SORGHUM.

G. E. PATRICK.

Within the last decade sorghum has taken its place among the important crops of the country.

As a fodder crop peculiarly adapted to the dry climate of parts of the West it has proved its worth; as a source of molasses and syrup it has become popular with both producer and consumer; but it is chiefly as a prospective source of the great staple which the people of the United States consume at the rate of fifty-six pounds per capita per annum, and of which we import annually one and one-third million tons at a cost of over 120,000,000 dollars, that sorghum now attracts the attention of all enlightened Americans.

SORGHUM SUGAR.

For nearly eight years past experiments, scientific and commercial, in the manufacture of sorghum sugar have been carried on at government, state and individual expense. Individuals have sunk fortunes, states have given bounties, equipped laboratories and promoted scientific research, while the general government has spent hundreds of thousands of dollars in research and practical experiment.

As a result of this united effort it is now believed that the great obstacles have all been overcome and that the sorghum sugar industry is in a fair way to become a permanent reality.

With sugar at its present low price, however, and no prospect of advance, it is more than likely that the new industry will need state (or governmental) assistance to give it a start; that such assistance, to a reasonable amount, will be readily granted (by other states than the three which have already set the example) no one who has watched public sentiment on the sugar question can doubt.

Conditions of Success.

Should the industry develop as it now promises it is evident, notwithstanding the wide geographical range over which sorghum flourishes, that some sections within that range will prove more favorable than others, but which will prove *per-*

manently the best adapted I believe it is yet too early to predict.

A long growing season is one desirable condition; therefore, other conditions being the same, the latitude of Kansas or Arkansas will probably prove more favorable than that of Iowa.

But it is by no means certain that other conditions are the same, such for instance as the adapation of soil, the prevailing states of the atmosphere as regards humidity, periods of rainfall, winds, etc., and the still more obscure conditions which may favor or oppose the ravages of insect enemies and parasitic diseases of the plant. (*)

Some of these conditions we know are not the same over very wide areas, others are at present practically unknown quantities, and to what extent any or all of them may tend to increase or diminish the advantage of a southerly latitude, cannot be known without thorough scientific investigation and perhaps experiment on a manufacturing scale.

But, supposing it turn out that these unmeasured factors in no way tend to offset the advantage of a longer season possessed by more southerly states, it by no means follows that Iowa cannot with profit make apart or the whole of the sugar she consumes. It is not, and probably would not be for a very long time to come, a question of competition between sugar makers *in different states*, because of the immense home market for the product.

Mr. E. B. Cowgill, Sugar Commissioner of Kansas, in his official report to the Secretary of Agriculture (1887), makes the following computation:

"The annual consumption of sugar per capita in the United States is about fifty-six pounds. The population of Kansas maybe taken as 1,500,000. These people consume each year $56 \times 1,500,000 = 84,000,000$ pounds of sugar. It will be safe to say that the annual average product of the factories will not exceed 1,500,000 pounds, so that fifty-six factories will be required to supply the sugar consumed by the present population of Kansas, and for which they pay over $5,000,000 annually."

On the same basis of computation, calling the population of Iowa a round 2,000,000(†) the annual sugar consumption of the state would be 112,000,000 pounds, which would require for its production seventy-four such factories. [The money

(*) Already a bacterial disease of sorghum has been observed in Illinois and Kansas which in the latter state is infesting the favorite early varieties the most seriously. See Bulletin No. 5. Kansas Experiment Station.

(†) In 1885, it was 1,753,980.

sent out of the state to purchase this 112,000,000 pounds cannot be far from 5,000,000 dollars]. Mr. Cowgill further shows that at least 2,000 factories, with an output each of 1,250,000 pounds would be required to supply the amount now imported into the United States.

Such figures illustrate clearly not only the immensity of the home market but the remoteness of all danger of competition *between home manufacturers.*

The question then in Iowa is not one of comparison of advantages with some other state, but merely of determining whether, under our own conditions and at present prices, this industry can be made profitable.

Will Iowa Make Her Own Sugar?

Two facts seem to support the idea that conditions existing in this state favor the developement of sucrose in the sorghum plant. They are,

1. Syrups made in certain localities in the state have shown themselves very prone to granulate; so much so that syrup-makers work to prevent it. The small amount of sugar thus far made in the state has nearly all been an incidental, perhaps more properly an *accidental*, product of the syrup industry.

The amount thus produced in 1887, without special effort or design and entirely without proper machinery, is placed by the State Secretary of Agriculture at 73,583 pounds.

In some cases a considerable amount, and of merchantable quality, has been made by a single individual. Thus Mr. C. Bozarth, a syrup-maker at Cedar Falls, reports (†) having made in 1880, 15,000 pounds which sold for eight cents per pound and in 1881 5,000 pounds which sold for eight and one-half cents per pound.

2. Analyses thus far made of sorghum juices produced in the state show, on the average, a very gratifying per centage of sucrose.

State Aid.

From the above facts and considerations it would seem that a policy of encouragement to the sugar industry would be a wise one for Iowa to pursue. Therefore I would respectfully urge upon our legislators the advisability of a law providing for a state bounty, of say two cents per pound, on all sugar above a certain standard of purity, say ninety per cent, made

(†) Encouragement to the Sorghum and Beet Sugar industry, (pamphlet) Dep't of Agriculture 1883.

in Iowa from sorghum or beets grown in the state. The hope would be that such assistance would prove only a temporary necessity, and that once fairly established—provided it prove a success—the industry would be able to stand unaided; in which case its great value to all citizens of the state would be unquestioned.

The effect of such encouragement offered by other states and countries has been most marked. In 1881 New Jersey offered a bounty of one cent a pound on sugar produced and $1.00 per ton on all sorghum actually used in making sugar. As a direct result a factory was immediately erected (at Rio Grande) in the operation of which for a number of years experience was gained which led *directly* to the abandonment of old and the adoption of new processes which have changed failure into comparative, and it is believed by many into absolute, success.

Kansas in 1887 offered a bounty of two cents per pound on sugars made in the state, with a limit of $15,000 as the maximum to be paid in any one year. This act did much to inspire the final efforts which resulted in the first positive financial success ever achieved in making sorghum sugar.

The beet-sugar industry of Europe obtained its start only by liberal governmental aid; to-day not only is it self-supporting but in Germany and France it has for years, by direct tax, aided materially in supporting the government.

Recent Improvement in Manufacture.

The improvements which in the last five years have so brightened the prospects of sorghum sugar have been mainly in the extraction of juice from the cane. The introduction of the diffusion process from Europe (there developed in treatment of the beet) and the adaptation of it to sorghum in place of the wasteful milling process, constitute the chief feature of this advance.

The principle of the diffusion process is the soaking out of the sugar (and juice) from the chipped cane by means of hot water—the same water acting successively on several lots of cane-chips, until rich enough to pay to evaporate.

Milling vs. Diffusion.

By the milling process only fifty to sixty per cent of the sugar in the cane is expressed, whereas by diffusion ninety per cent is easily extracted; the process is easily worked and

the juices are usually of higher purity than those from the mill.

These well established facts warrant the conclusion that the mill will find no place in the sorghum sugar industry of the future.

Such at least is the present outlook. There is however one possible chance, apparently a slim one, for the mill and the milling system to survive. Should a method be devised by which the farmer could at small expense reduce mill juice to a syrup *of good quality for sugar making*, the latter would find a market at the sugar factory, the farmer could en-silo his *half pressed* cane for winter feed, and the mill *might* remain a factor in commercial sugar making. These remarks apply only to that industry. The sorghum mill will continue to be used in syrup making for an indefinite period.

Results in Kansas.

While the diffusion process as applied to sorghum has been tested on a somewhat large scale *experimentally* in both New Jersey and Kansas, it has had what may be called a *commercial* trial only in Kansas, and there it can be said to have had a fair trial only at the two factories located, respectively, at Fort Scott and Topeka.

The latter was completed last fall too late to commence work at the proper time. For this reason it may have cleared no money, but, to quote Commissioner Cowgill's words, it "has demonstrated the practicability of the sugar industry at that place." (*)

The former made a brilliant success in 1887, and concerning its last season's work the same official says "the favorable results obtained in 1887, at Fort Scott, have been more than repeated at that place in 1888."

The Farmer's Side.

The Fort Scott factory paid $2.00 per ton for the cane, delivered, just as it left the field. Commissioner Cowgill says: (†) "Under ordinary methods of cultivation, ten tons of cleaned cane per acre is somewhat above the average, but the larger varieties often exceed twelve, while the small Early Amber sometimes goes below eight tons per acre. Let seven and one-half tons of cleaned cane per acre be assumed for the

(*) Sixth Biennial Report of the Board of Agriculture of Kansas.
(†) Bulletin No. 17, Department of Agriculture, Division of Chemistry.

illustration. This corresponds to a gross yield of ten tons for the farmer, and at $2.00 per ton gives him $20 per acre for his crop."

Commenting upon the present condition of the sugar industry in Kansas, the same official in his latest report, just published, says: "Indeed, upon the most careful study of the subject, I have no hesitation in saying that the sorghum-sugar industry is now on such a footing as to invite the investment of capital, where such investment is placed under good business management, efficient, practical skill, and competent scientific direction." (*)

Results in New Jersey.

The Hughes experimental sugar factory was erected at Rio Grande in 1887, to test the diffusion process. Its capacity is only fifteen to twenty tons of cane per day. Mr. Hughes' method of applying the diffusion principle is original, much simpler and less expensive than that used at Fort Scott, and yields a more concentrated juice. The result of the first season's work were so favorable that Director Cook of the New Jersey experiment station in his annual report for 1887, says: "This work goes far to demonstrate that the making of sugar from sorghum may, with profit, be added to our agricultural industries."

Two of the points demonstrated were:

1. "That ninety per cent of its total sugar can be diffused from sorghum."

2. "That seventy-two per cent of the total sucrose obtained can be secured in the form of raw sugar and that twenty-eight per cent of it will then remain in the molasses." (†)

The farmers who furnished the cane received therefor one-half the cash receipts for all the products of the crop, *i. e.*, sugar, syrup and seed. Their returns varied, according to their success in growing the crop, from $25.66 to $55.78 per acre—the higher results being attained by liberal use of fertilizers.

For the season of 1888 owing to poor crops the farmers' returns were smaller, ranging from $18.00 to $37.00 per acre. Results in the factory for 1888 were regarded as very favorable, and Director Cook in prefacing a detailed account (‡)

(*) Sixth Biennial Report, Board of Agriculture of Kansas.
(†) Eighth Annual Report, New Jersey Experiment Station.
(‡) Bulletin 51, New Jersey Agricultural Experiment Station.

of the season's work says: "The growing of sorghum and the manufacture of sugar from it by farmers everywhere in our country, at paying prices, appear to be assured. It is now ready for them to proceed in acquiring, by practice, the skill and experience which is to make it one of the great industries of the nation."

Improvement of the Cane.

The opinion is universal among those most competent to judge that the opportunity for improvement in the mechanical and chemical processes involved in making sorghum sugar is now but small; and equally universal is the opinion that very great improvement can be made in sorghum as a sugar producing plant.

The sugar beet originally contained but five to seven per cent of sugar, but by careful selection and cultivation this has been increased to ten to fifteen per cent, and it is believed that a similar course of treatment applied to sorghum will effect a like result, although probably in a smaller degree. This station has already commenced work in this line, our plan of work being to select seed from individual stalks found by analysis to be of superior quality.

Work of This Station.

Last spring Director Speer had several different areas, aggregating about four acres, on the station grounds planted with Early Amber, the seed for which was obtained from different localities, namely: Washington D. C; Masachusetts, (Gregory seedsman); Fort Scott, Kan.; Cedar Falls, Ia.; Des Moines, Ia., (Livingston, seedsman). About one-eighth acre was also planted with Early Orange.

No manure was applied. The land had been well manured two years before and was in good condition. The rows were three feet ten inches apart, hills the same distance apart in the row, with eight to ten seeds in the hill. The cultivation consisted in one treatment with the smoothing harrow, four with the cultivator and one with the hand hoe.

Two of the fields of Early Amber were on rather sandy, and two on black, heavy soil. It may as well be stated here that no difference in sugar content of the cane was observed which seemed clearly chargable to difference in soil.

The weather during the first half of summer was cool with abundant rains, during the last part it was hot and rather dry,

making a season such as is supposed to favor the development of sugar.

On September 11, we commenced testing individual canes, preserving the seed head of each, numbered to correspond to the record of analysis. The stalks were stripped in the field immediately upon cutting, and brought direct to the laboratory where they were topped and uumbered. Each cane was then weighed and passed twice through a Squiers' three roll hand mill. The juice was weighed and a portion of it defecated and polarized with a Schmidt and Haensch half-shade instrument; another portion was allowed to settle for a few hours, its specific gravity and temperature were taken, and from them the degrees of density by the Brix hydrometer at 17½ ° C. calculated.

Double polarization would have been preferable but the want of skilled assistance together with the necessity for pushing the work rapidly rendered this impossible, save in a few cases. For the same reasons determination of glucose (or reducing sugars) was usually omitted.

The stalks examined were taken from all parts of the several fields. The object being to secure stalks rich in sucrose, suckers and immature stalks were carefully avoided, so far as possible; doubtless therefore, the results obtained show a quality somewhat above the average for the entire crop.

Explanation of Terms.

Degrees Brix at 17 ½ ° C. show approximately the percentage of total solids in the juice.

Purity Coefficient is the per centage of sucrose in the total solids; thus a purity of seventy means that of every one hundred parts of solids in the juice seventy parts are sucrose.

AVAILABLE SUGAR. Before the introduction of diffusion the rule for calculating available sugar was to consider that all solids not sucrose prevented an equal weight of sucrose from crystallizing. (†)

The data obtained with the diffusion process are as yet very scant, and any rule that can now be formulated for calculating the sugar obtainable, per ton of cane *by that process* from analytical data *on mill juice from a given weight of said cane*, must be more or less empirical. The experiences at

(†) Dr. Wiley (Bulletin No. 3, Chemical Division, Department of Agriculture) makes a further deduction of five per cent of the sucrose present, but this has not been the usual custom.

Fort Scott and in New Jersey should, however, furnish some guidance.

At Fort Scott, in 1887, from cane which averaged through the season a *mill juice* containing 9.67 per cent sucrose and 16.3 per cent solids, Prof. Swenson by the diffusion process secured of *first sugars* (97 per cent pure,) "fully one hundred pounds" per ton of cleaned cane, throughout the season. A trial with 133 tons of cleaned cane gave a yield per ton of 113 pounds of first sugar and seventeen and one-half pounds of seconds. Commenting on this Prof. Swenson says : (*)

"It is at once apparent that the old method of calculating available sugar must be abandoned. According to this rule there would be but 61.6 pounds available sugar per ton of cane in the diffusion juice of the first trial, when as a matter of fact 130½ pounds were obtained. It would therefore, seem, that instead of preventing an equal weight of cane sugar from crystallizing, the glucose and other solids not sugar in the juice prevented only two-fifths of their weight of cane sugar from crystallizing."

From these and all other facts available I have deduced the following rule which, applied to average cane, gives figures fairly representing what *has been accomplished* by the best methods of manufacture known to-day : From the sucrose in the mill juice deduct one-half the solids not sucrose, calculate the result to the basis of cleaned cane (by using the per-centage of juice milled), increase this result by one-half (to account for better extraction by diffusion than by milling), and finally discount one-tenth for unavoidable losses.

Applied to poor cane this rule gives too high results. By it were calculated the figures in the sixth columns of the tables next following. Those in the seventh columns of same tables are by the old method of calculation, allowing an increase of fifty percent in yield for diffusion; on rich canes this method undoubtedly gives too low results.

(*) Department of Agriculture, Report for 1887, page 218.

RESULTS.

Of 180 stalks analyzed the ten best gave the following figures:

Analyses of Single Cleaned Canes. (†)

No.	Per cent Juice.	ON THE JUICE.			Available Sugar, New Method. Per ton of cleaned Cane.	Available Sugar. Old Method Per ton of cleaned Cane.
		Sucrose. Single Polarization.	Solids. Brix.	Purity. Co-efficient.		
		per cent	per cent		pounds	pounds
1	54.67	14.72	19.7	74.7	180	139
2	54.60	14.38	19.8	72.6	171	146
3	53.84	14.04	19.8	70.9	162	133
4	53.39	13.94	19.2	72.6	162	139
5	53.20	13.85	18.4	75.3	166	148
6	54.76	13.83	18.6	74.3	169	149
7	55.90	13.77	17.8	76.9	177	163
8	57.35	13.69	19.0	72.0	170	141
9	59.41	13.66	19.4	70.4	173	141
10	60.22	13.35	17.8	75.0	180	164
Average	55.73	13.92	18.9	73.4	171	146

The 10 next best stalks gave the following:

No.	Per cent Juice.	ON THE JUICE.			Available Sugar, New Method. Per ton of cleaned Cane.	Available Sugar, Old Method. Per ton of cleaned Cane.
		Sucrose. Single polarization.	Solids. Brix.	Purity. Co-efficient.		
		per cent	per cent		pounds	pounds
1	50.54	14.47	20.7	69.9	155	125
2	----------	14.14	19.5	72.0	--------	--------
3	50.49	14.01	18.6	75.3	159	142
4	----------	13.95	18.8	74.2	--------	--------
5	51.18	13.75	18.2	75.5	159	142
6	52.18	13.50	18.5	73.6	154	133
7	53.03	13.26	18.6	71.2	151	125
8	53.32	13.20	18.2	72.5	153	131
9	53.70	13.10	16.9	77.5	162	149
10	54.63	13.00	17.2	75.6	160	144
Average.	52.38	13.63	18.5	73.7	156	136

(†) Topped and stripped. A ton of field cane will make about 1500 lbs. of cleaned cane.

The 10 poorest stalks analyzed gave these results:

No.	Per cent Juice.	ON THE JUICE.			Available Sugar, New Method. Per ton of cleaned Cane.	Available Sugar, Old Method. Per ton of cleaned Cane.
		Sucrose. Single polarization.	Solids. Brix.	Purity Co-efficient.		
		per cent	per cent		pounds	pounds
1	63.97	6.67	13.7	48.7	On poor canes this method gives too high results.	none
2	58.43	6.90	14.2	48.6		none
3	43.61	7.00	13.6	51.5		5
4	58.41	7.46	13.4	55.7		26
5	58.82	8.33	15.0	55.5		29
6	59.49	9.15	16.1	56.8		39
7	53.92	9.30	15.4	60.4		51
8	61.84	9.30	15.6	59.6		55
9	64.64	9.40	15.1	62·5		73
10	48.79	9.88	17.6	56.1		31
Average.	57.19	8.33	14.9	55.5		30—

The 10 next lowest gave the following: (†)

No.	Per cent Juice.	ON THE JUICE.			Available Sugar, New Method. Per ton of cleaned Cane.	Available Sugar, Old Method. Per ton of cleaned Cane.
		Sucrose. Single polarization.	Solids. Brix.	Purity Co-efficient.		
		per cent.	per cent		pounds	pounds
1	60.60	9.96	16.0	62.2	113	71
2	58.11	10.03				
3	54.18	10.10	16.2	62.3	102	64
4	65.20	10.20				
5	62.42	10.22	15.7	65.0	126	88
6	65.42	10.26				
7	60.79	10.35	16.2	63.7	122	81
8	49.56	10.35				
9	63.04	10.48				
10	57.29	10.52				
Average.	59.66	10.24	16.0	63.3	115	76

(†) The density of some of the poorer juices was not taken, hence the omissions in the table.

The contrast between the best and poorest canes is best seen by a direct comparison of averages.

A=Average results from 20 best stalks.

B=Average results from 20 poorest stalks.

A	54.06	13.77	18.7	73.5	163	141
B	58.42	9.28	15.5	59.4		53—

Average on all Canes Analyzed.

The average on all canes analyzed during the season, so far as an average can be given, is as follows:

	ON THE JUICE.
Per cent Juice.	Sucrose. Single polarization.
	per cent
54.66	12.10

Error of Single Polarization.

The figures for sucrose in the above tables are probably all slightly above the truth, for the reason that certain substances present in sorghum juice (e. g. soluble starch and dextrin) tend to make the result too high when single (or direct) polarization is depended on. This error, which may be avoided by double polarization, is usually but slight. Dr. Wiley (*) determined it on 52 samples—comparing single with double polarization—and found it to average but .34 per cent. Calling it an even one-half per cent, and correcting (†) for it, the average of our twenty best canes stands thus:

Per cent Juice.	ON THE JUICE.			Available Sugar, New Method. Per ton of cleaned Cane.	Available Sugar, Old Method. Per ton of cleaned Cane.
	Sucrose.	Solids. Brix.	Purity. Co-efficient		
54.06	Per cent 13.27	Per cent 18.7	71	pounds 154	pounds 127

And the average on all canes analyzed stands

54.66	11.60

(*) Bulletin No. 3. Divison of Chemeststry, Dep't of Agriculture.

(†) Sucrose figures in the tables have been already corrected for error of .1 per cent due to volume of lead precipitate in defecation.

Glucose

was determined in only thirty-two stalks; it varied, on the juice, from 2.25 to 5.05 per cent with an average of 3.31. This is about normal for ripe sorghum and indicates that most of the stalks analyzed were well matured.

Early Orange.

Of the individual stalks comprising the 180 all were of Early Amber excepting fourteen which were of Early Orange, each from a separate hill. The results on these fourteen, after correcting as above for error of polarization, average thus:

Average of Analyses of Early Orange.

Per cent Juice.	ON THE JUICE.			Available Sugar, New Method. Per ton of cleaned Cane.	Available Sugar, Old Method. Per ton of cleaned Cane.
	Sucrose.	Solids. Brix.	Purity. Co-efficient		
55.84	Per cent 11.60	Per cent 17.2	67.4	pounds 133	pounds 100

It will be noticed that the sucrose figure for these canes is exactly that found as the average for all the canes analyzed; the purity of the juice also is fully up to the average.

Test by Hills—Rough Field Average.

A true average of the entire crop from one or all the fields would have been most valuable, but to secure it with use of a small hand mill would have involved so much labor that the idea was abandoned. The only thing which seemed feasible was to take a few average sized hills from several parts of a field, mill the entire hills, after cleaning, and take the mean result as a rough estimate for the field. Accordingly nine hills were selected from a field of Early Amber; they ran so even and so well that it will be instructive to give the entire analytical data.

Analyses of Nine Entire Hills of Early Amber.

Hill No.	Weight of Cleaned Cane. Grms.	Per cent Juice.	ON THE JUICE.			Available Sugar, New Method. Per ton of cleaned Cane.	Available Sugar, Old Method. Per ton of cleaned Cane.
			Sucrose. Single polariz'n.	Solids. Brix.	Purity Co-efficient.		
			per cent	per cent		pounds.	pounds.
1	2799	57.09	10.84	17.6	61.6	114	69
2	3594	55.34	13.19	18.5	71.3	157	130
3	2611	52.70	11.27	17.0	66.3	119	87
4	2941	51.30	12.40	18.6	66.6	128	95
5	3723	60.22	11.28	16.6	67.9	140	107
6	3890	64.49	12.17	17.5	69.5	165	132
7	4406	58.55	11.52	17.1	67.3	138	104
8	3657	60.97	11.52	17.1	67.3	143	108
9	4986	58.94	11.28	16.6	67.9	137	115
Average.		57.73	11.71	17.4	67.3	137	105

Correcting as above for error of polarization we have as the true average for the nine hills:

Corrected Average.	57.73	11.21	17.4	64.4	126	87

As an approximation to the average of the field this is an excellent showing.

Future Work in Selection.

This spring the seed from the best of the selected stalks will be planted, and in autumn the work of selection will be repeated.

If proper help can be secured at that time the analyses will be made more searching by including the determination of glucose for each stalk.

No one can with certainty predict how much or how little improvement can be made by continuing this selection for a series of years, but from the great variations always exhibited by sorghum it would seem to be a plant peculiarly fitted for improvement in this manner.

Effects of Suckering.

Incidental to the work of selection was an experiment to test the effect of removal of the suckers upon the quality of the cane.

Two rows of Early Amber were suckered on August 15. On September 19, six mature stalks, each from a separate hill, were taken from a suckered row and eleven from an unsuckered row alongside. Results on the juice from the cleaned canes were:

From suckered row, 12.65, 13.19, 12.97, 12.17, 11.59, 13.40. Average—12.66 per cent sucrose.

From unsuckered row, 10.35, 13.20, 11.90, 13.41, 13.15, 12.65, 9.44, 12.05, 12.46, 10.90, 12.65. Average—12.01 per cent sucrose.

This trial shows only .6 per cent difference in favor of the suckered cane.

Two hills from a suckered and two from an unsuckered row were then compared; all stalks, large and small, being included. Following are the mean results:

Suckered and Unsuckered Hills Compared.

	Per cent. Juice.	Sucrose. Double polarization.	Solids. Brix.	Purity Co-efficient.	Avail. Sugar, New Method, Per ton clean Cane.	Avail. Sugar, Old Method, Per ton clean Cane.
		per cent	per cent		pounds	pounds
Suckered hills	56.87	12.77	18.1	70.5	155	126
Unsuckered hills	56.22	11.77	18.1	65.0	130	91

Here we have a more decided gain in quality, apparently the result of suckering. Together with an increase of sucrose by a full per cent, we have a decrease of other soluble matters by exactly the same amount, so that the purity is raised 5.5 points, and the available sugar per ton of cleaned cane increased twenty-five or thirty pounds.

Dr. Collier (†) obtained with Early Amber an increase of only .5 per cent sucrose, while the average from thirty-four varieties was an increase of 2.62 per cent as the result of suckering. Along with this marked gain in sucrose was a diminution of glucose and other dissolved matters sufficient to materially raise the purity and increase the available sugar.

The largest gains, however, were made by late maturing varieties, for evident reasons; while with Early Amber, Early Orange and Early Golden there was an actual falling off in purity of juice and available sugar as a result of suck-

(†) Sorghum, by Collier, page 134.

ering—probably owing to *over ripeness* of the main stalks. All of which leads to the practical suggestion that, for sugar making, the part of the crop intended to be cut earliest should be suckered, or else at cutting the suckers should be sorted out and used only for making syrup.

Effects of Topping.

The effect produced on quality of the cane by removal of the seed heads early in their development was one of the points it had been planned to study. The seed heads were removed from a few rows early in August, but the rush of work in September forced this experiment into the background, and only a couple of hills were tested, in comparison with two in an untopped row alongside. The mean results following, show practically no difference.

Topped and Untopped Hills Compared.

	Per cent Juice.	Sucrose. Double polarization.	Solids. Brix.	Purity Co-efficient.	Avail. Sugar, New Method. Per ton clean Cane.	Avail. Sugar, Old Method. Per ton clean Cane.
		per cent	per cent		pounds	pounds
Normal Hills.	56.11	11.77	18.1	65.0	130	91
Topped Hills.	52.00	11.78	17.7	66.5	124	91

The theory was some years ago advanced that topping before the seeds developed would, by compelling the retention in the stalk of the seed forming material, increase the production of sugar. A few experiments made in Ohio, in 1882–3, appeared to support the theory in a marked degree, the gain in sucrose shown as the result of topping being from 2½ to 4½ per cent.

Dr. Collier (†) studied the subject and concluded that topping does increase the content of sucrose at a given *early* date in the season, merely by hastening the maturity of the plant. His opinion is that "the time necessary from planting to the maturity of the crop would be shortened from seven to ten days for each of the varieties, if the seed was removed early."

Dr. Wiley (*) in experiments on a large scale found an increase of but .3 per cent sucrose, from topping. He ex-

(†) Sorghum, by Collier, page 139.
(*) Bulletin No. 18, Division of Chemistry, U. S. Department of Agriculture.

presses the opinion that "we may at once dismiss all expectations of ever increasing the value of sorghum as a sugar producer by preventing the maturation of the seed." Thus the question stands to-day.

SORGHUM SYRUP.

Whether the making of sugar from sorghum shall prove successful in Iowa or not, there is no doubt that syrup will be made from it in large quantities for many years to come. This fact alone would furnish abundant motive for attempting to improve the quality of sorghum, even were there no thought of sugar making in the North.

The sorghum syrup industry took root early in Iowa. The first sorghum seed was brought to the United States in 1853, and was only distributed in any quantity in 1855 (†). *Five years later*, (in 1860) according to the U. S. census, Iowa was producing annually 1,211,512 gallons of sorghum syrup, more by over 300,000 gallons than any other state, Indiana being second with 881,049 gallons. In 1880, Iowa stood fifth in the list, at over two million gallons; and for 1887, the State Secretary of Agriculture places the product at 2¼ million gallons, with a value (reckoned at forty cents per gallon) of $900,000.

Sorghum Grower and Syrup Maker.

Most farmers who make sorghum syrup make the greater part to sell. They are, then, manufacturers, and their working outfit may be called factories. There are hundreds of these factories in Iowa. They vary in size, expensiveness and efficiency from small affairs of the crudest pattern to those fitted with modern machinery, run by steam, and producing annually thousands of gallons of high grade syrup. These larger establishments furnish a market for the sorghum grown by many farmers in their vicinity. Syrup maker and sorghum grower have common interests. Whatever impairs the market for sorghum syrup injures both.

Adulteration.

A few years ago number one sorghum syrup brought at wholesale fifty cents per gallon; now it brings but thirty-five.

Is this depression due altogether to increasing supply, or lessening demand, or is there some other cause? One of the

(†) Sorghum, by Collier, page 64.

most experienced sorghum syrup manufacturers of Iowa attributes it largely to the use of glucose or starch sugar as an adulterant, and even as the basis of entirely factitious "sorghum" syrups.

He says: "The market is full of so called "Minnesota sorghum," "Tennessee sorghum" etc., which are nothing more or less than glucose and cheap sweets mixed in various proportions and sold for two-thirds the price of good sorghum syrup. If there could be a law enacted compelling venders and dealers in glucose preparations to brand them just what they are it would do more for the sorghum interest than any other one thing."

If this is a true representation of facts those most interested should unite efforts to secure protection against such fradulent competition. Manufacturers and consumers of sorghum syrup have the same right to protection by the state against such fraud that manufacturers and consumers of butter have to protection against oleo-margarine. (†)

Glucose and oleo have a perfect right to sale under their own names, but not under assumed ones.

Detection of Adulteration.

As to the facts in regard to the sophistication of sorghum syrup, I make no assertion, not having investigated the subject. But as it is a subject of direct interest to large numbers of farmers this Station will co-operate with those who wish to ascertain the facts, by analyzing suspected samples of alleged "sorghum syrup" which any citizen of the state will send us, provided each sample is accompanied by a statement of its history so far as it can be learned, and the name and address of the seller as well as of the sender.

Samples should be sent by express, prepaid, and directed to the Station Chemist.

(†) Connecticut has for two years had a law prohibiting the sale of adulterated molasses. The Dairy Commissioner acts also as molasses inspector; but the actual analyzing of suspected samples is done by the State Agricultural Experiment Station, from whose report for 1888 the following instructive paragraph is taken:

"Fifty samples of molasses have been examined for the Dairy Commissioner. Of the first twenty two samples collected by him after the passage of the law regarding the adulteration of molasses, nine were found to be mixed with glucose; one also contained salts of tin. After giving public notice that after a fixed date, all sellers of such molasses would be prosecuted, further samples were drawn and sent here for examination, but they all proved to be pure molasses. Apparently molasses mixed with glucose is no longer sold in the State."