully recover and were of inferior size when ripe. The close of the season was favorable and the plants ripened normally. When we harvested the cane the weather was warm and dry. A less percentage of juice was extracted than usual, but we cannot be sure that the adjustment of the mill has remained constant.

An inspection of the tables of analysis will show that the juice was unusually rich—the richest in our five years' experience. The peculiarities of the season may have had to do with the rich juice, but one would hardly have predicted such results from a season of such questionable character. A careful comparison of the cane of this year with that of past ones can scarcely fail to convince one that there has been a change in the sorghum itself. This subject is further discussed under seed selection.

At various times during the course of our work we have received seed from farmers both within this State and outside of it, they claiming that

their sorghum is a superior kind. We have invariably found that, for our soil and climate, at least, these are far inferior to those we have been growing regularly. What standard of comparison is used by these sorghum growers is not known. But either these sorghums suffer very materially by change of climate, or there is some grave error in the method used in determining quality. Of course we use the same for all, and compare so many that the error cannot be with us. It seems certain that the growers misjudge the quality of the crop.

The Black Amber and the Broom-corn Sorghum, of table I, are examples of such sorghums grown the past year.

In the tables will be noticed analyses of two crosses of Orange and Amber, one of which is distinguished by the name "Colman." This latter variety was furnished us by the United States Department of Agriculture, the seed being grown at Sterling, this State. This is doubtless a cross of Orange and Amber, but it is distinctly different from ours, in that it resembles Orange much more than it does Amber, while ours resembles Amber most closely. The Department of Agriculture has given the name "Colman" to this variety, in honor to ex-Secretary Colman.

The Department of Agriculture has given the name "Collier" to what they previously designated as Undendebule No. 1. Seed obtained this year for comparison with our Undendebule shows that the two are identical. This variety was obtained from Hon. Peter Collier, whose eminent services in the cause of sorghum production have been fittingly recognized in the bestowal of his name upon this unsurpassed variety.

The varieties designated as Nearly Seedless, "208," "8x" and McLean were furnished us by the kindness of Mr. A. A. Denton, of the Sorghum Experiment Station, at Sterling. "208" and "8x" are especially good sorts. McLean has the advantage of a long, heavy seed-top, which is not attacked by birds. Nearly Seedless is a variety in which most of the glumes are empty, so that, although the top is of good size, it has but little seed. It was probably perpetuated with the thought that, as the seed-bearing function diminished, the capacity for sugar production might be increased. It is an excellent variety.

The following brief explanation of terms used in the tabulated statement may be useful, although they are in common use in such connection, and their import will be obvious to most readers: The "dressed cane" implies the stalk after the seed-top and the blades have been removed. These are the parts that are removed in preparing sorghum for the diffusers. Many determinations on numerous varieties have shown that the dressed weight is about two-thirds the total weight of the stalks. The per cent. of juice extracted is calculated upon this dressed cane.

The "cane sugar" is the sugar of commerce. It is sometimes known as crystallizable sugar. Chemists call it sucrose.

The "reducing sugar" is that which is often called glucose. It does not

crystallize in sugar-making, and carries into the molasses with it a considerable portion of the real crystallizable sugar. A very desirable character in sorghum is a very small amount of this sugar.

The "coefficient of purity" is the percentage of cane sugar found in the total solids in the juice. The higher this is the more perfectly the cane sugar can be separated from the other constituents, and the more desirable, other things being equal, the sorghum is for sugar-making. For syrup, a high coefficient of purity is not necessary, and if the solids other than cane sugar consist chiefly of glucose, the cane will be quite as good if not even better for syrup, as it will not be as likely to crystallize.

The samples with the large number of stalks in the first table are made up of the juice extracted in making stalk selections. Because of the large number handled, data upon height, weight and weight of juice were not taken, since this would have been necessary with each stalk separately.

TABLE I.—ANALYSES OF GENERAL SAMPLES OF SORGHUM.

VARIETY.	Date of analysis.	No. of stalks in sample.	Average height, in feet.	Average weight of dressed canes, in grams.	Average weight of dressed canes, in pounds.	Per cent. of juice extracted.	Specific gravity of juice.	Per cent. of cane sugar in juice.	Per cent. of reducing sugar in juice.	Coefficient of purity.
Black Amber	Sept. 5	10	7.0	312	.67	54.2	1.061	8.90	2.61	60
Black Amber	Sept. 30	10	7.2	368	81	44.0	1.072	12 54	.....	72
Broom-corn Sorghum	Oct. 10	15	8.0	487	1.07	51 0	1.047	5.31	4.34	46
Cross of Orange and Amber	Sept. 22	93	.....	.....	.....	.....	1.090	17.17	1.04	80
Cross of Orange and Amber	Sept 23	93	.....	.....	.....	.....	1 091	16.32	1 21	75
Cross of Orange and Amber	Sept. 28	11	7.3	391	.86	43.1	1.090	16.72	1.91	78
Cross of Orange and Amber (Colman)	Sept. 26	96	.....	.....	.....	.....	1 092	17 04	1.43	78
Cross of Orange and Amber (Colman)	Sept. 29	67	.....	.....	.....	.....	1.091	17 33	1.21	80
Dindemuka	Sept. 28	10	6.8	411	90	45.1	1.083	14 84	1.84	74
Early Amber	Sept 5	10	7 5	382	84	53 5	1.078	13.02	1.78	70
Early Amber †	Sept. 20	92	.....	.....	.....	.....	1.081	15.10	1.92	78
Early Amber†	Sept. 21	86	.....	.....	.....	.....	1.080	15.48	1 45	80
Early Amber	Sept. 30	10	7.5	397	.88	41.6	1 084	15.62	1.34	78
Folger's Early	Sept. 5	10	8.0	414	.91	45.1	1.077	14.18	1.85	76
Folger's Early	Sept. 19	62	.....	.....	.....	.....	1.079	14.23	1 58	76
Kansas Orange	Sept. 5	10	6.5	394	.87	55.5	1 074	12.67	2.38	71
Kansas Orange	Sept. 28	10	6 3	425	.94	44.1	1.090	17.30	1.21	80
Kansas Orange	Oct. 1	94	.....	.....	.....	.....	1.088	17.05	1.21	81
Kansas Orange	Oct. 3	95	.....	.....	.....	.....	1.091	17.26	1.12	80
Link's Hybrid	Sept 30	10	7.5	508	1.12	47.3	1.085	16.40	1.23	80
Link's Hybrid	Oct. 7	78	.....	.....	.....	.....	1.083	15 37	1.15	77
McLean	Sept. 28	10	8.7	448	99	45.1	1.087	16 34	1.21	78
McLean	Oct. 11	47	.....	.....	.....	.....	1.079	16 02	.96	84

TABLE I.—ANALYSES OF GENERAL SAMPLES OF SORGHUM—*Concluded.*

VARIETY.	Date of analysis....	No. of stalks in sample	Average height, in feet................	Average weight of dressed canes, in grams...............	Average weight of dressed canes, in pounds..........	Per cent. of juice extracted.........	Specific gravity of juice................	Per cent. of cane sugar in juice....	Per cent. of reducing sugar in juice...............	Coefficient of purity ....
Medium Orange	Sept 5.	10	6 5	326	.72	50 9	1.077	14.40	.91	77
Medium Orange	Sept. 17	76	...	...	...	...	1 078	13.78	1 03	73
Medium Orange	Sept. 27	46	...	...	...	...	1 081	15.15	66	78
Medium Orange	Sept. 27.	43	...	...	...	...	1 080	14 76	87	77
Sorghum Bicolor	Sept. 28	10	7.3	317	80	42.9	1.085	15 20	1 00	75
Sorghum Bicolor, from E. Link	Sept. 28	10	7.0	394	.87	43.9	1.087	17.50	1.70	84
Swain's Early Golden	Sept. 5	10	7 8	260	.57	42.3	1 073	12 82	1.61	73
Ufatane	Sept. 30	10	7 0	484	1.06	45 1	1 087	16.65	1 31	80
Undendebule No. 1 (Collier)*	Sept. 30	10	7 5	415	91	41 7	1 100	19.33	97	81
Undendebule No. 1 (Collier)	Oct. 6	68	...	...	...	...	1.098	18.71	.97	80
Undendebule	Sept. 28	10	7 8	501	1.10	44.0	1 097	18 29	.91	79
Undendebule	Oct. 4	48	...	...	...	...	1.096	18.15	.91	79
Undendebule	Oct. 4	21	...	...	...	...	1.097	18.68	...	81
Undendebule	Oct. 5	69	...		...	...	1.097	18 29	86	79
Undendebule	Oct. 7	10	...	559	1 23	44.0	1 098	18.27	72	78
H. P. W.'s seed	Sept. 28	10	7.8	394	.87	43 7	1.074	13.75	1.06	77
Nearly Seedless variety*	Sept. 28	10	7.9	381	.84	40.6	1 091	17 24	.65	79
Nearly Seedless variety*	Oct 11	47	...	...	...	...	1.083	16.18	.66	81
"8 x"*	Sept 28	10	7.5	406	89	47 6	1.090	17 64	88	82
"8 x"*	Oct. 10	81	...	...	...	...	1.089	16.98	.68	80
"208"*	Sept. 30	10	7 8	457	1.00	46.1	1.092	17.76	1 24	81
"208"*	Oct. 8	83	...	...	...	...	1.099	19 36	.76	82

* From seed received from Mr A. A. Denton. † Seems to be a cross with Orange

TABLE II.—ANALYSES OF SINGLE STALKS OF SORGHUM.

VARIETY.	Date of analysis	Number of stalks from which selections were made.....	Specific gravity of juice.....	Per cent. of cane sugar in juice.	Per cent. of reducing sugar in juice	Coefficient of purity .
Cross of Orange and Amber	Sept. 22	100	1.097	18.29	.86	79
Cross of Orange and Amber	Sept. 22	100	1.096	18.37	.91	80
Cross of Orange and Amber	Sept. 22	100	1.096	18.29	.74	80
Cross of Orange and Amber	Sept. 22	100	1.097	18.91	.67	82
Cross of Orange and Amber	Sept. 22	100	1.096	18.38	.83	80
Cross of Orange and Amber	Sept. 22	100	1.096	18.03	.93	79
Cross of Orange and Amber	Sept. 22	100	1.095	18.64	.79	82
Cross of Orange and Amber	Sept. 23	100	1.100	18.95	.84	80
Cross of Orange and Amber	Sept. 23	100	1.099	18.81	.69	80
Cross of Orange and Amber	Sept. 23	100	1.098	18.38	1.01	79
Cross of Orange and Amber	Sept. 23	100	1.098	18.89	.72	81
Cross of Orange and Amber	Sept. 23	100	1.098	18.45	.80	79
Cross of Orange and Amber	Sept. 23	100	1.098	18.23	.81	78
Cross of Orange and Amber	Sept. 23	100	1.097	18.21	.97	79
Cross of Orange and Amber (Colman)	Sept. 26	101	1.097	18.28	1.27	79
Cross of Orange and Amber (Colman)	Sept. 26	101	1.095	17.53	1.52	77
Cross of Orange and Amber (Colman)	Sept. 26	101	1.097	17.52	.87	76
Cross of Orange and Amber (Colman)	Sept. 26	101	1.096	17.85	1.34	78
Cross of Orange and Amber (Colman)	Sept. 26	101	1.096	17.56	1.20	77
Cross of Orange and Amber (Colman)	Sept. 29	75	1.100	19.23	.97	81
Cross of Orange and Amber (Colman)	Sept. 29	75	1.099	19.33	.91	82
Cross of Orange and Amber (Colman)	Sept. 29	75	1.098	18.78	.99	81
Cross of Orange and Amber (Colman)	Sept. 29	75	1.097	18.70	1.11	81
Cross of Orange and Amber (Colman)	Sept. 29	75	1.097	18.53	1.04	80
Cross of Orange and Amber (Colman)	Sept. 29	75	1.097	18.65	1.04	81
Cross of Orange and Amber (Colman)	Sept. 29	75	1.097	18.87	.....	82
Cross of Orange and Amber (Colman)	Sept. 29	75	1.096	18.51	.....	81
Early Amber	Sept. 20	98	1.087	16.45	1.96	79
Early Amber	Sept. 20	98	1.085	15.90	2.00	78
Early Amber	Sept. 20	98	1.088	16.30	2.04	77
Early Amber	Sept. 20	98	1.090	16.78	1.13	78
Early Amber	Sept. 20	98	1.088	16.32	1.70	78
Early Amber	Sept. 20	98	1.088	16.73	1.29	79
Early Amber	Sept. 21	92	1.089	16.52	1.22	78
Early Amber	Sept. 21	92	1.088	15.89	1.16	75
Early Amber	Sept. 21	92	1.088	16.44	1.09	78
Early Amber	Sept. 21	92	1.087	16.35	1.16	79
Early Amber	Sept. 21	92	1.090	17.23	.82	80
Early Amber	Sept. 21	92	1.090	16.99	1.00	79
Folger's Early.....	Sept. 19	71	1.088	16.00	1.52	76
Folger's Early.....	Sept. 19	71	1.087	15.61	1.79	75
Folger's Early.....	Sept. 19	71	1.087	15.72	1.61	75
Folger's Early.....	Sept. 19	71	1.087	15.87	1.51	76
Folger's Early.....	Sept. 19	71	1.087	15.81	1.46	76

TABLE II.—ANALYSES OF SINGLE STALKS OF SORGHUM — *Continued.*

VARIETY.	Date of analysis.	Number of stalks from which selections were made.....	Specific gravity of juice.	Per cent. of cane sugar in juice.	Per cent. of reducing sugar in juice	Coefficient of purity .....
Folger's Early	Sept. 19	71	1.085	15.62	.....	77
Folger's Early	Sept. 19	71	1.086	15.37	.....	75
Folger's Early	Sept. 19	71	1.086	15.51	.....	75
Folger's Early	Sept. 19	71	1.086	15.31	.....	74
Kansas Orange	Oct. 1	99	1.098	19.26	.69	83
Kansas Orange	Oct. 1	99	1.097	18.51	.74	80
Kansas Orange	Oct. 1	99	1.096	18.04	.88	79
Kansas Orange	Oct. 1	99	1.095	18.19	.77	80
Kansas Orange	Oct. 1	99	1.095	18.33	.72	81
Kansas Orange	Oct. 3	100	1.099	18.53	.91	79
Kansas Orange	Oct. 3	100	1.097	18.59	1.04	81
Kansas Orange	Oct. 3	100	1.096	18.42	1.17	81
Kansas Orange	Oct. 3	100	1.096	18.48	.....	81
Kansas Orange	Oct. 3	100	1.095	18.82	.....	83
Link's Hybrid	Oct. 7	84	1.095	17.88	.88	79
Link's Hybrid	Oct. 7	84	1.094	17.53	.76	78
Link's Hybrid	Oct. 7	84	1.092	17.51	.65	80
Link's Hybrid	Oct. 7	84	1.092	17.07	.61	78
Link's Hybrid	Oct. 7	84	1.091	17.58	.98	81
Link's Hybrid	Oct. 7	84	1.091	17.44	.88	80
McLean	Oct. 11	50	1.089	14.88	.57	70
McLean	Oct. 11	50	1.088	16.28	.64	77
McLean	Oct. 11	50	1.086	16.25	.77	79
Medium Orange	Sept. 17	84	1.086	15.28	.58	74
Medium Orange	Sept. 17	84	1.086	15.37	.89	75
Medium Orange	Sept. 17	84	1.085	15.59	.51	77
Medium Orange	Sept. 17	84	1.085	15.31	.85	75
Medium Orange	Sept. 17	84	1.085	14.64	.54	72
Medium Orange	Sept. 17	84	1.089	15.86	.57	75
Medium Orange	Sept. 17	84	1.089	16.16	.48	76
Medium Orange	Sept. 17	84	1.087	15.61	.57	75
Medium Orange	Sept. 27	46	1.087	16.12	.71	77
Medium Orange	Sept. 27	46	1.086	16.23	.73	79
Medium Orange	Sept. 27	46	1.086	15.70	.....	76
Medium Orange	Sept. 27	49	1.089	15.78	.78	74
Medium Orange	Sept. 27	49	1.087	16.28	.51	78
Medium Orange	Sept. 27	49	1.087	16.56	.....	75
Undendebule	Oct. 4	75	1.103	19.48	.96	80
Undendebule	Oct. 4	75	1.102	18.84	1.06	78
Undendebule	Oct. 4	75	1.102	19.11	.73	80
Undendebule	Oct. 4	75	1.102	19.03	.78	79
Undendebule	Oct. 4	75	1.101	18.44	.87	77
Undendebule	Oct. 4	75	1.101	19.07	.....	80
Undendebule	Oct. 4	12	1.104	19.93	.57	80

TABLE II.—ANALYSES OF SINGLE STALKS OF SORGHUM—*Concluded.*

VARIETY.	Date of analysis	Number of stalks from which selections were made.	Specific gravity of juice.	Per cent. of cane sugar in juice.	Per cent. of reducing sugar in juice	Coefficient of purity.
Undendebule	Oct. 4	12	1.101	19.68	.....	82
Undendebule	Oct. 4	12	1.099	19.13	.....	81
Undendebule	Oct. 4	12	1.098	19.02	.86	82
Undendebule	Oct. 5	7	1.102	19.03	.....	79
Undendebule	Oct. 5	75	1.105	19.14	.41	77
Undendebule	Oct. 5	75	1.102	19.08	.68	79
Undendebule	Oct. 5	75	1.102	19.08	.91	79
Undendebule	Oct. 5	75	1.102	19.19	.65	80
Undendebule	Oct. 5	75	1.102	19.14	.69	79
Undendebule	Oct. 5	75	1.102	19.19	.64	80
Undendebule No. 1 (Collier)*	Oct. 6	76	1.109	20.49	.87	80
Undendebule No. 1 (Collier)	Oct. 6	76	1.107	20.39	.79	81
Undendebule No. 1 (Collier)	Oct. 6	76	1.106	20.34	.68	81
Undendebule No. 1 (Collier)	Oct. 6	76	1.104	19.82	.94	81
Undendebule No. 1 (Collier)	Oct. 6	76	1.104	20.09	.96	82
Undendebule No. 1 (Collier)	Oct. 6	76	1.104	20.01	.87	81
Undendebule No. 1 (Collier)	Oct. 6	76	1.104	20.17	.79	82
Undendebule No. 1 (Collier)	Oct. 6	76	1.103	19.94	.....	82
Undendebule No. 1 (Collier)	Oct. 6	76	1.103	19.42	.....	80
Variety "208"	Oct. 8	90	1.108	20.97	.53	83
Variety "208"	Oct. 8	90	1.108	19.28	.60	76
Variety "208"	Oct. 8	90	1.108	20.87	.58	82
Variety "208"	Oct. 8	90	1.106	20.46	.62	82
Variety "208"	Oct. 8	90	1.106	20.61	.53	80
Variety "208"	Oct. 8	90	1.105	20.75	.60	84
Variety "208"	Oct. 8	90	1.105	20.43	.63	82
Variety "8 x"	Oct. 10	85	1.095	18.22	.70	81
Variety "8 x"	Oct. 10	85	1.095	18.13	.65	80
Variety "8 x"	Oct. 10	85	1.094	18.17	.57	81
Variety "8 x"	Oct. 10	85	1.093	17.78	.69	78
Variety "Nearly Seedless"	Oct. 11	50	1.091	16.97	.57	78
Variety "Nearly Seedless"	Oct. 11	50	1.090	17.41	.57	81
Variety "Nearly Seedless"	Oct. 11	50	1.090	17.64	.76	82

* Very small stalk, as mentioned in text.

In both the foregoing tables the sorghum shows well as to quality. In general, there is a slight increase in both cane sugar and glucose sugar over the same varieties last year; but not uniformly so. It may be that the dry, hot weather prevailing at the time the cane was harvested caused a concentration of the juice within the stalk, and thus increased the percentage of both kinds of sugar somewhat. This does not seem sufficient, however, to account for the high sugar content of these sorghums. When the results of the five years' experiments with sorghum are compared, the change in quality becomes most striking. In table III, this comparison is made.

Extended comment upon the quality of the sorghum grown this year, as shown in table I, is not necessary. When samples consisting of from 75 to 100 stalks, taken at random, afford juice that contains from 17 to 19 per cent. of sugar, after some half-dozen of the best stalks are removed for separate analysis, it would seem that but little more can be desired. These results were obtained in cross of Amber and Orange, Colman, Kansas Orange, Undendebule, "8x," and "208."

IMPROVEMENT BY SEED SELECTION.

The selection of individual stalks of special merit has now been in progress for five years. Its success has been less perfect than would have been the case but for circumstances beyond our control, such as drought, flood, and the ravages of insects and English sparrows. Throughout the series of experiments, it has been the plan to preserve average seed, as well as selected, for purposes of comparison, but owing to a variety of circumstances it has not been possible to carry out this plan perfectly, so that nearly all of our present stock of seed has shared more or less in the general result of seed selection. Table III presents a comparison of analyses of sorghum grown from average seed and from selected seed. It will be noticed that there has been a marked increase in sugar content, the improvement ranging from about 15 to 35 percentage of the amounts observed in 1888. We are far from maintaining or believing that this improvement is the result of seed selection wholly, for although the "average" seed has been largely tinctured by the selected seed, it is not believed to have been sufficiently so to account for all of its increase in quality. Acclimatization and perhaps favorable seasons the last two years should be allowed considerable weight. Making such allowance, however, there still remains a large improvement which can be accounted for only by admitting the efficiency of persistent scientific seed selection.

In comparing the figures of the table for the five years, one should have in mind the very unfavorable season of 1890. As explained in our report for that year, two circumstances interfered with the normal growth of the crop—first, dry, hot weather in June and July, followed by cool, wet weather in August and September, which caused a renewed growth; and second, an early frost, which caught much of this new growth while immature.

TABLE III—SHOWING IMPROVEMENT IN FIVE YEARS.

	KANSAS ORANGE.		EARLY AMBER.		LINK'S HYBRID.		CROSS OF ORANGE AND AMBER.		UNDENDEBULE.	
	Average.	Best single stalk.	Average.	Best single stalk.	Average.	Best single stalk.	Average.	Best single stalk.	Average.	Best single stalk.
1888	12.62	15.51	.....	.....	14.01	14.27	12.70	14.18	.....	.....
1889	13.88	16.79	13.95	15.56	15.32	16.94	14.83	17.47	.....	.....
1890	11.65	Frozen	14.37	16.01	10.95	14.47	14.59	16.03	13.47	15.79
1891	16.82	18.59	12.75	16.48	16.37	17.41	16.49	18.25	17.21	18.95
1892	17.30	19.26	15.62	17.23	16.40	17.88	16.72	18.95	18.27	20.39

A few statistics may serve to present in stronger light the economic importance of this question. Elsewhere in this Bulletin we have called attention to varieties of sorghum which are regarded as of very superior quality in the neighborhood where grown, but which, by comparison with ours, are shown to be really inferior to many which we have entirely discarded from our list. It is safe to assert that the sorghum now grown through the State will not average 10 per cent. of sugar in the juice. By using improved seed, this average could undoubtedly be raised 2 or 3 and perhaps 5 or 6 per cent. above what it is at present. In the year 1890, the estimated value of the syrup product of the State was over $1,400,000. If cane had been grown which had contained even one-tenth more sugar, the expense of cultivation, handling and manufacture would have been no greater, but the value of the product would have been $140,000 more.

Nor is this question of importance only to those making syrup. Sorghum for fodder increases rapidly in value as the per cent. of sugar increases. It is just as important to plant a heavy, highly saccharine sorghum for ensilage or other fodder as it is for syrup. By using better varieties of sorghum for this purpose, many thousand dollars more would be added to the value of our sorghum crop, without adding one cent to its cost.

In former publications we have enlarged upon the difficulty of improving sorghum by seed selection on mere inspection. No means has yet been observed by which rich canes can be selected by their physical characteristics; a chemical analysis of the juice is necessary. Rough trials can be made by tasting the juice, it is true, and much less rough trials by getting the specific gravity of it; but chemical analysis only can furnish accurate data for judgment. Realizing that it is of very little use to the farmers of the State to demonstrate that sorghum can be improved by seed selection unless the results of that improvement are made available to them, we have preserved a quantity of improved seed from the best varieties, and hold it for distribution to those interested enough to forward postage for a small package, with the understanding that they will report to us the result of the trial. Address all inquiries to G. H. Failyer, Manhattan, Kas.

THE TRIAL WITH FERTILIZERS.

In 1890 a trial with fertilizers on sorghum was begun. The results for 1890 and 1891 are given respectively in Bulletins 16 and 25. The plan of this experiment as there outlined is as follows: "An experiment was begun to see whether better sorghum may be produced by the use of fertilizers and good cultivation. To this end plats were staked off permanently, so that the same treatment may be given these plats for a series of years. The treated plats alternate with 'nothing' plats. The following substances were selected for trial: Lime, superphosphate, nitrate of soda, sulphate of potash, plaster (gypsum), and a complete fertilizer composed of superphosphate, sulphate of potash, nitrate of soda, and plaster. The lime was ap-

plied at the rate of 20 bushels per acre; the superphosphate at the rate of 600 pounds per acre; nitrate of soda, 400 pounds; sulphate of potash, 400 pounds; and plaster 200 pounds. To the plat receiving the complete fertilizer the following amounts per acre were applied: Sodium nitrate, 200 pounds; potassium sulphate, 200 pounds; superphosphate, 300 pounds; plaster, 100 pounds. The fertilizer was sown broadcast along the rows soon after planting. Salt was applied at the rate of 150 pounds per acre. The plats are one-fiftieth of an acre in area, containing four rows 62.2 feet long and 3½ feet apart. The samples for analysis were taken from one of the middle rows of each plat, all canes, large and small, being included." As heretofore, the same seed, Kansas Orange, was used on all the plats, and uniform cultivation was given them. The samples from the several plats were analyzed on the 24th and 25th of September, the cane being fully ripe. The quality of the cane is shown in table IV. Table V presents a comparison of the crops for the three years that the fertilizers have been tried. The comparison includes size of stalks, cane sugar, glucose sugar, and degree of purity. Each fertilized plat is compared with the average of the "nothing" plats, both sides. When the figures for the fertilized plat are higher, the plus sign is used; when lower, the minus sign. Weights are fractions of a pound; other figures express percentages calculated on the juice.

TABLE IV.—COMPOSITION OF THE SORGHUM OF FERTILIZER TRIALS.

FERTILIZER APPLIED, AND AMOUNT PER ACRE	Number of plat	Average weight of dressed canes, in pounds	Per cent. of juice extracted	Specific gravity of juice	Per cent. of cane sugar in juice	Per cent. of reducing sugar in juice	Coefficient of purity	Cane sugar above or below the mean of "nothing" plats each side
Nothing	1	.95	42.52	1.0835	15.54	1 07	78	....
Complete manure, 800 pounds	2	.96	42.99	1.0825	15 04	1.10	76	—.22
Nothing	3	.93	42.23	1.0820	14.98	1.25	76	....
Sulphate of potash, 400 pounds	4	1.00	44.10	1.0825	14.93	1.15	75	—.13
Nothing	5	1.01	43.71	1.0810	15.15	1.28	78	.
Nitrate of soda (Chili saltpeter), 400 pounds.	6	.95	42.69	1.0830	15 51	1 18	78	+.01
Nothing	7	94	42.54	1.0850	15 85	1.15	78	.
Superphosphate, 600 pounds	8	1 10	41.58	1 0810	15.26	1 40	78	—.49
Nothing	9	87	42 34	1.0850	15.65	1.25	77	.. ..
Gypsum (plaster), 200 pounds.	10	.68	37 73	1.0850	16.12	1 12	79	+.17
Nothing	11	.73	38.93	1.0850	16.26	1.12	80	....
Lime, 20 bushels.	12	.79	38.87	1.0840	15.85	1.25	78	—.41
Nothing	13	.66	37 84	1.0850	16.27	1 02	80	.
Salt, 150 pounds.	14	.76	38.70	1 0810	16.19	1 19	83	—.06
Nothing	15	64	39.03	1 0850	16.23	1 05	79	. .

TABLE V.—DIFFERENCES BETWEEN FERTILIZED PLATS AND THE MEAN OF THE "NOTHING" PLATS BOTH SIDES

PLAT.	1890*				1891.				1892.				Mean of the cane sugar for three years
	Average weight	Cane sugar	Glucose sugar	Purity	Average weight	Cane sugar	Glucose sugar	Purity	Average weight	Cane sugar	Glucose sugar	Purity	
Complete manure	—.03	**+ 29**	— 19	..	—.06	**— 17**	+.10	0	+ 02	**—.22**	—.06	—1	**— 03**
Sulphate of potash	—.06	**—1.01**	+.34	—3	+.16	**— 11**	— 06	+2	+ 03	**— 13**	— 11	—2	**—.41**
Nitrate of soda	+.05	**+ 52**	+.03	0	—.04	**+.88**	—.52	+1	—.02	**+.01**	—.03	0	**+.47**
Superphosphate	+.01	**—.42**	+.03	0	—.05	**—.11**	+.09	—1	+.10	**—.49**	+.20	0	**—.34**
Gypsum (plaster)	+.06	**—.25**	—.06	0	—.10	**—.02**	+.08	—1	—.12	**+ 17**	—.06	0	**—.03**
Lime	—.10	**—.12**	—.16	—1	+.08	**+ 46**	—.20	0	+.10	**—.41**	+.18	—2	**—.02**
Salt	—.11	**—.44**	— 12	..	—.03	**—.21**	+.22	+1	+.11	**— 06**	+ 15	+4	**—.24**

*Injured by frost before analysis; results therefore less trustworthy.

The last column in above table permits a comparison at a glance of the several fertilizers for three years. The sodium nitrate is the only one that has produced cane equal in percentage of crystallizable sugar to the cane not fertilized. And the apparent good effect of this salt is emphasized by the further fact that the crop has been uniformly good, high in cane sugar and low in glucose sugar. Were it not that these characters in this plat are so constant, no importance would be attached to it, for the amounts are quite within the limits of error in plat experimentation; and they lend but little encouragement to the continuation of the work. But it may be quite as important to learn that fertilizers are without effect as to get an affirmative answer. It is so when viewed only as an experiment to obtain agricultural facts The prime object now, however, is to get a better sort of sorghum. If it cannot be obtained by the use of fertilizers, we wish to know it; and if it can, we hope to demonstrate this fact, as well as to develop this better sorghum. Therefore, this work will be continued on the same lines.

SUMMARY ON SORGHUM.

We have selected the best varieties of sorghum from several hundred, and are giving most attention to efforts to improve these, principally by seed selection. Most of these best varieties are kinds that have not been grown generally in this country, and some of them are very recent importations.

In general, our sorghum was better this year than ever before. Large samples of variety "208" running to 19.36 per cent. of cane sugar and .76 per cent. of glucose sugar; Undendebule, 18.71 per cent. of cane sugar, and .87 per cent. of glucose sugar; Kansas Orange, 17.26 per cent., and 1.12 per cent.; cross of Amber and Orange (Colman), 17.33 per cent., and 1.21 per cent.; cross of Amber and Orange (not the same as preceding), 17.17 per cent., and 1.04 per cent.; "8x," 16.98 per cent., and .68 per cent.; Nearly Seedless, 16.18 per cent., and .66 per cent.; McLean, 16.34 per cent., and 1.21 per cent.; Early Amber, 15.48 per cent., and 1.45 per cent.

The work in seed selection has been in progress five years, and has been attended by a constant improvement in the quality of the sorghum. It is probable that a portion of this improvement is due to acclimatization; but it seems certain that it is partially, possibly mainly, due to seed selection. Many stalks were obtained from these best varieties containing from 18 to 20 per cent. of cane sugar and less than 1 per cent. of glucose sugar; some as low as one-half of 1 per cent. of the latter. The richest stalk of variety "208" contained 20.97 per. cent. of cane sugar and .53 per cent. of glucose sugar; Undendebule, 20.49 per cent. of cane sugar and .87 per cent. of glucose sugar; cross of Amber and Orange (Colman), 19.33 per cent. and .91 per cent. of these sugars, respectively; Kansas Orange, 19.26 per cent. and .69 per cent.; cross of Amber and Orange, 18.95 per cent. and .84 per cent.; "8x," 18.22 per cent. and .70 per cent.; Link's Hybrid, 17.88 per

cent. and .88 per cent. Many other stalks of these varieties were nearly as good as those just given, while other varieties are nearly as high as the lowest of above.

The trial of fertilizers on sorghum has been continued three years on the same plats. Nitrate of soda, Chili saltpeter, is the only one of the common fertilizers whose use has been uniformly attended by increased sugar in the juice. All others show an average loss, although a gain in some years. The excess of the nitrate plats over the "nothing" plats is slight. The experiment will be continued on the same plats.

EXPERIMENTS WITH SUGAR BEETS.

In 1890 the Department began experiments with sugar beets, by growing 10 sorts and analyzing the beets when mature. The results appear in Bulletin No. 16, 1890. The scope of the experiment was materially extended in 1891, by the distribution of beet seed to numerous farmers of the State, with full instructions for planting and cultivation. A number of counties were visited and the prospective growers of the beets seen personally, and their aid thus secured. The beets sent in to the Station in the fall were analyzed and the results published. The full details of the experiment are given in Bulletin 31 of this Station. As there stated, the season was exceedingly unsatisfactory, owing to the almost unprecedentedly wet spring and summer, which, by preventing planting, by rotting the seed, by drowning out the young plants, and by preventing proper care after the beets were up, greatly reduced the proportion of those who sent in beets out of the number who planned to raise them. The crop was of rather low sugar content, as a whole; but some samples were very good. The inferior character may have been due to the poor season. It was well understood that one, or even two, years would not be conclusive, whether favorable or unfavorable.

During the present season the work on sugar beets has been continued on the same general lines as last year. All those who showed interest in the work by reporting upon their success or failure last year, some 240, and about 100 other farmers in various portions of the State, who, it was thought, would be interested in the experiment and whose addresses were obtained, were requested by letter to aid us so far as to grow beets from seed sent, and in accordance with printed instructions. Two hundred and fifty-one consented, and beet seed was sent them. Only the seed of approved strains of sugar beet was used. These farmers were scattered all over the State.

The spring of 1892 was probably less favorable than that of 1891. It was certainly so at this Station. After our ground was prepared, frequent and excessive rains prevented our planting for two weeks. The season was much the same elsewhere as here, and in some places reported as even worse. In connection with this, remembering that sugar beets require garden culture, one will not be surprised that returns were meager. Only 85 men sent in beets for analysis.

We aimed to follow European methods of preparing the soil, cultivating the beets, etc., thinking that, although their methods of agriculture are so different from ours, we could be able to compare the *quality* of our beets

with that of the beets which now produce so much of the sugar of the world. Whatever modifications of European practices our different conditions may necessitate when working on a manufacturing scale, in the first experimental stage it seemed the part of wisdom to employ methods which are known to produce good beets. A failure would then scarcely be chargeable to faulty treatment. To show approximately what beet culture really is where the growing of sugar beets is so successful and such an important part of their agriculture, as it is in Germany and France, the instructions and directions, based upon these, which we sent the beet growers, are here given. The reports required upon the culture of the beets are also included.

INSTRUCTIONS FOR GROWING SUGAR BEETS.

Size of Plat.— The best of preparation and cultivation of the soil are far more important than size of the plat. It will be better to take a plat of a few square rods and put plenty of work on it than to plant an eighth or a quarter of an acre and slight it during the hurry of the season. A very small plat should be taken if the subsoil is to be spaded. The plat should be of such proportion as to give not less than six rows.

The Soil.— Old ground that is in a good state of cultivation should be selected. The deeper it has been previously plowed, the better. Only that which is naturally open and porous, and which has been kept clear of weeds, will be available in this trial. Soil to which no barn-yard manure has been added for a year or more will be preferable.

Preparation of the Soil.— The soil must be loosened to a depth of 16 or 18 inches without bringing much of the subsoil to the surface. This is best done by running a common plow about an inch deeper than the ground has been previously stirred, and following in each furrow with a subsoil plow, putting it down to the required depth. If a subsoil plow is not available, the experimental plat may be prepared by spading the bottom of each furrow to the required depth before turning the next. It may be prepared wholly by spading if necessary. After the soil is dried somewhat, it must be thoroughly harrowed, to reduce it to a fine, mellow condition. It is best to roll the ground finally.

The Planting.— The planting should be done as soon as the ground is ready, so that the weeds will not start in advance of the beets. Plant in straight drills, 18 inches apart. Drop three or four seeds together, at intervals of 8 to 12 inches in the drills, the distance being less with rich than with poor soil. Cover one inch deep, pressing the earth down firmly on the seed. The crop should be planted early—as early as garden beets.

Cultivation.— The weeds must be kept down and the surface soil kept open and porous. If the weeds are not allowed to get a start, the cultivation can be done without much hand work. After the beets are well started, showing about four leaves, they must be thinned to one plant at a place, leaving the most thrifty plant and taking care not to disturb it in pulling

out the others. As soon as the leaves shade the ground, cultivation is to be discontinued. Care should be taken not to injure the leaves in cultivation. Beets that tend to rise out of the ground must be covered by drawing the soil up around them. This should be done during the cultivation of the beets, as directed above.

Directions for taking and forwarding samples will be sent in the fall. Let the beets stand in the ground until these are received.

DIRECTIONS FOR TAKING AND SENDING SAMPLES.

From the middle rows of the plat select six beets weighing not more than two pounds each and preferably about 1½ pounds. Should most of the beets be very much larger than two pounds, send an average sample. Take them from various places so as to represent the whole plat. Reject any which are not regular in outline and sound at the crown. Cut off the leaves, wash the roots, and wipe or drain them dry, but do not expose to the sun much. Wrap each beet carefully in paper. Wrap the whole in strong paper and tie securely, or put in a light box of suitable size. Attach the enclosed tag to the package and send by express at our expense. If neighboring farmers will pack together and send by freight, it will save expense. Be sure to fill out the blank for name of sender, or we can do nothing with the beets.

REPORT UPON CULTURE OF SUGAR BEETS.

Name of grower,——; post office,——; country,——. Did you subsoil the plat? ——. If so, how deep? ——. If not, how deep was the ground plowed? ——. Describe kind of soil, briefly, including subsoil, and state whether soil has been manured, and if so, when?——. State in a general way the distribution of rainfall during the season, and whether the weather as a whole seemed to be favorable to the growth of the crop——. Variety of beet, if known ——. Date of planting——. Did the seed germinate well?——. Distance between rows——. Distance between beets in row——. Describe cultivation given——. If any insects or diseases have attacked the leaves or roots so as to attract attention, please describe them ——

The samples of beets sent in were all analyzed on the day of their arrival at the laboratory. The beets were first weighed whole, the leaves having been removed; this gave the gross weight given in the table. The crowns were then cut off as far down as the beets had projected above the surface of the soil, and the remainder gave the net weight. The entire sample was then reduced to a fine pulp and the juice extracted by means of a powerful screw press. After standing a few minutes, the specific gravity of the juice was taken and the sugar in it estimated by the saccharimeter. Reducing sugars were not determined, as they are known to be present in but small quantity in beets.

No attempt was made to determine the percentage of sugar in the beets, only that in the juice. Since the proportion of juice varies in beets, there is not a constant ratio between the percentages of sugar in the juice and in

the beets. But an approximately correct comparison of beets may be made by the use of the proportion of sugar found in the juice. However, there is usually about 95 per cent. of juice in sugar beets. Therefore, the percentage of sugar in beets is about 95 per cent. as high as the juice. The analysis then resolved itself into determining the specific gravity of the juice and polarizing it after clarifying it. The specific gravity affords a means of getting the approximate amount of total solids in the juice. Knowing the amount of solid matter, and the amount of cane sugar, we determine the coefficient of purity, a very important element, by calculating what percentage the sugar is of the total solid matter in the juice.

The efficiency of the very simple cutter, which we described in last year's bulletin, was greatly increased by the use of a geared pulley, turned by a crank, which we set off some six or eight feet and connected it with the cutter by means of a belt. A very high rate of speed was thus easily maintained.

Table No. VI, given hereafter, contains the results of our work in growing beets elsewhere in the State. We have brought into the table such statements from the culture reports as seemed available. It is not probable that the terms used always have exactly the same significance in the minds of our correspondents; but as they are intelligent farmers, they have doubtless used them with their ordinary meaning. It has not been possible in all cases to reduce to the requirements of a column in a tabular statement the explanations given in a sentence or two. Our tables are to this extent imperfect. The data upon the beets themselves were taken after the arrival of the beet samples at the laboratory, and of course refer specially to the beets received here. The analyses are arranged by counties, in four belts from east to west across the State, beginning in the southeast.

Table VII contains in concise form the result of work upon the sugar beets grown at the Station. It also contains a comparison of the crops of 1891 and 1892, as to cane sugar and purity. Our ground was subsoiled last year. It was well prepared to receive the seed last spring, but immediately afterward the soil was so softened by rains that it seemed to run together, and was then so beaten down by heavy rains that the surface became very hard. Two weeks of almost continuous rain brought about the result just described and delayed the planting so long. The planting was finally effected during the short intervals between rains, May 7 to 16, inclusive. The seed germinated very poorly under these unfavorable conditions, and a very poor stand was secured on most of the plats. The beets made a big growth, becoming entirely too large, owing to being thin on the ground. They were free from attacks of insects and disease and matured well. In sampling, the beets were taken from those portions of the plats having the best stand, and an attempt was made to get beets of proper size and form.

TABLE VI.—SHOWING ANALYSES OF

NAME OF GROWER.	COUNTY.	POST OFFICE.	Kind of soil.	Depth soil was stirred, inches.	Date of planting.	Distance between rows, in	Distance in rows, inches.
P. W. Jury	Allen	Humboldt	Ash land	16	May —	.....	8
J. T. Tredway	Allen	La Harpe	Black, yellow subs	16	Apr. 21	36	.....
J. W. Rose	Woodson	Yates Center	Limestone	10	Late	18	10–12
Wm. Tannehill	Greenwood	Severy	Upland prairie	6	May 15	48	12
J. G. Erdman	Montgom'y	Independence	Limestone loam	10	Apr. 16	18	12
W. J. Burtis	Wilson	Fredonia	Clay soil, h'd-pan subs.	16	Apr. 29	24	.....
R. E. Walker	Elk	Grenola	Black loam, clay subs.	7	Apr. 20	32	12–24
F. M. Savage	Cowley	Burden	Black loam	16	Apr. 20	18	12
S. E. Maxwell	Cowley	Arkansas City	Black loam, clay subs.	7	May 6	36	4–8
Nat. Brooks	Cowley	Burden	Black loam	13	May 13	18	8
T. Nixon	Sumner	Zyba	Black loam, sand subs.	18	.....	18	6
T. Bassler	Sumner	Geuda Springs	Clay loam, gumbo subs.	18	Mar. 28	10	5
B. K. Melick	Sumner	Geuda Springs	.....	.....	.....	.....	.....
H. H. Grover	Butler	El Dorado	Prairie loam	12	June 3	24	.....
H. H. Grover	Butler	El Dorado	Prairie loam, bl'k soil	12	June 3	24	.....
W. L. Stump	Sedgwick	Ruby	Bl'k soil, red s'dy subs.	16	May 1	16	12
J. R. Maphet	Reno	Olcott	Sandy clay	12	Apr. 10	18	8
G. W. Warren	Reno	Hutchinson	Sandy loam	12	May 3	16	.....
Eli Benedict	Barber	Medicine L'dge,	Red soil, clay subs	13	May 5	30	4
Eli Benedict	Barber	Medicine L'dge,	Red soil, clay subs	13	May 5	30	4
J. E. Bright	Comanche	Wilmore	Sandy bottom	8	Apr. 1	36	.....
W. C. Dunker	Edwards	Offerle	Sandy loam, clay subs.	16	May 15	18	12
J. E. Millikin	Ford	Wright	Loam	16	May 22	18	8
N. Mayrath	Ford	Dodge City	S'dy l'm, yel. marl subs.	13	May 8	36	6
R. R. Hobble	Ford	Dodge City	Light sandy	6	Apr. 8	18	2–3
J. L. Finley	Ford	Dodge City	Clay loam	10	May 20	30	6–12
G. W Milton	Linn	Cadmus	Dark red, reddish subs.	12	Apr. 10	42	8
Jos. Teagarden	Linn	La Cygne	Red soil	5	May 10	36	4
M. L. Ward	Franklin	Ottawa	Black loam	18	.....	24	9
S. Tripp	Franklin	Ottawa	Gravelly l'm, clay subs.	4½	May —	15	6
J. A. McNabb	Osage	Melvern	Black, gumbo subs	8	May 29	18	12
C. M. Smith	Osage	Burlingame	Dark loam	8	May 1	24	4–6
M. O. Martin	Coffey	Waverly	Black loam, waxy subs.	12	May —	36	.....
Mrs. M. A. Brown	Coffey	Waverly	.....	.....	.....	.....	.....
Wm. Wood	Chase	Strong City	Black loam	12	Apr. 14	16	12
N. Stout	Chase	Strong City	Loam	20	.....	12	.....
Wm. Norton	Chase	Cottonw'd F'ls	Black soil, clay subs.	6	Apr. 28	6	6

SUGAR BEETS SENT TO THE STATION.

Cultivation.	Variety of beet.	Form of beet.	AVERAGE WEIGHT, IN POUNDS.		Specific gravity of juice.	Total solids in juice	Cane sugar in juice	Purity . . .
			Gross.	Net.				
Plowed and hoed..	Vilmorin, Kansas grown...	Fair.....	2.40	1.90	1.0485	11.995	7.78	65
Hoed.....	Bulteau Desprez.....	Fair.....	1.50	1.05	1.0620	15.150	11.70	77
Well hoed.....	Bulteau Desprez.....	Fair.....	1.80	1.40	1.0570	13.990	10.80	77
Hoed and plowed..	Vilmorin, Kansas grown...	Fair.....	2.60	1.80	1.0545	13.410	10.10	75
Hoed and plowed..	Bulteau Desprez.....	Fair.....	1.60	1.20	1.0560	13.760	10.10	74
Hoed and plowed..	Vilmorin, Kansas grown...	Fair.....	1.90	1.50	1.0580	14.220	10.90	77
Hoed and plowed..	Vilmorin, Kansas grown...	Good.....	1.70	1.30	1.0585	14.340	10.20	71
Hoed and weeded,	Vilmorin, Kansas grown...	Poor	1.40	1.00	1.0580	14.220	9.54	67
Hoed and plowed..	Vilmorin, Kansas grown...	Good.....	3.10	2.10	1.0640	15.600	11.50	74
Hoed.....	Vilmorin.....	Twisted.....	2.40	1.70	1.0575	14.108	10.40	74
Hoed five times....	Vilmorin, Kansas grown...	Good.....	1.20	.90	1.0700	16.980	12.80	75
Hoed four times...	Bulteau Desprez.....	Fair.....	1.80	1.40	1.0650	15.830	12.10	76
.....	Bulteau Desprez.....	Very good....	1.50	1.20	1.0690	16.725	13.47	80
Hoed good.....	German Vilmorin.....	Wilted.....	3.00	2.60	1.0755	18.185	13.94	76
Hoed good.....	Klein Wanzlebener.....	Wilted.....	1.30	1.00	1.0700	16.980	12.99	76
Hoed.....	Bulteau Desprez.....	Good.....	.33	.30	1.0650	15.830	12.50	79
Hoed.....	Bulteau Desprez.....	Good.....	2.50	1.90	1.0550	13.530	10.20	75
Hoed.....	Vilmorin.....	Fair.....	1.80	1.40	1.0560	13.760	10.50	76
Hoed.....	Bulteau Desprez.....	Very good....	1.10	.90	1.0530	13.060	10.30	78
Hoed.....	Vilmorin.....	Very good....	1.10	.90	1.0540	13.290	10.50	78
Hoed and plowed..	Bulteau Desprez.....	Fair.....	1.50	1.10	1.0520	12.820	9.15	71
Hoed.....	Bulteau Desprez.....	Good.....	.70	.50	1.0830	19.930	16.40	82
Hoed.....	Bulteau Desprez.....	Very good....	1.00	.80	1.0620	15.150	11.30	74
Hoed and plowed..	Bulteau Desprez.....	Good.....	2.30	1.80	1.0690	16.730	12.30	73
Hoed.....	Bulteau Desprez.....	Fair.....	1.60	1.30	1.0700	16.980	13.80	81
Hoed.....	Bulteau Desprez.....	Good.....	1.70	1.30	1.0660	16.050	12.40	77
Hoed and plowed..	Vilmorin, Kansas grown...	Good.....	1.70	1.20	1.0565	13.876	11.30	82
Hoed and plowed..	Vilmorin.....	Poor	1.60	1.20	1.0630	15.380	11.70	76
Hoed and plowed..	Vilmorin, Kansas grown...	Stumpy.....	1.80	1.30	1.0510	12.586	8.75	69
Hoed.....	Bulteau Desprez.....	Fair.....	.20	.16	1.0810	19.480	15.70	81
Hoed.....	Vilmorin, Kansas grown...	Good.....	2.30	1.80	1.0575	14.108	9.66	68
Plowed.....	Seed of 1891.....	Poor	1.70	1.08	1.0490	12.114	7.98	66
Plowed.....	Vilmorin, Kansas grown...	Good.....	2.30	1.80	1.0685	16.610	13.50	81
.....	Bulteau Desprez.....	Good.....	.90	.70	1.0635	15.490	12.40	80
Hoed.....	Vilmorin, Kansas grown...	Good	1.40	1.10	1.0520	12.810	8.49	66
Hoed.....	Bulteau Desprez.....	Fair.....	2.20	1.60	1.0575	14.108	10.70	76
Hoed and plowed..	Vilmorin, Kansas grown...	Fair.....	2.40	1.60	1.0410	10.210	7.44	72

TABLE VI—CONTINUED.—SHOWING ANALYSES

NAME OF GROWER.	COUNTY.	POST OFFICE.	Kind of soil.	Depth soil was stirred, inches.	Date of planting.	Distance between rows, in.	Distance in rows, inches
W. M. Blackburn	Chase	Matfield Green	Black loam, clay subs	14	May 8	24	6
T. S. Urie	Marion	Ramona	Black soil	10	Apr. 28	36	6
J. Miller	Marion	Ramona	Heavy	6		30	
J. J. Pettyes	Barton	Ellinwood	Clay subsoil	14	May 1	36	8
J. W. Allen	Rush	La Crosse	Upland loam	10	May 20	30	
Mrs. R. A. Hogsett	Ness	Brownell	Bottom land	8	Apr. 20	36	2–6
C. Bastian	Garfield	Kalvesta					
P. Mersereau	Garfield	Kalvesta	Dark, sandy	12	Apr. 21	36	16
J. A. Keeler	Garfield	Ravanna	Gray loam	12	May 20	24	12
W. H. Fant	Finney	Garden City	Black, sandy loam	12	Apr. 19	18	2–12
W. H. Fant*	Finney	Garden City	Black, sandy loam	12	Apr. 19	18	2–12
W. P. Cowhick	Finney	Garden City	Sandy loam, soft subs	10	Apr. 25	18	6
A. B. Dille	Johnson	Edgerton	Black loam, clay subs	10	May 16	40	16
S. H. Ayres	Johnson	Olathe	Black loam, stiff subs	10	June 20	18	12
C. H. Berry	Johnson	Edgerton	Black loam	6	Apr. 7	16	5–8
H. Jewett	Johnson	Gardner	Reddish clay	15	May —	24	12–24
Sam'l Fisher	Douglas	Alfred	Black loam	10	May 1	18	18
M. M. Maxwell	Jefferson	Valley Falls	Light, sandy upland	8	Apr. 27	16	6
J. Rumbaugh	Jefferson	Dean	Limestone	9	June 15	18	
A. L. Entsminger	Shawnee	Silver Lake	Sandy loam	8	May 6	12	
J. H. Dearborn	Shawnee	Silver Lake	Sandy loam	18	Apr. 30	18	
J. H. Dearborn	Shawnee	Silver Lake	Sandy loam	18	Apr. 30	18	
Ed. Pape	Shawnee	Topeka					
Ed. Pape	Shawnee	Topeka					
J. F. Willard	Wabaunsee	Wamego	Sandy loam	18		18	
J. F. Willard	Wabaunsee	Wamego	Sandy loam	18		18	
J. F. Willard	Wabaunsee	Wamego	Sandy loam	18		18	
B. Cotton	Wabaunsee	Wamego	Good	10	Apr. 10	18	6
E. H. Pixley	Wabaunsee	Wamego	Sandy	7	Apr. 20	16	
F. F. Creveceur	Pot'wat'mie	Onaga	Black loam	10	Apr. 9	18	8–10
A. W. Paige	Riley	Manhattan	Black	8–9	May 1	18	6–10
T. T. Waddle	Clay	Clay Centre	Light	10	Apr. 5		4–6
Sam. Engel	Clay	Wakefield	Black loam, red. subs	10	May 1	24	10
Chas. Young	Dickinson	Abilene	Sandy loam	16	Apr. 20	24	
C. E. Smith	Dickinson	Herington	Loam, clay subsoil	14	Apr. 25	18	8
J. H. Treton	Dickinson	Chapman	Sandy	10	Apr. 25		12

*Irrigated once.

OF SUGAR BEETS SENT TO THE STATION.

Cultivation.	Variety of beet.	Form of beet.	AVERAGE WEIGHT, IN POUNDS.		Specific gravity of juice.....	Total solids in juice	Cane sugar in juice..... ..	Purity.. ... .
			Gross.	Net. ..				
Hoed six times....	Vilmorin, Kansas grown...	Good.....	1.10	.80	1.0650	15.830	12.10	76
Hoed and plowed..	Vilmorin, Kansas grown...	Good.....	1.80	1.40	1.0615	15.040	11.50	76
Hoed.....	Bulteau Desprez.....	{Short and stumpy.}	1.28	1.00	1.0770	18.580	15.70	84
Hoed and plowed..	Bulteau Desprez.....	Good.....	.30	.25	1.0590	14.460	9.90	68
Shallow.....	Vilmorin, Kansas grown...	Good.....	1.80	1.70	1.0660	16.050	12.40	77
Hoed and plowed..	Vilmorin, Kansas grown...	Fair.....	3.00	2.30	1.0570	13.990	10.20	73
.....	Bulteau Desprez.....	Good.....	1.20	.90	1.0675	16.387	12.30	76
Hoed and plowed..	Bulteau Desprez.....	Good.....	1.60	1.30	1.0770	18.580	14.60	78
Hoed.....	Vilmorin, Kansas grown...	Good.....	1.70	1.40	1.0710	17.230	12.60	74
Hoed.....	Bulteau Desprez.....	Good.....	1.70	1.30	1.0625	15.262	12.10	79
Hoed,.....	Bulteau Desprez.....	Good.....	1.70	1.40	1.0660	16.050	12.50	78
Weeded and hoed,	Bulteau Desprez.....	Excellent.....	2.40	2.00	1.0680	16.500	13.40	81
Plowed and hoed..	Bulteau Desprez.....	Good.....	1.50	1.10	1.0495	12.470	7.69	61
Hoed.....	Vilmorin.....	Poor	2.00	1.50	1.0500	12.350	8.43	68
Hoed.....	Vilmorin.....	Fair.....	1.90	1.40	1.0570	13.990	10.70	77
Plowed and hoed..	White Vilmorin, K. g'n....	Fair.....	2.60	1.90	1.0565	13.876	10.80	78
Hoed.....	White Vilmorin, K. g'n...	Poor	3.50	2.30	1.0470	11.640	7.71	66
Hoed.....	White Vilmorin, K. g'n....	Very good.....	.83	.70	1.0700	16.980	14.60	86
Plowed and hoed..	Bulteau Desprez.....	Stumpy.....	2.20	1.60	1.0555	13.650	9.60	70
Hoed.....	Bulteau Desprez.....	Fair.....	2.10	1.50	1.0490	12.110	9.31	76
Good.....	White Vilmorin.....	Fair.....	.90	.80	1.0490	12.110	8.87	73
Good.....	Grower calls "French"....	Good.....	1.10	.80	1.0440	10.930	7.64	70
.....	Wilhelmena.....	Good.....	.80	.70	1.0760	18.350	14.90	81
.....	Wilhelmena.....	Good.....	1.40	1.10	1.0580	14.220	10.80	76
.....	Bulteau Desprez.....	Good.....	1.30	.90	1.0460	11.400	8.52	72
.....	White Vilmorin, K. g'n....	Good.....	.90	.70	1.0490	12.110	9.10	75
.....	Bulteau Desprez.....	Good.....	1.10	.80	1.0440	10.930	8.04	73
Hoed.....	.....	Stumpy.....	2.40	1.70	1.0500	12.350	9.38	76
Hoed.....	Vilmorin, Kansas grown...	Good.....	.70	.50	1.0400	9.970	5.55	55
Hoed.....	Vilmorin, Kansas grown...	Fair.....	1.40	1.10	1.0480	11.870	6.89	58
Hoed.....	White Vilmorin, K. g'n....	Poor	.80	.60	1.0640	15.600	11.20	71
Hoed.....	Vilmorin, Kansas grown...	Good.....	3.10	2.30	1.0520	12.820	8.35	65
Hoed.....	Bulteau Desprez.....	Good.....	1.98	1.60	1.0610	14.930	10.90	73
Hoed and weeded,	Vilmorin, Kansas grown...	Fair.....	2.60	1.90	1.0580	14.220	9.98	70
Hoed.....	Bulteau Desprez.....	Good.....	3.30	2.50	1.0670	16.280	12.50	77
Hoed.....	Vilmorin, Kansas grown...	Fair.....	1.90	1.40	1.0580	14.220	11.60	81

TABLE VI — CONTINUED. — SHOWING ANALYSES

NAME OF GROWER.	COUNTY.	POST OFFICE.	Kind of soil.	Depth soil was stirred, inches.	Date of planting.	Distance between rows, in.	Distance in rows, inches.
A. Henquenet	Dickinson	Hope	Black	6	May 24	36	6
L. Donmeyer	Dickinson	Solomon City					
H. Ableson	Dickinson	Rhodes	Sandy loam	18	May 2		1–12
T. Tinkler	Saline	Gypsum City	Dark loam, clay subs	12	Apr. 23	30	20
S. Detwiler	Brown	Hiawatha	Upland prairie	5	May 15	36	
J. W. Johnson	Nemaha	Corning	Dark, rich	8	June 20	24	3–24
F. Kruger	Nemaha	Seneca	Black, sandy	18	May 27	18	10
J. Shearer	Marshall	Frankfort	Black loam	18	May 5	18	12
J. M. Frost	Marshall	Blue Rapids	Sandy soil, clay subs	10	May 15		18
J. G. Binder	Marshall	Waterville	Upl'd prairie, clay subs,	14	May 18	18	6–24
T. M. Lewis	Washington,	Greenleaf	Black loam, clay subs	10	May 27	44	6–8
S. Douglass	Washington,	Clifton	Black, sandy loam	18	May 15	18	10
E. D. Haney	Republic	Cortland	Black bottom land	6	June 1	36	18
C. W. Olson	Cloud	Clyde	Good	10	Apr. 28		8–10
S. B. Babbitt	Cloud	Clyde	Loam prairie	16	Apr. 29	16	6–12
J. W. Hahn	Osborne	Bloomington	Black loam, clay subs	10	May 10	24	20
J. W. Graham*	Rooks	Zurich	Upland prairie	8	May 16	18	
J. W. Graham	Rooks	Zurich	Upland prairie	16	May 16	18	
J. W. Graham	Rooks	Zurich	Upland prairie	16	May 16	18	
J. W. Graham	Rooks	Zurich	Upland prairie	8	May 16	18	
W H. Archer	Thomas	Otterbourne	Black, sandy loam	14	May —	24	8
M. L. Lacey	Thomas	Colby	Dark loam	12	May 18	24	

*Sent four samples — first two, November 2; second two, November 14.

OF SUGAR BEETS SENT TO THE STATION.

Cultivation.	Variety of beet.	Form of beet.	AVERAGE WEIGHT, IN POUNDS.		Specific gravity of juice	Total solids in juice	Cane sugar in juice	Purity
			Gross.	Net.				
Hoed	Vilmorin, Kansas grown	Good	1.90	1.50	1.0580	14.220	10.30	72
	White Vilmorin, Kas. g'n	Fair	1.80	1.50	1.0630	15.380	12.80	83
Plowed and hoed	Vilmorin, Kansas grown	Good	1.60	1.40	1.0670	16.280	13.30	82
Plowed and hoed	Vilmorin	Good	1.60	1.20	1.0710	17.230	12.60	74
Plowed and hoed	Vilmorin, Kansas grown	Fair	2.40	1.90	1.0505	12.468	9.00	72
Plowed	Vilmorin, Kansas grown	Good	1.70	1.40	1.0600	14.700	10.90	74
Hoed	Vilmorin, Kansas grown	Excellent	2.50	1.60	1.0490	12.110	8.21	68
Plowed and hoed	Bulteau Desprez	Fair	3.30	2.40	1.0485	11.995	8.70	72
Plowed and hoed	Bulteau Desprez	Stumpy	1.50	1.10	1.0570	13.990	9.90	70
Plowed	Bulteau Desprez	Fair	1.80	1.30	1.0745	18.012	14.30	79
Plowed	Bulteau Desprez	Good	4.10	3.30	1.0545	13.410	10.00	74
Hoed	Vilmorin, Kansas grown	Good	2.40	1.90	1.0550	13.530	9.20	69
Hoed and plowed	Vilmorin, Kansas grown	Poor	2.30	1.80	1.0400	9.970	6.54	66
Hoed and plowed	Bulteau Desprez	Good	4.70	3.40	1.0540	13.290	9.37	70
Hoed	Vilmorin, Kansas grown	Very good	1.90	1.40	1.0620	15.150	11.20	73
Hoed	Bulteau Desprez	Good	1.00	.80	1.0740	17.900	13.70	76
Surface	Bulteau Desprez	Fair	1.10	.90	1.0890	21.280	17.50	82
Surface	Bulteau Desprez	Excellent	1.20	.90	1.0990	23.530	17.90	76
Surface	Bulteau Desprez	First rate	1.10	.80	1.0760	18.350	13.10	71
Surface	Bulteau Desprez	Good	1.40	1.20	1.0725	17.562	13.20	80
Plowed and hoed	Bulteau Desprez	Good	1.80	1.40	1.0540	13.290	9.68	73
Hoed	Vilmorin	Good	.75	.60	1.0660	16.050	11.50	71

TABLE VII.—SHOWING ANALYSES OF SUGAR BEETS GROWN BY THE STATION.

NAME OF VARIETY.	No. of plat	Date of analysis	Form of beet	Weight, in pounds. Gross	Weight, in pounds. Net	Net weight, in grams	Specific gravity of juice	Total solids in juice	Cane sugar in juice	Coefficient of purity	Same varieties in 1891 gave— Cane sugar in juice	Same varieties in 1891 gave— Coefficient of purity
White, green top, Brabant	1	Nov. 1	Very good.	1.76	1.21	549	1.047	11.64	7.74	66	5.29	46
Vilmorin, white, improved	2	Nov. 1	Good.	1.54	1.08	589	1.061	14.93	10.85	72	10.01	71
Dippe's Improved Klein Wanzlebener	3	Nov. 1	Good	1.18	.91	412	1.059	14.46	10.24	71	12.30	77
Klein Wanzlebener, from Vilmorin	4	Nov. 1	Fair	1.11	.83	377	1.059	14.46	10.70	74	8.20	64
White, gray top, from Vilmorin	5	Nov. 1.	Poor	1.39	.86	390	1.042	10.45	6.50	62	5.73	57
White Vilmorin, Kansas grown seed	6	Nov. 1	Good	1.27	.95	432	1.056	13.76	9.89	72	9.75	85
Dippe's Improved White Imperial	7	Nov. 1	Good	1.41	1.08	490	1.056	13.76	10.29	76	8.98	69
Bulteau Desprez	8	Nov. 2	Good	1.74	1.29	585	1.051	12.59	8.72	69	8.05	65
White, red top, from Vilmorin	9	Nov. 2.	Good	1.79	1.31	595	1.046	11.40	7.34	64	5.53	60
French, very rich, from Vilmorin	10	Nov. 2	Fair	2.02	1.53	694	1.053	13.06	8.88	68	7.82	70
Dippe's Klein Wanzlebener, from Dept. of Agriculture	11	Nov. 2.	Poor	1.90	1.28	582	1.061	14.93	10.85	73	......	......
Bulteau Desprez, richest, from Dept. of Agriculture	12	Nov. 2.	Fair	2.18	1.64	812	1.048	11.88	7.89	66	7.81	69
Dippe's Vilmorin, from Dept. of Agriculture	13	Nov. 2		1.77	1.28	580	1.058	14.22	10.47	74	10.85	71
Klein Wanzlebener, from Vilmorin	14	Nov. 2	Good	1.77	1.31	594	1.053	13.06	10.28	79	8.20	64
Bulteau Desprez	15	Nov. 5	Good	1.39	.98	444	1.062	15.15	11.19	74	10.48	80
Dippe's White Improved	16	Nov. 5.	Good	1.28	.96	438	1.059	14.46	10.44	72	......	......
German, from Heinrich Hette	17	Nov. 5.	Good	1.35	.97	444	1.058	14.22	10.32	73	11.01	77
French, very rich, Vilmorin	10	Nov. 10	Fair	1.89	1.39	632	1.048	11.88	7.95	67	7.82	70
Bulteau Desprez	8	Nov. 10	Fair	1.89	1.35	615	1.041	10.20	5.87	57	8.05	65
Bulteau Desprez	16	Nov. 10	Good	1.14	.83	377	1.054	13.29	8.88	67	......	......

The analyses of beets grown on the Station grounds show almost to a certainty that that soil is not adapted to their growth. Notwithstanding the subsoiling, the most of the beets were of poor form, and grew largely above ground. There is probably too little sand in it to give it a proper texture. In most varieties, the crop this year is better than that of last, owing, perhaps, to a drier fall. They are at best, however, very unsatisfactory. The total beet crop of Germany yields, in the sugar factory, 12 per cent. of sugar, implying an average composition appreciably above this.

A comparison of the results on beets sent in last year with those of this year will show that the latter are somewhat better. But, on the whole, they cannot be regarded as lending great encouragement to the hope of successful establishment of the beet-sugar industry in this State. There are, however, a considerable number of samples showing a high percentage of sugar. It is highly probable that these are due to favorable conditions of soil not found in other cases. The plan of distributing seed to farmers in all parts of the State, without regard to soil, or direct personal interest in the matter on the part of those growing the beets, cannot be regarded as a success. Less than one-third of those having seed sent in beets. It seems advisable that in the future the growing of samples should be mainly restricted to localities in which our past experience or other means of judgment indicates that success will be most likely to be attained. We shall, however, still be glad to analyze beets, grown in any locality from good seed, and in accordance with approved directions. It is especially desirable that people who desire to test the adaptability of their soil to beet culture should cooperate, and plant a considerable number of plats all over the area in question.

Thus far, we have not observed among our farmers any marked interest in this question, and yet it is one of great importance. Diversification of crops, as much as possible, is an essential element of successful agriculture for at least two reasons: It renders the farmer less subject to embarrassment from low prices of any single product, and it maintains the fertility of the soil at its highest point. Beets are an excellent crop for this purpose. German states which were poor before the establishment of the beet-sugar industry, are now wealthy. The aggregate of other crops obtained is greater than before, and the beet crop is obtained beside. This is because of the added capacity given to the soil by reason of the culture given the beets, and the rotation of crops incident to their cultivation. The successful planting of this industry in our State would be of inestimable value to us. Whether this can be accomplished or not depends on two things, viz., whether our farmers will raise beets, and whether the beets, if grown, will be worth anything for sugar-making. The latter question we have undertaken the task of answering; we cannot, however, without the hearty coöperation of the farmers of the State. The Station has furnished seed and paid express charges on samples of beets, leaving the farmer then only the expense of growing the small plat necessary. The value of the beets for

feed is such that no one would be out anything by raising a plat, if anything like a good crop were obtained; and yet, as said before, it is difficult to get farmers to raise them.

The possibility of growing sorghum containing an abundant percentage of sugar, rivaling indeed the tropical cane in that respect, has been amply shown in this State. On this question the sole difficulty rests with the manufacture of the sugar from the raw material. Sugar-making from sorghum presents difficulties which are not found in making sugar from either beets or sugar cane. There seems much reason to believe that these difficulties will be ultimately overcome. The manufacture of beet sugar, however, has been brought to the highest perfection, and all that is necessary to make its introduction into our State successful is good beets every year. Whether this is possible or not should be determined at once, and, if possible, capital will flow to the State for investment in an industry which would be of great advantage to our people; if impossible, the matter will be set at rest. We, as in the past, are ready and equipped to do the necessary analytical work. The Station has, however, no funds available with which to hire farmers to grow plats of beets in any considerable number. For this we must still depend on the public spirit of the farmers themselves. We take this opportunity of tendering our hearty thanks to all who have assisted us in this may during the last two years.