U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF CHEMISTRY—BULLETIN NO. 75.

H. W. WILEY, CHIEF OF BUREAU.

SUGAR-CANE CULTURE IN THE SOUTHEAST

FOR THE MANUFACTURE OF TABLE SIRUP.

BY

H. W. WILEY,
Chief of the Bureau of Chemistry.

I. FERTILIZER EXPERIMENTS ON SUGAR CANE,
Conducted by W. B. RODDENBERY, *Cairo, Ga.*

II. REPORTS OF SPECIAL AGENTS ON SUGAR-CANE CULTURE,
Introduction by G. L. SPENCER, *Chief of Sugar Laboratory.*

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF CHEMISTRY,
Washington, D. C., April 4, 1903.

SIR: I submit herewith for your inspection and approval a manuscript describing the agricultural experiments conducted in Georgia, Alabama, Mississippi, and Florida during the year 1902 in connection with the investigations of the Department of Agriculture relative to the manufacture of table sirup, and recommend its publication as Bulletin No. 75 of this Bureau.

Respectfully,

H. W. WILEY,
Chief of Bureau.

Hon. JAMES WILSON,
Secretary of Agriculture.

CONTENTS.

SUGAR-CANE CULTURE IN THE SOUTHEAST

FOR THE MANUFACTURE OF TABLE SIRUP.

I. FERTILIZER EXPERIMENTS ON SUGAR CANE.

(Conducted by W. B. Roddenbery, Cairo, Ga.)

In harmony with an act of Congress approved June 3, 1902, a series of experiments was commenced in various sections of the South to ascertain the methods in use for making table sirup from sorghum, sugar cane, and other sugar-producing plants. The funds for this purpose were not available for use before July 1. Fortunately, through the liberality of Mr. W. B. Roddenbery, of Cairo, Ga., a series of experiments was begun early in the spring which would not have been possible without his assistance.

ORGANIZATION OF THE EXPERIMENTS.

On February 25, 1902, a letter was received from Mr. Roddenbery inclosing a memorandum of proposed agricultural experiments with sugar cane, and asking that such suggestions and modifications as were deemed advisable be made. The plans submitted for approval, which in the main were excellent, are outlined below, followed by the modifications made:

It is proposed that the experiments be made on 24 plats of three rows each, 70 yards long, of ordinary pine land which was planted in collards in the winter of 1900–1901, and in sweet potatoes in the summer of 1901. The land was rooted by hogs during the fall and broken broadcast by a two-horse plow in January, 1902. The cane is to be planted in 4½-foot rows about March 1.

Two one-horse turn-plow furrows are to be thrown out, leaving a small ridge or balk to be burst by the 8-inch round shovel on the guano distributer as the guano[a] is being put in the furrow. The cane is to be planted in the same furrow on top of the guano and covered with two 7-inch round-shovel furrows. The second application of guano will be put out on both sides of each row by a guano distributer when a good stand of cane is up. The third application is to be made in the same manner when the cane is laid by. Subsequent cultivation is to be carried on in the usual way, the cultivations being all alike and made at the same time.

The experiments are to be repeated in every detail on another piece of pine land that was planted in velvet beans in 1901, a very rank and heavy growth having been turned under in December, 1901.

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[a] In this section the term "guano" is applied to any fertilizer containing acid phosphate, nitrogen, and potash.

For the sandy soil of the fields used the following formula for a standard, normal fertilizer is proposed, the standard amount being 1,200 pounds per acre, used in two applications:

	Pounds.
16 per cent acid phosphate	1,200
8 per cent upland meal	400
19 per cent nitrate of soda	200
50 per cent muriate of potash	200

In the application of 1,200 pounds of such a fertilizer to an acre, the land would receive the following amounts of plant food: 720 pounds of acid phosphate, 240 pounds of cotton-seed meal, 120 pounds of nitrate of soda, and 120 pounds of muriate of potash.

In order to ascertain the best manner of applying the above formula and also the quantity per acre that would give the most profitable results the following applications of this mixture were made to plats 1 to 10, inclusive:

TABLE I.—*Experiments with normal fertilizer on plats 1–10.*

Plat No.	Pounds per acre.	Method of application.
1	1,200	Broadcast before planting and turn under.
2	1,200	One application in furrow with cane.
3	1,200	Two applications; one when planted, one in spring.
4	1,200	Three applications; one when planted, one in spring, one in summer.
5	2,000	Broadcast.
6	2,000	One application.
7	2,000	Two applications.
8	2,000	Three applications.
9	800	One application.
10	800	Two applications.

To ascertain the relative value of the ordinary and the lower grade fertilizers generally used under cane, plat No. 11 is to receive 1,200 pounds per acre in two applications of the following formula:

	Pounds.
13 per cent acid phosphate	1,000
8 per cent cotton-seed meal	600
Kainit	400

To ascertain the relative importance of each of the plant foods, and as a guide to the most desirable proportions to be used, the following experiments are to be made on plats Nos. 12 to 17, inclusive, in which each ingredient is omitted and doubled in turn. Two applications of the fertilizer will be made:

TABLE II.—*Experiments with varying proportions of plant foods on plats 12–17.*

Plat No.	Pounds per acre.			
	Acid phosphate.	Cotton-seed meal.	Nitrate of soda.	Muriate of potash.
12	720	240	120	None.
13	720	None.	None.	120
14	None.	240	120	120
15	1,440	240	120	120
16	720	480	240	120
17	720	240	120	240

As an experiment in the relative value of cotton-seed meal and nitrate of soda ammoniates the following compounds are to be applied to plats Nos. 18 and 19. Two applications were made:

TABLE III.—*Cotton-seed meal and nitrate of soda compared.*

Plat No.	Pounds per acre.			
	Acid phosphate.	Cotton-seed meal.	Nitrate of soda.	Muriate of potash.
18	675	525	.....	110
19	756	.....	221	126

As an additional experiment as to the relative value of cotton seed as an ammoniate (cost, 25 cents per bushel) and cotton-seed meal (at $23 per ton), when applied in the usual quantity used by the best cane growers, i. e., 50 bushels to the acre, the following mixtures were tried on plats Nos. 20 and 21, two applications being made as usual:

TABLE IV.—*Comparison of cotton seed and cotton-seed meal.*

Plat No.	Pounds per acre.		
	Acid phosphate.	Cotton seed.	Muriate of potash.
20	720	[a] 728	120
21	650	[b] 1,720	97

[a] Equivalent to 24 bushels, which at 25 cents per bushel cost $6.

[b] Equivalent to 50 bushels, or 525 pounds of meal, which at $23 per ton cost $6.03. This is about the amount used by the smaller cane planters who do not count the cost of seed.

To ascertain the relative value of muriate of potash and kainit, the following fertilizers were applied to plats Nos. 22 and 23. Two applications were made:

TABLE V.—*Kainit and muriate of potash compared.*

Plat No.	Pounds per acre.				
	Acid phosphate.	Cotton-seed meal.	Nitrate of soda.	Kainit.	Muriate of potash.
22	720	240	120	480	.....
23	720	240	120	.....	120

Plat No. 24 received no fertilizer, being used as a check plat. The cane from each plat is to be accurately weighed and the juice tested by the Baumé saccharimeter.

The following suggestions were made to Mr. Roddenbery in modification of the plans submitted and were put into effect:

Instead of having only three rows in each plat 4 feet apart, four were planted, inasmuch as the outside rows in one plat might be slightly affected by the fertilizer applied to the next one. The space of one row was allowed between each plat, either planted with cane of which no account was taken or left fallow. With each series of experiments a plat was introduced containing no fertilizer. Arrangements were also made for special analysis of the fertilizer used, franked packages for sending samples of them being provided and directions

given for securing a fair sample. These suggestions were adopted by Mr. Roddenbery, and later arrangements were made, after the money appropriated by Congress became available, to send a special agent to Cairo for the purpose of assisting in the harvesting and weighing of the crops and in securing samples for analysis.

AGRICULTURAL DATA.

The two fields finally selected for this experiment are designated as A and B. The soil is a sandy loam, with clay subsoil and of low fertility, being fairly representative of the soils of that section. In the growth of all standard crops in this locality where large and profitable yields are desired, fertilizers are universally applied. The water supply is usually sufficient and the water comes near the surface. The season, taken as a whole, was a favorable one and the tonnage probably better than the average. Each field was 70 yards wide and 140 yards long, and was divided into 24 plats, each consisting of four rows 4 feet apart. The fertilizer was applied only to the three rows, the fourth row being unfertilized as a check between the plats.

Field A is situated in the middle of a 15-acre field of sugar cane and was thus subjected to the ordinary conditions of growth. This field has been in cultivation about twenty years and is in a low state of fertility, and most of the available plant food was supplied by the fertilizer. The field was planted to sweet potatoes in 1901, was plowed with a two-horse disk plow in January, 1902, and again plowed just before the cane was planted. On April 3, Field A was planted with stubble cane cut short and placed end to end in the row.

Field B is situated in the middle of a 25-acre field of sugar cane one-half mile distant from Field A. The soil is similar in every respect to Field A, but has been in cultivation only five or six years and is in a much higher state of fertility than Field A. Field B was planted to velvet beans in 1901 and a very rank growth of these beans was plowed under in the autumn of 1901, the field being again plowed just before the cane was planted, namely, on April 4. Stubble cane was also used for this field, which was planted in the same manner as Field A. No special cultivation was given the experimental plats, but they received exactly the same attention as the whole field in which they were situated.

Mr. Ralph Hoagland, of Minnesota, was appointed a special agent of the Bureau of Chemistry and detailed to assist Mr. Roddenbery in the harvesting and testing of the crop.

The agricultural data were obtained directly at the fields and factory by weighing a part of the crop and calculating the entire yield from the area harvested. Samples from each plat were separately milled and samples of juices from the mill were secured and transmitted to the Washington laboratory for analysis. The plats on Field A and Field B were treated precisely alike in every particular.

The following observations as to stand were made on the two fields on the dates given:

TABLE VI.—*Stand on Fields A and B.*

Plat No.	April 28.		May 23.		Plat No.	April 28.		May 23.	
	A.	B.	A.	B.		A.	B.	A.	B.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*		*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
1	80	50	85	85	13	40	40	85	85
2	20	15	90	80	14	50	50	85	80
3	40	40	95	90	15	40	75	85	90
4	40	50	95	90	16	20	10	85	60
5	80	90	100	95	17	25	15	90	60
6	10	10	40	50	18	50	20	90	75
7	15	25	80	70	19	25	60	85	85
8	25	25	85	65	20	80	50	100	70
9	25	35	85	75	21	75	40	100	60
10	20	20	80	75	22	15	10	80	65
11	15	15	80	60	23	60	30	85	80
12	25	40	85	75	24	50	40	75	50

The percentages expressing condition of the crop as given in the following table are used in the same sense as such numbers are used by the Bureau of Statistics of this Department in its crop reports:

TABLE VII.—*Condition and height of cane, May 23–October 13.*

Plat No.	Condition, May 23.		Height,[a] July 10.		Height,[a] July 30.		Height,[b] Oct. 13.	
	A.	B.	A.	B.	A.	B.	A.	B.
	Per cent.	*Per cent.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*
1	90	80	54	49	75	68	60	60
2	80	75	54	50	75	71	62	49
3	95	80	53	50	74	73	61	60
4	90	85	52	49	73	72	63	60
5	100	90	58	52	82	75	64	68
6	50	50	52	42	72	64	62	64
7	90	70	54	51	78	74	63.5	68
8	90	65	55	47	76	68	66	64
9	90	75	53	48	72	71	56	58
10	85	80	52	49	72	69	51	58
11	85	70	53	46	72	66	58	54
12	85	75	54	47	69	67	52	58
13	85	85	50	49	68	67	53	60
14	80	75	46	42	63	60	57	68
15	90	90	54	50	73	72	60	68
16	85	65	55	44	75	69	61	66
17	90	70	54	47	74	70	56	64
18	90	75	54	45	75	65	60	62
19	85	90	49	49	73	71	58	66
20	95	90	51	47	68	63	53	60
21	100	70	55	45	79	65	61	64
22	75	70	51	44	76	64	59	67
23	90	75	58	49	79	68	59	67
24	70	65	44	35	59	48	46	36

[a] Height measured to top of leaves.
[b] Height measured to top of first red joint.

The general condition of Field A on October 15 was not as good as that of Field B. In Field A the dead leaves were about halfway up the stalks. The double phosphoric acid plat (No. 15) had the largest, tallest cane and the unfertilized plat (No. 24) the smallest. The cane in Field B did not show as many dead leaves, but the plats of the two fields appeared about the same, except that the "no ammonia" plat (No. 13), Field B, had very good cane while the same plat in Field A had poor cane.

The general progress of the cane in the two fields between October 17 and November 3 is shown in the following tabulated observations:

TABLE VIII.—*General condition of Field A, October 17, 1902.*

Plat No.	No. of stalks.[a]	General condition of cane.
1	375	Fair quality of cane.
2	428	Trifle better than 1.
3	437	About the same as 2.
4	408	Do.
5	462	Good cane; better than 3 and 4.
6	359	Light stand, fair cane, too much fertilizer in drill.
7	451	About the same as 5.
8	412	Do.
9	326	Much poorer than 8, light stand.
10	324	Same as 9.
11	328	About the same as 10.
12	320	Rather poor cane.
13	321	Very poor cane, not healthy green.
14	343	Fair cane, far better than 13.
15	411	Heavy, fine cane.
16	469	Do.
17	408	Very fair cane, not as good as 15.
18	415	Not as good as 17; good cane.
19	328	Poor stand, fair quality cane.
20	350	Lighter cane than 19, but not so many gaps.
21	416	Good cane, much better than 20.
22	398	Good cane, but not as good as 21.
23	439	Very good cane.
24	255	Very poor, short cane.

[a] Number of stalks of cane of fair size in middle row of each plat.

OBSERVATIONS ON FIELD A, NOVEMBER 3.

This field of cane will yield fewer tons of cane per acre than Field B, but at this time is much nearer maturity, the dead leaves reaching nearly up to the tuft at the top of the cane.

Plat 1. Fair cane, good stand; not as good as Field B, plat No. 1.
Plat 2. Fairly good cane, stand better than plat No. 1.
Plat 3. About the same as plat No. 2.
Plat 4. About the same as plats Nos. 2 and 3.
Plat 5. Very good cane, not as good as Field B, plats Nos. 3 and 5.
Plat 6. Good cane, but not as good as plat No. 5.
Plat 7. Very good cane, better than plat No. 6.
Plat 8. About the same as plat No. 7.

Plat 9. Fair cane only, fair stand, shows need of more fertilizer.
Plat 10. Same as plat No. 9.
Plat 11. Fairly good cane, better than plats Nos. 9 or 10.
Plat 12. Cane poor to fair, poor stand.
Plat 13. Very poor cane, poorer than plat No. 12; short and yellow.
Plat 14. Fairly good cane, better than plats Nos. 12 and 13.
Plat 15. Very good cane, better than plat No. 14; a trifle better than plats Nos. 3 and 4.
Plat 16. Very good cane, better than plat No. 15; greater diameter of stalk, yield will be a trifle heavier.
Plat 17. Good cane, not quite as heavy as plat No. 16.
Plat 18. Good cane, about the same as plat No. 17.
Plat 19. Good cane, about the same as plat No. 18.
Plat 20. Very poor cane, but little better than the unfertilized plat.
Plat 21. Good cane, about the same as plats Nos. 3 or 4.
Plat 22. Very good cane, better than plat No. 21.
Plat 23. Very good cane, better than plat No. 22.
Plat 24. Very poor cane; short, yellow.

TABLE IX.—*General condition of Field B, October 20, 1902.*

Plat No.	No. of stalks.[a]	General condition of cane.
1	454	Heavy cane, much better than Field A, plat No. 1.
2	478	Very heavy cane, about the same as plat No. 1.
3	496	Very heavy cane, trifle heavier than plat No. 2.
4	456	Very heavy cane, about the same as plat No. 3.
5	542	Very heavy cane, heavier than plat No. 4; badly twisted.
6	451	Good cane, only fair stand, stalks smaller than plat No. 5.
7	481	Heavy cane, but stalks smaller than plat No. 4.
8	461	Rather heavy, larger stalks than plat No. 7.
9	437	Not as good stand nor cane as plats Nos. 7 and 8.
10	414	Cane good, about the same as plat No. 9.
11	398	Fair cane, about the same as plat No. 10.
12	389	Only fair cane, about the same as plat No. 11.
13	397	Good cane, much better than plat No. 12.
14	340	Very poor cane, short; light stand, but little better than plat No. 24.
15	493	Very heavy stand, tall cane, fair diameter; too thick, too much phosphoric acid.
16	392	Good cane, large diameter, fair height; not as good as plat No. 15.
17	377	Good cane, about the same as plat No. 16.
18	423	Very good cane, nearly as good as plat No. 15.
19	436	Do.
20	390	Good cane, fair stand.
21	335	Good cane, poor stand.
22	377	Good cane, stand uneven.
23	360	Good cane, not as good as plats Nos. 1 and 2.
24	262	Poor stand of cane, a trifle better than plat No. 24, Field A.

[a] Number of stalks of fair-sized cane in middle row of each plat.

OBSERVATIONS ON FIELD B, OCTOBER 30, 1902.

The dead leaves were hardly halfway up on the cane.
Plat 1. Very heavy cane, good stand.
Plat 2. Perhaps trifle heavier than plat No. 1.

Plat 3. About the same as plat No. 2.

Plat 4. About the same as plat No. 2.

Plat 5. Very heavy cane, perhaps a trifle heavier than plat No. 4; badly twisted and down, worse in that respect than plat No. 4.

Plat 6. Heavy cane, but rather poor stand; shows injurious effect of large amount of guano in drills.

Plat 7. Extra heavy cane, heavier than plats Nos. 3 and 4; large stalks, rather badly twisted.

Plat 8. About the same as plat No. 7.

Plat 9. Very good cane, about the same as plat No. 1.

Plat 10. Same as plat No. 9.

Plat 11. Good cane, fair stand, cane perhaps trifle better than plat No. 10.

Plat 12. Only fair cane, poor stand, not as good as plats Nos. 9 and 10; shows need of some fertilizing element.

Plat 13. Good cane, much better than plat No. 12; stalks of good size; shows need of but little ammonia.

Plat 14. Fair cane only, not as good as plat No. 13, about the same as plat No. 12; shows need of another fertilizing element.

Plat 15. Very heavy stand, tall cane, stalks of small diameter and joints long, due to rapid growth(?). Yield will probably not be greater than that of plats Nos. 5 and 7.

Plat 16. Very heavy cane, large diameter, good height but not as tall as plat No. 15, fair stand.

Plat 17. Very good cane and stand; diameter yield will be better than plat No. 16 and nearly as good as plat No. 15.

Plat 18. Very good cane, about the same as plats Nos. 3 and 4.

Plat 19. Seems to be a trifle better, heavier cane than on plat No. 18.

Plat 20. Cane fair to good; fair stand.

Plat 21. Very good cane but poor stand, cane about as plats Nos. 3 and 4; yield hardly as large.

Plat 22. Very good cane, fair stand; about the same as plats Nos. 3 and 4.

Plat 23. Very good cane, about the same as plats Nos. 1 and 22; no better than plot No. 22. Can see no advantage in mixing guano with soil before planting.

Plat 24. Poor cane, poor stand, but better than plat No. 24, Field A.

COMPOSITION AND COST OF FERTILIZERS.

The composition of the samples of fertilizers received from Mr. Roddenbery were analyzed in this Bureau with the following results:

TABLE X.—*Analyses of fertilizers.*

Serial No.	Variety.	Phosphoric acid.				Potash. (K_2O.)	Nitrogen. (N.)	Ammonia. (NH_3.)
		Water soluble.	Citrate soluble.	Available.	Total.			
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
23991	Acid phosphate	10.27	3.09	13.36	15.30	.....	0.13	0.16
23992	Acid phosphate[a]	15.14	2.82	17.96	18.16	.....	.17	.21
23993	Cotton-seed meal	.63	1.32	1.95	2.53	1.82	6.54	7.94
23994	Nitrate of soda	.....	.....	.....	.....	1.52	13.93	16.91
23995	Kainit	.....	.....	.....	.....	12.49	.02	.....
23996	Muriate of potash	.....	.....	.....	.....	50.72	.03	.....
	Normal[b]	.....	.....	11.95	.....	5.58	.....	3.53

[a] Used in composition of normal fertilizer. [b] Calculated.

In the following table is given the cost per ton of the different fertilizers mentioned in Table X and the cost per pound of the principal fertilizing elements contained therein. In Table XII will be found the cost of the various mixtures as applied, per acre.

TABLE XI.—*Cost of fertilizers.*

Fertilizer.	Cost per ton.	Amount of principal fertilizing elements per ton.		Cost of principal fertilizing elements per pound.
		Kind.	Quantity.	
	Dollars.		*Pounds.*	*Cents.*
Acid phosphate (16 per cent)	12.50	Phosphoric acid	359	3.5
Acid phosphate (13 per cent)	11.80	do	267	4
Sodium nitrate	48.00	Nitrogen	338	14.2
Muriate of potash	45.00	Potash	1,014	4.4
Cotton-seed meal	23.50	Nitrogen	158.8	14.8
Cotton seed	16.66	do	76	21
Kainit	13.50	Potash	258.8	5.2

In the above table it will be noted that in estimating the cost of the fertilizing elements per pound only the principal one has been selected and the whole cost of the fertilizer charged to that. This is of course an unobjectionable method, provided the fertilizer contains only one element, as was the case with the acid phosphates of kainit and muriate of potash above mentioned. In the case of cotton-seed meal the phosphoric acid and the potash, however, are worth something, and hence the value of these should be deducted from the total expense, and their value should not be charged to the nitrogenous element alone. In making this change we find that the cotton-seed meal contained 1.82 per cent of potash, or 36.4 pounds per ton, which, at 5 cents per pound, amounts to $1.82. The cotton-seed meal contained also 1.96 per cent of available phosphoric acid, which, at 4 cents per pound and 39.2 pounds per ton, amounts to $1.57. Potash and phosphoric acid together, therefore, are worth $3.39. Deducting this from the price per ton of cotton-seed meal, namely, $23.50, we find the value of the nitrogenous element to be $20.11. Dividing this by the number of pounds of nitrogen reckoned as ammonia, namely, 158.8, we find the price of the ammonia to be 12.6 cents per pound.

In determining the cost of phosphoric acid and potash per unit it will be seen that the high-grade fertilizers furnish these elements at a cheaper rate than the low grade. For instance, the guaranteed 16 per cent acid phosphate supplies phosphoric acid at 3½ cents a pound, while the guaranteed 13 per cent available phosphoric acid supplies this element at 4 cents per pound. It will be noticed in both cases that the acid phosphates were above the guarantee in available phosphoric acid, one being 0.36 per cent and the other 1.96 per cent above the guarantee.

COMPARISON OF AGRICULTURAL AND CHEMICAL DATA.

A summary of the agricultural and chemical data obtained in the fertilizer experiments are given in Table XII. The analytical results in this table, as well as the figures given on the cane juices throughout the reports of the special agents in Part II, were obtained by the assistants in the sugar laboratory of this Bureau working under the direction of Mr. G. L. Spencer, the sucrose and purities having been determined by A. Wilbur Bache and the reducing sugars by H. W. Houghton.

The practical result of the experiment that would naturally be considered first is the tonnage. This, however, is not an absolute standard, as a study of the chemical data in connection with the tonnage will show, the former being of the greatest importance in sirup making in so far as quality is concerned. A glance at the analytical data will show that the juices coming from the cane of Field A were very distinctly superior, both in sugar content and in purity, to the juices obtained from the cane of Field B. It is evident, therefore, that a higher grade of sirup would be made from the cane grown on Field A.

TABLE XII.—*Summary of agricultural and chemical data on fertilizer experiments, Fields A and B.*

No. of plat.	Sucrose.		Reducing sugar.		Purity.		Yield per acre.		Number of stalks.		Cost of fertilizer per acre.	Fertilizers: Composition,[a] quantity, and method of application.[b]
	A.	B.	A.	B.	A.	B.	A.	B.	A.	B.		
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*			*Tons.*	*Tons.*				
1	16.22	14.97	.40	.80	91.52	89.05	19.96	26.88	1,227	1,340	$13.50	1,200 pounds normal fertilizer to acre; broadcast before planting and turned under.
2	15.51	15.10	.51	.89	90.12	88.82	20.56	27.64	1,231	1,410	13.50	1,200 pounds normal fertilizer to acre; 1 application in furrow with cane.
3	15.66	15.56	.44	.71	91.04	88.89	20.36	28.72	1,254	1,423	13.50	1,200 pounds normal fertilizer to acre; 2 applications when planted, May 23.
4	15.76	13.90	.39	1.18	90.58	86.34	19.60	28.00	1,179	1,381	13.50	1,200 pounds normal fertilizer to acre; 3 applications when planted, May 23—July 10.
Average	15.79	14.88	.44	.90	90.82	88.28	20.12	27.81	1,225	1,389	13.50	
5	16.04	13.36	.75	1.18	92.18	84.56	23.24	35.36	1,367	1,574	22.50	2,000 pounds normal fertilizer to acre; broadcast and plowed under before planting.
6	14.55	12.68	.56	1.48	87.88	81.81	19.40	23.84	1,091	1,323	22.50	2,000 pounds normal fertilizer to acre; 1 application in furrow with cane.
7	15.21	14.25	.52	.98	91.06	86.88	24.60	39.40	1,475	1,431	22.50	2,000 pounds normal fertilizer to acre; 2 applications May 23—July 10.
8	15.18	13.34	.54	1.25	89.82	88.86	24.60	28.88	1,307	1,322	22.50	2,000 pounds normal fertilizer to acre; 3 applications when planted, May 23—July 10.
Average	15.25	13.41	.59	1.22	90.24	85.54	22.96	31.87	1,310	1,413	22.50	
9	15.03	14.09	.53	1.04	90.00	86.42	16.88	25.76	1,102	1,126	9.00	800 pounds normal fertilizer to acre; 1 application in furrow with cane.
10	15.58	14.68	.44	.92	88.02	86.86	21.48	28.32	1,096	1,389	9.00	800 pounds normal fertilizer to acre; 2 applications.
Average	15.35	14.39	.49	.98	89.01	86.64	19.18	27.04	1,099	1,258	9.00	
12	15.27	14.74	.55	.91	89.83	88.26	13.56	19.76	1,036	1,150	10.20	720 pounds 16 per cent acid phosphate; 240 pounds cotton-seed meal; 120 pounds nitrate of soda; *no potash.*
13	16.41	14.52	.37	.92	.....	87.47	10.80	24.40	914	1,190	7.20	720 pounds 16 per cent acid phosphate; *no ammonia;* 120 pounds muriate of potash.
14	16.25	14.79	.33	1.18	91.52	84.28	14.72	18.80	1,027	1,139	8.40	*No acid phosphate;* 240 pounds cotton-seed meal; 120 pounds nitrate of soda; 120 pounds muriate of potash.
Average	15.98	14.68	.42	1.00	90.68	86.67	13.03	20.99	992	1,160	8.60	
15	16.01	14.01	.46	.91	91.50	86.48	18.24	31.50	1,223	1,493	17.40	*1,440 pounds acid phosphate (double);* 240 pounds cotton-seed meal; 120 sodium nitrate; 120 pounds muriate of potash.
16	14.93	13.01	.64	1.52	88.86	82.28	23.44	24.50	1,406	1,235	18.60	720 pounds acid phosphate; *480 pounds cotton-seed meal (double); 240 pounds sodium nitrate (double);* 120 pounds nitrate of potash.
17	16.31	12.66	.39	1.29	91.12	80.13	19.84	25.60	1,255	1,184	15.60	720 pounds acid phosphate; 240 pounds cotton-seed meal; 120 pounds sodium nitrate; *240 pounds muriate of potash (double).*
Average	15.75	13.23	.50	1.24	90.49	82.96	20.51	27.20	1,295	1,304	17.20	

[a] When cotton seed was used, instead of cotton-seed meal, it had the following composition: Available phosphoric acid, 1.27 per cent; nitrogen as ammonia, 3.8 per cent potash, 1.17 per cent.

[b] Unless otherwise stated two applications of the fertilizer were made.

TABLE XII.—*Summary of agricultural and chemical data on fertilizer experiments, Fields A and B*—Continued.

No. of plat.	Sucrose.		Reducing sugar.		Purity.		Yield per acre.		Number of stalks.		Cost of fertilizer per acre.	Fertilizers: Composition, quantity, and method of application.
	A.	B.	A.	B.	A.	B.	A.	B.	A.	B.		
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*			*Tons.*	*Tons.*				
TO ASCERTAIN RELATIVE VALUE OF ORIDINARY AND LOW-GRADE FERTILIZERS GENERALLY USED WITH CANE.												
11	15.63	14.23	.40	1.00	90.33	87.30	15.04	24.08	997	1,248	9.36	1,200 pounds to acre (1,000 pounds 13 per cent acid phosphate; 600 pounds cotton-seed meal; 400 pounds kainit). Two applications; one when planted, one May 23.
TO ASCERTAIN RELATIVE VALUE OF COTTON-SEED MEAL AND NITRATE OF SODA AS AMMONIATES.												
18	16.22	15.05	.40	.80	91.64	88.52	17.32	29.00	1,156	1,303	12.90	675 pounds acid phosphate; 525 pounds cotton-seed meal; 110 pounds muriate of potash.
19	15.56	14.47	.49	.91	91.00	86.10	20.36	29.08	1,212	1,323	12.86	756 pounds acid phosphate; 221 pounds nitrate of soda; 126 pounds muriate of potash.
Average	15.89	14.76	.45	.86	91.32	87.31	18.84	29.04	1,184	1,313	12.88	
TO ASCERTAIN RELATIVE VALUE OF COTTON SEED AND MEAL.												
20	16.22	14.52	.42	.86	91.16	86.89	13.80	26.32	1,073	1,227	13.20	720 pounds acid phosphate; 728 pounds cotton seed; 120 pounds muriate of potash.
21	16.28	14.55	.39	.83	92.50	87.64	19.08	31.62	1,239	1,136	20.62	650 pounds acid phosphate; 1,720 pounds cotton seed; 97 pounds muriate of potash.
Average	16.25	14.54	.41	.85	91.83	87.27	16.44	28.97	1,156	1,182	16.41	
TO ASCERTAIN RELATIVE VALUE OF KAINIT AND MURIATE OF POTASH.												
22	16.12	13.26	.44	1.25	91.07	84.43	19.00	26.60	1,123	1,326	13.17	720 pounds acid phosphate; 240 pounds cotton-seed meal; 120 pounds nitrate of soda; 480 pounds kainit.[a]
23	16.20	14.28	.44	.94	91.53	86.02	19.32	26.60	1,178	1,192	13.50	720 pounds acid phosphate; 240 pounds cotton-seed meal; 120 pounds nitrate of soda; 120 pounds muriate of potash.[b]
Average	16.16	13.77	.44	1.05	91.30	85.23	19.16	26.60	1,151	1,259	13.34	
24	15.72	14.17	.44	1.21	91.40	85.33	9.12	12.00	743	841	.....	No fertilizer.

[a] Compare also with plat No. 3.

[b] Fertilizer mixed with dirt before planting cane.

This better quality of sirup would naturally command a better price in the market; therefore the actual financial difference in the results between the two fields would not be so great as would appear from a study of the tonnage data alone. In comparing the yields from Fields A and B it must not be forgotten that the actual fertility of Field B is greater than Field A, because it has been a shorter time under cultivation, and in addition to this the crop in Field B was preceded by a leguminous crop, a nitrogen gatherer which was plowed under, thus adding a large amount of available nitrogen to the succeeding crop. In Field A, on the contrary, sweet potatoes had been grown, and this crop adds nothing to the fertility of the soil, but rather tends to diminish it.

The basic data for comparison are found in Plat 24, to which no fertilizer was applied. The yield of cane per ton on this plat was 9.12 tons in Field A and 12 tons in Field B. It is to be regretted that one or two additional check lots were not provided, since the difference in yield in the two plats 24 in Fields A and B is not so great as one would expect. In other words, although Fields A and B were treated exactly alike, if you should add only 3 tons per acre to the yield of Field A you would not reach the yield of Field B in many instances. This fact leads to the inevitable conclusion either that the two plats 24 in each field do not afford a sufficient comparison, or else the previous treatment of Field B made it unusually well adapted to utilize to the very best advantage the plant foods added in the fertilizer. In another experiment there should be at least four unfertilized plats in each field.

Without going over the data in detail it will be interesting to compare the yields per acre on the plats which were treated with the same amount of fertilizer, but applied differently, namely, 1, 2, 3, and 4; 5, 6, 7, and 8; and 9 and 10. It will be evident at once that the normal fertilizer suggested is the best combination of fertilizing material with which experiments were made. The yields per acre, the percentage of sugar, and the purity of the juice are the data on which our judgment must be based.

On Field A with 1,200 pounds of normal fertilizer the average yield was 20.12 tons per acre on plats Nos. 1 to 4, inclusive. On plats Nos. 5 to 8, inclusive, with 2,000 pounds of the normal fertilizer we see that the average yield was 22.96 tons per acre, while on plat No. 24, to which no fertilizer was applied, the yield was 9.12 tons per acre. These data show that on Field A the application of the normal fertilizer more than doubled the yield when applied at the rate of 1,200 pounds; while with the use of 2,000 pounds per acre the yield was increased almost exactly 152 per cent. Where the application dropped to 800 pounds per acre the average yield was also very satisfactory, being almost exactly double the yield without fertilizer. The appli-

cation of the fertilizer on plat No. 11 was less efficacious, while the fertilizers on plats Nos. 12, 13, and 14 were still less remunerative. Plats Nos. 15, 16, and 17, however, gave good results; plats Nos. 18 and 19 fair results; plat No. 20 poor results; and plats Nos. 21, 22, and 23 also good.

Plats Nos. 12, 13, and 14 perhaps are the most instructive in Field A, for they show that a complete fertilizer is absolutely necessary to give the best results. To plat No. 12 no potash was added, to plat No. 13 no nitrogen, and to plat No. 14 no acid phosphate. The most striking feature of this part of the experiment is that nitrogen is shown to be the most deficient element in the soil of Field A, since when no nitrogen was added the yield per acre was only a little above 1 ton more than when no fertilizer was added. The next most important plant food to the crop is potash, and the third phosphoric acid.

Turning to Field B, we find, of course, a different condition of affairs, for in that field a natural fertility of the soil exists. On plats Nos. 12, 13, and 14 good crops were grown, showing that no fertilizing element was altogether absent. In the blank plat the yield was about 33 per cent higher than in Field A. The fertilizers, as a rule, give larger results on Field B than on Field A. For instance, 1,200 pounds on plats Nos. 1 to 4, inclusive, Field B, produce an average yield of 27.81 tons per acre—that is, an increased average yield of 15.81 tons per acre—while on plats Nos. 5 to 8, 2,000 pounds of normal fertilizer produce an average yield of 31.87—that is, an increased yield of 19.87 tons per acre. In Field B it is also seen that the 800 extra pounds of normal fertilizer applied to plats Nos. 5 to 8, inclusive, produced a yield of nearly 4 tons per acre in excess of the yield of plats Nos. 1 to 4 with 1,200 pounds of fertilizer. If we value the cane at $3 per ton, the 800 pounds of fertilizer produced an increase of crop worth $12 per acre.

In addition to the fertilizers mentioned, barnyard manure is very much prized by cane growers, and it gives much better results than would be expected, judging from its chemical analysis. This is doubtless due to the mechanical changes which the organic matter produces in the soil and to the introduction of the organisms causing fermentation and decomposition, which quickly form considerable quantities of humus, a constituent in which the sandy soil is particularly deficient. The growth of velvet beans, which are either plowed under or used as a pasture by stock, is also found in many instances to give beneficial effects. The velvet bean being a leguminous crop, it would naturally become a nitrogen gatherer, and when the crop is plowed under in the course of time it also tends to add a considerable quantity of humus to the soil.

It is evident that in so far as the artificial fertilization of ordinary sandy soils, of which Fields A and B are types, is concerned, the

mixture characterized as normal fertilizer, and consisting of acid phosphate, cotton-seed meal, nitrate of soda, and muriate of potash, affords the best financial returns.

In regard to the quantities to be used, the results of the experiments show conclusively that from 800 to 1,200 pounds per acre will yield the best financial results. While a larger crop is secured on the poorer soils by the use of 2,000 pounds of this mixture to the acre, the increase does not justify the additional cost of the fertilizing materials.

Perhaps the most striking result based upon the data obtained from the plats of the two fields is shown in the fact that the large quantity of nitrogen made available by plowing under the crop of velvet beans on Field B can not be fully assimilated by the growing crop unless the other essential plant foods are supplied. As has been mentioned before, in the unfertilized plat of Field B the yield of cane was a little less than 3 tons greater than on the unfertilized plat of Field A. If, however, the other essential elements of plant food are supplied the increased yield due to the presence of the decaying velvet beans is at once apparent. On plat No. 12 of Field B we find that 720 pounds of acid phosphate were used and a yield of 19.76 tons were secured, which is 7.76 tons above the yield of the unfertilized plat No. 24. In plat No. 13, where 720 pounds of acid phosphate and 120 pounds of muriate of potash per acre were employed, the yield is 24.4 tons, being 12.4 tons in excess of the yield of plat No. 24. On plat No. 14, where 120 pounds of muriate of potash were used, and no acid phosphate, the yield was 18.8 tons, being 6.8 tons above the yield of plat No. 24. On plats Nos. 12 and 14 a considerable quantity of nitrogen was used in the fertilizer, while in plat No. 13 no additional nitrogen was used. The data from these three plats show very conclusively that the velvet beans supplied practically all the nitrogen necessary to produce a large crop. Nevertheless, on comparing plats Nos. 12 to 14, inclusive, with plats Nos. 1 to 4, inclusive, it is seen that where all the essential plant foods are present the addition of an increased amount of nitrogen shows a considerable increase in the yield.

In plats Nos. 18 and 19 a comparison is made of the utility of nitrogen in the form of cotton-seed meal and in the form of nitrate of soda; the quantity of phosphoric acid and potash applied to these two plats were as nearly the same as possible—that is, the phosphoric acid and the potash in the cotton-seed meal added to that given as acid phosphate and muriate of potash would make the quantities of these two fertilizing elements in plat No. 18 the same as those added to the fertilizer applied to plat No. 19. The results of the experiments show that there is practically no difference in the availability of the nitrogen applied as cotton-seed meal and as nitrate of soda, the tonnage in the plats compared being almost identical in Field B. In plats Nos. 20 and 21 a comparison is made between the nitrogen in cotton-seed meal and

in cotton seed. The quantities of nitrogen, phosphoric acid, and potash applied on the two plats were practically the same. In this case it appears that nitrogen in the form of cotton seed was more effective than in the form of cotton-seed meal. Additional data, however, would be required before asserting positively that such is the case. In plats Nos. 22 and 23 a comparison is made between the value of potash as kainit and potash as muriate. The data obtained show that there is no difference in the availability of the potash in these two forms. In plat No. 11 a fertilizer was employed in which the phosphoric acid and potash was supplied from low-grade materials instead of the high grade as used in preparing the normal fertilizer. The result of this one test is not definite, but seems to indicate that it is advisable to use a higher grade material.

EFFECT OF SOIL AND FERTILIZERS ON THE CHEMICAL COMPOSITION OF THE CANE.

The principal effect which the soil has upon the crop is shown in the quantity which is produced. It is well known, however, that the character of the soil also influences to a greater or less extent the chemical composition of the crop. Crops which are grown in a very fertile soil are usually coarser in texture than those grown in one less fertile. If, therefore, we are seeking for a particular flavor, taste, or character of product it is to be remembered that the fertility of the soil has an influence of quite a marked character in many of these particulars. If we examine the quantity of sugar contained in the cane grown on plat No. 24 of Field A, we find that the juice of the cane contained 15.72 per cent of sucrose and 0.44 per cent of reducing sugar with a purity of 91.4 per cent. This typical composition of the juice is shown by all the crops on Field A. It is a remarkable showing of purity and high sucrose content with a low reducing sugar content. The quantity of sugar in these canes and the purity of their juices compare favorably with the data obtained from sugar canes grown under favorable conditions in the Tropics. In fact, it appears that the purity is, as a rule, higher than that of the juices of tropical sugar canes. The effect of the fertilizer on Field A is not very marked in so far as variations in chemical composition are concerned.

Twelve of the fertilized plats, viz, Nos. 1, 4, 5, 13, 14, 15, 17, 18, 20, 21, 22, and 23 have a higher content of sugar than plat No. 24, and the other eleven have a lower sugar content.

In regard to the purity of the juices, seven of the fertilized plats, viz, Nos. 1, 5, 14, 15, 18, 21, and 23, have a higher purity than plat No. 24, and the others a lower purity. In this enumeration plat No. 13 is excluded, since the number expressing the purity as recorded is evidently an error and the data are not at hand to ascertain the magnitude of the mistake.

In regard to reducing sugar, ten plats, viz, Nos. 2, 5, 6, 7, 8, 9, 12, 15, 16, and 19, have a larger amount than plat No. 24. Four have

the same amount, viz, Nos. 3, 10, 22, and 23, and the others a smaller quantity.

It is seen that the general effect of the added fertilizers on the composition of the juices is unimportant. If we compare, on the other hand, the character of the canes in Field B with plat 24 of Field A, we see at once a marked inferiority in the juices. This is shown both in the lower content of sucrose, a higher content of reducing sugar, and a lower purity. Not one of the plats in Field B produced a juice having as high sugar content, as small a quantity of reducing sugar, or as high purity as the juice of the cane on plat 24 of Field A.

Inasmuch as the same quantities of fertilizers were added to Field A and Field B, the conclusion is evident that the inferior character of the cane grown on Field B was due to the comparative newness of the soil and to the influence of the heavy crop of velvet beans plowed under during the previous season. It is not to be inferred from the above that the chemical character of the canes grown on Field B was low; on the contrary, they are of quite an excellent composition, both in content of sugar and in purity of juice. The inferiority, therefore, is in their comparison with the canes grown on Field A. The logical conclusion to be drawn from this discussion is that the large excess of available nitrogen and organic nitrogenous matter in the soil, while tending to produce a large crop, also has a decided tendency to diminish the excellence and purity of the product. It would be quite logical to infer from the above data that the canes grown on Field A would make a better quality of sirup, having a brighter color, and bringing a larger price in the market than that yielded by the same weight of canes grown on Field B.

SUMMARY OF RESULTS.

(1) Velvet beans have a high value as a fertilizing agent, but this value reaches its maximum only when other essential elements of plant food other than nitrogen are applied in the fertilizer.

(2) In the application of fertilizing materials it is far better not to apply the whole amount at the time of or before planting, but to apply a part of the fertilizer at the time of planting and the rest at intervals during the growing season.

(3) In regard to the amount of the fertilizer to be applied to obtain the best financial results, it appears that 1,200 pounds of the normal fertilizing material is probably the best amount for Field A, while for Field B a larger amount of this fertilizer may be used. It is plain, however, in this case, that the increased amount of fertilizer could be more profitably secured by adding larger quantities of phosphoric acid and potash and a smaller quantity of the nitrogenous constituents. On Field A there was a profit in using 1,200 or even 2,000 pounds of the fertilizer per acre rather than 800 pounds, but on Field B there was no

profit in using 1,200 pounds rather than 800 pounds, and a slight profit in using 2,000 instead of 800. In general it may be said that on land which contains a high percentage of fertilizing materials, as found in Field B, it is not advisable to use over 800 or 1,000 pounds of normal fertilizer per acre, while on land possessing only a normal natural fertility, as in Field A, 1,200 to 1,500 pounds per acre of normal fertilizer may be used to advantage.

(4) It is evident that fertilizers such as phosphoric acid and potash which contain large quantities of fertilizing ingredients give better results than those which contain small quantities.

(5) Muriate of potash apparently gives somewhat better results than kainit, especially on Field A.

(6) Nitrate of soda, upon the whole, seems to be a more satisfactory source of nitrogen than cotton seed and cotton-seed meal at practically the same cost.

(7) Sodium nitrate, however, should be added in small quantities at a time and at rather frequent intervals to avoid loss by leaching during the heavy rains. Cotton seed is a more expensive fertilizer than sodium nitrate or cotton-seed meal.

(8) On soils represented by Field A more nitrogen is needed in the fertilizer in proportion to the potash and phosphoric acid than on Field B, and vice versa.

(9) It is evident that excessive amounts of any single fertilizing ingredient are inadvisable, because the plants can not assimilate the excess. The ration for a plant should be carefully balanced to meet the requirements, basing the character of the fertilizer on the amount of available plant food already in the soil, and adding to the fertilizer larger quantities of the elements missing in the soil and diminishing in the fertilizer those elements which are abundant therein.

It will be interesting also in this connection to note the conclusions reached by Mr. Roddenbery from a study of the data given in Table XII. In this case we have the conclusions deduced by a practical man of affairs illustrating the fact that such scientific data have an immediate and extremely practical value when placed in the hands of a thinking business man, though he may not be a scientist. Mr. Roddenbery's deductions are as follows:

CONCLUSIONS ON THE FERTILIZER EXPERIMENTS.

By W. B. Roddenbery.

FIELD A.

(1) A high percentage of nitrogen assists germination and favors suckering. Compare plats Nos. 5, 7, 8, and 16 with 9, 10, 11, 13, and 24.

(2) When applied, however, in the furrow with seed cane, heavy fertilization with complete fertilizers prevents germination. See plat No. 6 as to stand.

(3) Nitrate of soda is a better source of nitrogen than cotton-seed meal or cotton seed. Compare plat No. 19 with Nos. 11, 18, 20, and 21.

(4) Cotton seed is not a profitable fertilizer for sugar cane. Compare plats Nos. 20 and 21 with Nos. 3, 7, 10, and 23. Cotton-seed meal gives $14 per acre more profit than the same value in cotton seed. Compare plat No. 18 with plat No. 20. (In all estimates of profits cane is valued at $4 per ton.) Nitrate of soda shows $12 per ton more profit than the same value in cotton-seed meal. Compare plat No. 19 with No. 18.

(5) Two applications of the fertilizer give the best results.

(6) Doubling potash shows no gain in tonnage over that given by the normal fertilizer, and the general trend of the experiments indicates about 50 pounds of actual potash per acre as being the most profitable amount for this soil.

(7) Doubling nitrogen shows a gain of 3 to 3½ tons per acre over the tonnage given by the normal fertilizer and about $9 per acre more profit. In general, the experiment indicates 65 pounds of nitrogen per acre as the most profitable proportion for this soil, the source of the nitrogen to be mainly nitrate of soda.

(8) Doubling phosphoric acid gives no gain over the tonnage given by the normal fertilizer, but for some unknown reason shows a decrease of 1½ tons per acre and a gain of only 3½ tons per acre over the "no phosphoric acid" plat, No. 14. In general the experiments point to 100 pounds per acre of phosphoric acid as a sufficient amount for this land.

(9) All the results indicate that the following formula will give the fertilizer most suitable for a land like Field A:

	Pounds.	
12.5 per cent acid phosphate	800	(100 pounds phosphoric acid = 7.7 per cent).
Cotton-seed meal	100	(55 pounds nitrogen = 4.2 per cent).
Nitrate of soda	300	
Muriate of potash	100	(50 pounds actual potash = 3.8 per cent).

FIELD B.

(1) No special effect on the stand was noted as a result of the different fertilizers, except that plat No. 6 had a very poor stand at first; but this was overcome later by heavy suckering, which was probably the result of a large application of nitrogen to this plat.

(2) No difference was noted due to the source of the nitrogen, nitrate of soda and cotton-seed meal showing the same tonnage.

(3) Cotton seed is not as good as the same value in cotton-seed meal. Compare plats Nos. 18 and 20.

(4) Two applications give the best results.

(5) Doubling the potash gave no gain over the normal potash ration, and the general trend of the experiments points to 50 pounds per acre of actual potash as being sufficient on a soil of this kind.

(6) Doubling the nitrogen gives the same tonnage as the "no nitrogen" plats. Compare plats Nos. 13 and 16, both of which give 4 tons less per acre than the normal ration. The general trend of the experiments points to the need of a very small application of nitrogen; possibly none would have been more profitable, but 20 pounds per acre is certainly sufficient.

(7) Doubling the acid phosphate gives a gain of 13 tons per acre over the "no acid phosphate" plat and a gain of 3 tons over the normal ration. In general the need of a larger application of phosphoric acid is shown, and probably about 200 pounds of this fertilizer per acre would be the most profitable proportion.

(8) All results indicate that the following formula for a fertilizer would give the best results on such land as Field A, on which a heavy growth of velvet beans had been grown and plowed under the previous year:

	Pounds.
12.5 per cent acid phosphate	1,600 (200 pounds phosphoric acid=11.1 per cent).
Nitrate of soda	100 (nitrogen=1 per cent).
Muriate of potash	100 (50 pounds actual potash=2.72 per cent).

REPORTS OF SPECIAL AGENTS ON THE SUGAR INDUSTRY.

INTRODUCTION.

By G. L. SPENCER, *Chief of Sugar Laboratory.*

There is probably not a State, Territory, nor possession of the United States, with the exception of Alaska, in which sirup, or a semisolid product, formed of a mixture of sugar and sirup, is not manufactured. In the Northern sirup industry this product is obtained from sorghum cane and the sap of the maple tree. In the South both sorghum and sugar cane are used in sirup manufacture. An additional source of sirup is maize or indian corn, from which large quantities of glucose are made. This branch of the sirup industry and maple sirup will not be considered in this bulletin.

The extent of the sirup industry is indicated by the following data from Bulletin No. 237, Agriculture, Twelfth Census:

Of the total area devoted to sugar cane, exclusive of Hawaii, the South Atlantic division contained 47,223 acres, or 12.2 per cent, of which 55.2 per cent was in Georgia, and the South Central division 339,713 acres, or 87.8 per cent of the total, of which Louisiana contributed 81.5 per cent. There were 50 acres reported from Arizona in the Western division. The increase in area since 1889 in the South Atlantic division was 43.6 per cent, and in the South Central division 40.3 per cent.

The above figures indicate that comparatively little cane is grown for sirup making except in Georgia, Alabama, Florida, and Mississippi, since the cane in Louisiana and Texas is almost exclusively employed in sugar manufacture.

The increase in the South Atlantic division of 43.6 per cent is largely due to the expansion of the industry in Georgia. The Census report cited gives the total number of gallons of sirup produced as 12,293,032, the greater part of which was consumed as table sirup. A considerable quantity of sirup is produced in Louisiana and sold to the sugar factories. There are no data in the Census report to show whether this sirup is excluded from the returns for table sirup, but in any event these figures indicate the present magnitude of the cane-sirup industry. The Census report gives the following additional data in regard to sorghum sirup:

In 1899, 446,621 farmers produced from 293,152 acres 1,911,046 tons of sorghum cane. Of this they sold 291,703 tons and from the remaining product manufactured 16,972,783 gallons of sirup.

Of the total area devoted to sorghum, the North Atlantic division reported 126 acres and the South Atlantic 54,152 acres, or 18.5 per cent of the whole, of which Georgia and North Carolina together contributed 69.4 per cent.

The North Central division contained 92,166 acres, or 31.4 per cent of the whole, of which Kansas and Missouri together contributed 56.1 per cent. In the South Central division there were 145,812 acres, or 49.7 per cent of the whole, of which Alabama, Arkansas, Kentucky, Mississippi, Tennessee, and Texas together furnished 88.1 per cent. The Western division contained 896 acres, or 0.3 per cent of the whole, of which 371 acres were in Utah. The North Atlantic division contained 0.1 per cent of the total acreage.

There was a decrease in area since 1889 of 29.5 per cent.

From these figures, showing a total production of table sirup amounting to 29,265,815 gallons from cane grown by more than 500,000 farmers, the importance of this industry and its extent are apparent. Louisiana has long been a producer of a favorably-known sirup termed "open-kettle molasses," while Georgia, Florida, and other Gulf States have lands upon which cane can be grown that produces sirup of exceptionally good flavor. The agricultural phase of the industry as it is now being developed in this section of the country is illustrated by the following reports of the special agents who have during the past year investigated the agricultural conditions and methods now existing.

SUGAR-CANE CULTURE AT CAIRO, GA.

By Ralph Hoagland and R. D. Stubbs, *Special Agents.*

Sirup making from sugar cane is the important industry in this section, there being numerous steam factories and a great many horsepower mills using the open-kettle process. During last season, October 1, 1901, to March 1, 1902, 10,777 barrels of sirup were shipped from Cairo (Plant System), while over the whole of that railway system in Georgia only 16,618 barrels were shipped, thus showing Cairo to be the center of the greatest sirup-producing section in the State.

In consultation with Mr. J. B. Wight, president of the Cane Growers' Association of Cairo, the following points were decided upon for study and investigation:

(1) Best fertilizer for tonnage of cane.
(2) Best fertilizer for sucrose content.
(3) Effect of potash in effecting early development of sucrose.
(4) Best method of application of fertilizers.
(5) Amount of fertilizer that can be profitably used per acre.
(6) Difference in sucrose content at time of full development, of cane fertilized with acid phosphate and potash and ammonia in excess, and of cane fertilized with normal fertilizer.
(7) Careful noting of any differences that may appear in any respect in cane raised on velvet-bean land as compared with cane on potato land.
(8) Differences in flavor of sirup made from cane receiving different fertilizers.
(9) Differences in purity coefficients of cane receiving different fertilizers.
(10) Determination, by measurement and weighing, of tonnage per acre in various fields to obtain the average yield per acre. (2) To determine maximum yield.
(11) Average juice extraction at various mills of different types.
(12) Fall planting of cane.
(13) Planting of tops.
(14) Best method of saving stubble.
(15) Variety tests, and breeding of cane to increase sucrose content.
(16) Best and simplest method of clarification for small factories; for steam factories.
(17) Effect of sulphur and lime upon quality of sirup.

The comments on the fertilizer experiments are found in Part I of this bulletin, even one year's work being very instructive as to some points, while in regard to others, such as methods of planting, cultivation, saving seed, etc., several years'

work would be necessary to obtain conclusive results. The following general observations, however, on these points may be of interest:

Nature of the land.—The land is cut-over pine land, of which the surface soil is a sandy loam and the subsoil a red clay. The water supply is quite near the surface and the land rather level, but rolling enough to give good drainage. The natural fertility of the land is low and fertilizers are needed for all crops, even on new land. Fields which have been long in cultivation and have received little or no organic manures do not respond readily to heavy applications of commercial fertilizers, thus showing the need of humus in the soil.

Varieties of cane planted.—The common purple cane is the only variety planted extensively here for commercial purposes. Some green and ribbon cane is grown, but it is not as well liked as the purple. Mr. Wight, of Cairo, in 1902, planted two-thirds of an acre of cane known as No. 74, sent to him by Dr. W. C. Stubbs, of the Louisiana Sugar Experiment Station. This variety has a dark green color, growing very erect, but showing in this experiment no increase in tonnage over purple cane and a decrease in sucrose. The sirup produced from this cane, while clear and light in color, had such a salty flavor that it was not deemed advisable to can it. The cane was planted on high, dry land, but has a taste as though grown around horse lots, which was not the case.

Dr. Stubbs in writing in regard to the experiment with this cane said:

No. 74 is one of our seedling canes, grown very successfully in the State. It is of early maturity, fine tonnage, rich in sucrose, a good soft cane, giving an extraction in our 9-roller mills of 80 per cent. I would not, by any means, take the first determinations you have made to be conclusive in regard to the value of this cane in your section. I believe it will have by the end of the season a much better showing, and on account of its excellent properties, besides its larger sucrose content, it is a cane greatly to be desired.

Experiments with this variety of cane will be continued another year. In comparing the Georgia and Louisiana cane, Dr. Stubbs said further:

Your canes in Georgia are richer than ours here, and while the tonnage is much less, the manufacturer has less difficulty in sugarhouses in evaporating the juice. When sugar returns to its former value of 4 or 5 cents a pound, Georgia will unquestionably figure in manufacturing sugar.

A stalk of ribbon cane 11 feet 10 inches long was brought into Cairo on December 9, 1902, by M. J. Harrison.

Preparation of land, planting, suckering, etc.—The preparation of the land for planting is begun in December, immediately after the harvesting season. Two and three horse plows are generally used for loosening the soil, though sometimes harrows or disk plows are preferred. After the land is thoroughly broken to a depth of about 6 inches it is bedded into rows of good height, 4 or 5 feet apart, thereby securing satisfactory drainage and easy cultivation. The middles are then broken and beds opened deep with a long scooter, when the ground is ready to receive the cane, which is planted about April 1, one running stalk to the row. The cane is not covered deep, only 2 or 3 inches of soil being thrown over it. The row is raked to break the crust, if any be formed, which offers resistance to the young plants. When the cane sprouts a scooter furrow is run over each side, to aid in the development of suckers. No soil is thrown back until there is a sufficient number of suckers to insure a full stand, when it is sided with sweeps. The question of suckering is very important, and presents opportunity for further investigation as to the best time to plant cane in order to get the largest number of suckers, and how to cultivate them that they may be vigorous and develop quickly. The remaining cultivation is effected with a weeding hoe, and about July 1 the cane is laid by with five furrows to the row with a broad sweep.

Fertilization.—Fertilization is necessary to the growth of sugar cane in this section, and it is the most complex and perplexing problem which confronts the planter of

southern Georgia. Various points must be considered in selecting a fertilizer, among them the resulting tonnage, sucrose content, and quality of product, in connection with the cost of the fertilizer. For instance, a fertilizer giving a very large yield might give a small sucrose content, and vice versa. It must also be determined whether the soil most needs phosphoric acid, nitrogen, or potash, what amounts of each will be most profitable, and what is the best time and method for applying the fertilizer. It is well known among fruit growers that potash promotes the early ripening of fruits, and the question arises as to whether the analogy would hold good for sugar cane, causing an early development of sucrose. A number of experiments along these lines, made at Mr. Roddenbery's plantation, are given in detail in Part I of this bulletin. In general, however, far too little attention is paid to the question. The fertilizer commonly used per acre is from 15 to 25 bushels of cotton seed and 800 pounds of guano, having about the following composition: 9 per cent of phosphoric acid, 2 per cent of nitrogen, 3 per cent of potash. Large amounts of cotton seed are used by nearly all the planters, some using as much as 90 bushels to the acre, although 25 bushels is the usual amount. The fertilizer is put on in two applications—one in the furrow with the cane and the other in drills at each side of the row later on in the summer. In using cottonseed and guano the cottonseed and half the guano are applied in the drill with the seed cane, while the remainder of the guano is applied in drills later in the season. Barnyard manure or compost is highly prized as a fertilizer for cane, and gives much larger returns than its mere fertilizing constituents could produce.

It is not only necessary that fertilizers be used during the cultivation of cane, but some form of humus must be added to the soil continually in order to prevent a decrease in the fertility. Two legumes are used for increasing fertility, viz, velvet beans and cow peas. Velvet bean land showed a distinct superiority over rye land with the same amount of fertilizer on both, and when plowed under as a green manure or pastured off by stock the beans undoubtedly have a very beneficial effect upon the land. Besides adding nitrogen to the soil, the beans probably help to make inert plant food available through the addition of humus to the soil, as does barnyard manure. The question arises, however, as to whether cow peas can not be more profitably grown for this purpose, although the velvet beans may add somewhat more fertility to the soil. The beans have a very rank growth, and can be used for feeding purposes only by grazing, causing of course a large waste, whereas if peas are planted together with corn, after they have performed their function of supplying nitrogen to the soil, the farmer gathers enough to plant next year's crop, and probably 15 bushels of corn per acre. Or the peas may be sown broadcast and mowed, making the finest hay obtainable. The question of obtaining food for stock confronts the farmers of this section, as the land naturally furnishes very poor pastures. For this reason velvet beans are used on only a few of the extensive plantations, and corn and peas are generally planted for an "upbuilder."

In regard to the question of cottonseed versus cottonseed meal, which is touched upon under fertilizer experiments, Mr. Wight, of Cairo, thinks that if cottonseed meal is used correctly, in proper proportion and properly applied, better results can be obtained than by using cottonseed. Good results have been obtained, however, by using the seed as a top dressing in middles when cane is laid by, the general opinion among the farmers being that cottonseed makes just as good a manure after sprouting as before. A disadvantage in using a large amount of seed is that the cane is frequently attacked by wood lice. This can be prevented, however, by mixing the seed with guano containing phosphoric acid before applying. The usual amount of cottonseed applied is 15 bushels per acre, while of cottonseed meal 400 bushels per acre is used.

While drainage is not a question with the south Georgia planter, the best cultivation during a drought is a practical issue, and here again fertilization must be con-

sidered, for oftentimes a fertilizer that would make the best cane if there were plenty of rain would ruin the crop if dry weather prevailed.

Harvesting of cane.—Sirup making usually begins during the latter part of October. This year (1902) grinding generally began on October 27, although some small mills started a week or ten days earlier. Cutting begins when the juice tests about 8° Baumé or when most of the leaves of the cane, except the tuft at the top, are dead. The cane is stripped a short time before cutting, topped and cut close to the ground with a broad, heavy hoe. The patent stripper is very satisfactory when the cane is fairly straight. The implement generally used in this section is a cane stripper which has a flattened handle about 3½ feet long, to one end of which a steel spring is attached by means of a slide bolt. The cane is pushed through the opening into the oval portion of the spring and the implement pushed down the stalk, thus removing the leaves.

The top, above the first red joint in the case of the purple cane, is taken off with a corn knife just before the cane is cut. The farmers in this vicinity make no use of the tops, though they have been tried for seed and given good results, the cane from them giving just as large a tonnage and as much sirup as cane from stubble.

The cane is cut only a short time before hauling to the mill, very little being cut ahead. Negroes strip, top, cut, and pile up the cane at convenient distances apart on every third row for from $3.75 to $4.50 per acre. An ordinary wagon is used for hauling, and two large hemp ropes are laid in the wagon and the cane placed straight upon them. The load being procured, the ropes are tied, and thus you have two large bundles of cane on the wagon, which are lifted off by machinery at the mill and placed in position. Mr. T. Wight's two-horse wagons generally haul from 1,200 to 2,000 pounds of cane per load.

Cane that is stripped but not topped and left standing in the field does not increase in sucrose any more rapidly than cane that is not stripped. To try the effects of stripping and topping the cane and of leaving it unstripped and untopped before cutting, samples for analysis were taken under the following conditions:

A. Samples of cane stripped ten days before cutting, and topped when cut.

B. Samples of cane topped and stripped ten days before cutting, from the same plat as sample A.

C. Sample of cane stripped and topped when cut from the same plat as sample A.

B 3. Samples of cane stripped and topped when cut, to replace sample C, which was not a good average sample.

The canes from which the different experiments were made were harvested at Cairo, Ga., on November 11, 1902, and analyzed as soon as they reached Washington, D. C. The analytical data obtained on these samples are as follows:

TABLE XIII.—*Analyses of canes harvested under varying conditions.*

Sample.	Sucrose.	Purity.	Reducing sugar.
	Per cent.		*Per cent.*
A.	11.85	80.6	1.56
B.	11.85	81.7	1.21
C.	13.63	83.1	1.38
B 3.	12.56	79	1.94

From these data it is seen that it is not a good policy to strip or top the cane before cutting. Both samples A and B were inferior to samples C and B 3, and markedly inferior to C. Sample C, however, is not regarded as a typical sample. Samples A and B were superior to B 3 in having a smaller content of reducing sugar and a

higher purity. This superiority, however, is only from a chemical point of view and not from a sirup-making standpoint. In other words, a sirup made from sample B 3 would be less likely to granulate than a sirup from samples A and B. The total quality of sirup-making materials is obtained by adding together the sucrose and the reducing sugar. Judging from these tests, samples C and B 3 are positively superior to A and B

Saving stubble for seed cane.—No cane is planted in the fall in this vicinity, as first-year stubble usually supplies sufficient seed cane. Many planters do nothing to save stubble and hence first-year stubble cane is very uncertain, and at best but a poor crop. Some planters, however, save the seed cane in the following way: The cane is dug up by the roots during the latter part of October, just before the grinding season begins, placed in large windrows 4 to 5 feet wide and 2 to 3 feet deep, the tops of the cane lapping the butts and covered with a few inches of dirt from two or three furrows thrown up on each side of the windrow. Cane so stored in well-drained land keeps very well through the winter. But very little first year planted cane is used for seed. In saving seed cane it is calculated that 1 acre of good cane will plant 6 acres, or if the cane is short, 5 acres.

Data on Mr. Polk's farm.—Mr. Polk has 10 acres of excellent purple cane, about as good a stand as was seen. The rows were 5 feet apart and the cane tall and heavy, but rather green. The land has been in cultivation twenty years, but has been well manured. The fertilizer is put on in two applications, one in the drill at planting and one in June, and has the following composition: Thirty bushels of cotton seed per acre; 400 pounds of guano (1.88 per cent nitrogen, 11 per cent soluble phosphoric acid, 2 per cent insoluble; 1 per cent of potash). This fertilizer costs about $22 per ton retail, or $19 wholesale. In addition 4 loads of stable manure per acre were used. Mr. Polk values manure very highly and probably the fine condition of the cane was largely due to its use. In saving seed cane furrows are plowed from each side over the stubble after a part of the waste has been burnt off, and very good results have been obtained.

Data on the farm of Mr. Vanlandingham.—Three and three-quarters acres of purple cane were planted on March 1, 1902, from which a yield of 69.2 tons was obtained, an average of 18.5 tons per acre.

The fertilizer used per acre was 600 pounds of commercial guano (8 per cent phosphoric acid, 4 per cent potash) and 15 bushels of cotton seed. The land was broken broadcast and bedded into rows 4½ feet wide, in which deep furrows were opened and the cane put down with 400 pounds of the guano mentioned above and 15 bushels of cotton seed. The seed were sprinkled down "green" in the drill when the cane was planted. It is then lightly covered, unless the season is very dry, when it is covered deep. The row is run over with a board, or better with a rake, thus leveling off the uneven spots. The cane is plowed only twice, barred off with a sweep, and no soil is thrown back until a full stand of suckers is obtained. The cane is thinned and laid by when shoulder high to a man of medium height, by plowing five furrows to the row with a large sweep. This is generally done about July 1, and Mr. Vanlandingham thinks that cultivating after this time does more harm than good, as it injures the feed roots.

The crop was sold to Mr. Wight, of Cairo, for $3.75 per ton. Immediately before harvesting cane for planting is dug up with tops and roots and placed in windrows 4 to 5 feet wide with butts 8 inches apart and tops overlapping to keep the dirt from them. The soil is thrown on to a depth not exceeding 2½ inches, as Mr. Vanlandingham thinks more cane is lost in this section from heat than from cold, the cane being covered too deep in the windrows. When the cane is dug up for planting it is stripped, topped, and cut in two pieces, so that if a piece is pulled up in cultivating less is displaced.

The first killing frost occurred on November 29, and as there had not been enough frost previous to that date to stop the growing of the cane, the stubble had sprouted

and was killed, leaving only the eyes underground to provide the stubble cane of the next season.

Data from the farm of Mr. J. B. Wight.—Mr. Wight planted about 33 acres with purple cane between March 15 and April 1. The cultivation was much the same as that already described, the fertilizer used being as follows:

Eight hundred pounds of guano (9 per cent phosphoric acid, 2 per cent of ammonia, and 3 per cent of potash), at $19 per ton; 300 pounds of cotton-seed meal, at $23.40 per ton; 15 bushels of cotton seed, at 25 cents per bushel. Total cost per acre, $14.86.

Four hundred pounds of guano and 15 bushels of cotton seed were put in the drill when the cane was planted; 400 pounds were put in siding furrows, and 300 pounds of meal in the middle when the cane was laid by.

The following estimates as to the profits on raising sugar cane for sirup making in southern Georgia, involving the consideration of the advisability of having one central mill for each community fitted out with the most modern machinery procurable, are taken from an address made by Mr. Wight before the fourth annual convention of the Association of Commissioners of Agriculture of the Cotton Growing States, held at Nashville, Tenn., in August, 1902:

Approximate cost of bringing 1 acre of sugar cane to maturity and manufacturing it into sirup.

Seed cane to plant 1 acre	$10.00
Fertilizer	10.00
Cultivation and rent of land	10.00
Stripping and hauling	10.00
Manufacturing into sirup	20.00
Thirteen empty barrels, at $1.10 each	14.30
Total cost	74.30
Thirteen barrels of sirup (32 gallons per barrel), at 25 cents per gallon	104.00
Profit per acre	$29.70

In case the farmer has no mill and gets a neighbor to make his sirup, the cane grower delivers the cane at the mill, the mill owner bears all the expense of manufacturing, each pays for the barrel to hold his share of the sirup, and the owner receives three-fourths of the product and the manufacturer the remainder. In such a case the account of the grower stands thus:

Cost of growing and delivering cane at mill	40.00
9¾ empty barrels	10.73
Total cost	50.73
9¾ barrels (312 gallons) of sirup, at 25 cents per gallon	78.00
Net profit to grower per acre	27.27

A comparison of these figures with those of other field crops of this section shows sugar cane to have the advantage. It is also to be noted that the figures given represent only an average crop, sometimes as much as 800 gallons of sirup per acre being obtained.

In the States east of Louisiana 99 per cent of cane is manufactured into sirup, which brings up the question of overproduction. But when 90 per cent of the sirup sold in grocery stores is an inferior and adulterated product and the demand for a good quality of sirup is increasing, no fear from this source need be entertained. In regard to the increased demand for good sirup which has been developed at Cairo, Mr. Wight says:

Sixteen years ago it was hard to find a market for the 1,500 barrels of sirup annually shipped from the town, and one crop was frequently not sold before another was produced. Now that a better grade of goods is being made, 12,000 barrels of sirup are easily sold before another crop is produced. This sirup is marketed from Massachusetts to Texas, 3,644 barrels of last year's crop going from Cairo to the latter State alone.

As would be expected from the known effect of the quality and grade of land on the sucrose content of cane, the sirup produced from cane grown on the higher lighter lands of South Carolina, Georgia, Alabama, Mississippi, and Florida is of a better quality than that produced on the low alluvial lands of Louisiana.

In regard to sugar cane versus sugar beets the following data are given:

The cost of growing an acre of sugar beets, exclusive of the rent of the land, averages $30. The average yield is 10 tons per acre, which sell at from $4 to $4.50 per ton. This gives gross returns varying between $40 and $54 and a net profit of from $10 to $24 per acre. These figures give sugar cane an advantage of from $8 to $9 per acre over beets.

The cane in 1902, until about November 20, was not as sweet as usual, because the autumn was late and exceedingly warm and the cane continued to grow and therefore matured very slowly. This was a disadvantage to farmers having a large acreage, as they could not wait until the most suitable time for making sirup because the limited capacity of the mills would in such a case prolong the time of manufacturing too far.

The following table shows the composition of the cane juices as obtained at the factories of J. B. and T. Wight:

TABLE XIV.—*Composition of cane juices sampled at the factories of J. B. and T. Wight, Cairo, Ga.*

Proprietor.	Date of observation.	Composition of juice.			Proprietor.	D te of observation.	Composition of juice.		
		Sucrose.	Reducing sugars.	Purity.			Sucrose.	Reducing sugars.	Purity.
	1902.	*Per ct.*	*Per ct.*			1902.	*Per ct.*	*Per ct.*	
T. Wight	Oct. 28	10.06	2.23	76.82	T. Wight	Nov. 14	12.15	2.02	82.64
J. B. Wight	Oct. 29	8.95	1.93	69.92	Do	Nov. 17	11.83	1.92	75.84
T. Wight	do	10.27	1.55	75.44	Do	Nov. 18	11.28	1.81	75.69
Do	Oct. 30	10.22	2.11	74.14	J. B. Wight	Nov. 19	11.77	1.15	79.52
Do	Oct. 31	10.36	1.99	72.96	Do	do	12.61	1.59	81.88
Do	Nov. 1	10.43	1.90	77.26	T. Wight	do	11.75	1.63	77.31
Do	Nov. 3	10.28	2.25	71.40	Do	Nov. 20	12.19	2.19	75.25
Do	Nov. 5	11.30	1.82	78.47	Do	Nov. 21	12.21	1.69	79.80
Do	Nov. 6	Rejected.			Do	Nov. 24	13.18	1.15	82.38
J. B. Wight	Nov. 7	9.22	1.58	70.38	Do	Nov. 25	13.31	.72	83.71
Do	do	11.55	1.51	77.51	Do	Nov. 26	12.83	1.27	82.77
Do	Nov. 10	11.12	1.81	76.68	Do	Nov. 27	13.15	.92	83.22
T. Wight	Nov. 11	11.88	1.78	79.20	Do	Nov. 28	12.64	1.44	82.62
Do	Nov. 12	10.82	1.82	73.10	Average		11.42	1.68	77.49
Do	Nov. 13	11.06	1.52	76.28					

CANE GROWING IN THE VICINITY OF GUYTON, GA.

By ARTHUR GIVEN, *Special Agent.*

The country about Guyton is very well adapted to cane growing. It is flat, with a slight slope toward the Ogeechee River. The soil is a rich black loam with clay subsoil at a depth of from 8 inches to 2 feet. Some of the land is rather high, with light soil, and does not produce large cane crops. The lower land requires to be drained as in Louisiana. South and east of Guyton is a great extent of swamplands which, if cleared and drained, would make valuable cane land. Every farmer in this part of the State grows from one-quarter to 2 or 3 acres of cane, and some of them as much as from 5 to 20 acres. The largest of the mills in this vicinity is that of Mr. J. T. Wells, where cane juices were sampled for the analyses given in the following table. The cane was from farms near Guyton and from two plantations at Halcyon Dale and Pooler, 10 and 14 miles distant, respectively, from Guyton by rail.

TABLE XV.—*Composition of sugar-cane juices sampled at the factory of J. T. Wells, Guyton, Ga.*

Date of observation.	Composition of juice.			Date of observation.	Composition of juice.		
	Sucrose.	Reducing sugars.	Purity.		Sucrose.	Reducing sugars.	Purity.
1902.	*Per cent.*	*Per cent.*		1902.	*Per cent.*	*Per cent.*	
Nov. 20	11.47	1.97	76.97	Dec. 13	9.43	2.86	64.14
24	9.68	3.12	66.75	15	10.39	2.14	72.16
28	9.99	2.01	68.89	16	9.95	2.37	72.63
29	9.18	2.40	66.52	17	8.99	2,86	62.42
Dec. 1	10.44	1.74	74.05	18	9.50	2.83	62.08
2	11.23	1.40	77.44	19	11.08	2.02	72.42
2	9.68	2.42	71.18	22	10.26	2.56	62.94
2	10.04	2.32	70.70	23	9.82	2.76	62.54
2	9.68	2.42	69.64	27	10.50	3.18	64.03
2	10.39	2.42	69.27	29	9.69	3.23	60.18
3	10.96	1.52	76.64	30	12.00	1.64	74.53
4	11.26	1.32	77.65	31	10.16	2.30	68.18
5	13.07	1.48	81.69	1903.			
8	13.37	1.29	81.52	Jan. 2	9.01	2.83	67.24
9	12.08	1.34	82.58	5–6	9.42	2.78	65.86
10	11.51	1.39	78.29				
11	11.52	2.28	71.56	Average	10.50	2.24	70.69
12	10.18	2.56	69.25				

CANE GROWING FOR SIRUP MAKING AT WAYCROSS, GA.

By HAROLD A. IVES, *Special Agent.*

Sugar cane is the most important crop grown in this vicinity and will be planted next year to a greater extent than ever before. The soil here seems to be perfectly adapted to the successful raising of the several varieties of sugar cane—purple, green, and ribbon—the purple cane, however, being more extensively used than the other two varieties. Cotton seed and cotton-seed meal are the fertilizers most used, although when available cow-pen fertilizer has the preference. The plan followed by most of the farmers is to fertilize before planting and again when the plants stand about 3 feet above the ground.

The sugar cane when planted for seed is frequently injured by a small worm which eats all the way through the stalk, and if the next stalk lies against the first the worm goes on through both. In order to prevent this the cane is cut into short pieces of about six joints and planted so that the end of one piece is not on the same line with that of another.

The cane is planted in rows about 4 feet apart, and it requires about 2,000 average-sized stalks to plant an acre. Before and shortly after the cane makes its appearance the ground is kept plowed in order that the earth may be loose about the young plants. After this all that is necessary is to keep the weeds from crowding out the young cane. The plant will soon protect itself from the weeds and grass, and then no more cultivation is necessary.

Within a radius of 5 miles of Waycross there are about 450 acres of sugar cane available for manufacture. As a rule the farmers use about one-sixth of an acre to plant an acre—that is, 16⅔ per cent of their cane is used for seed. In 1902 the farmers used about 30 per cent of the crop for seed, as the cane was damaged by frost and was therefore small.

The following analyses show the composition of the cane juices from the various plantations about Waycross:

TABLE XVI.—*Composition of cane juices sampled at factories near Waycross, Ga.*

Proprietor.	Date of observation.	Composition of juice.			Proprietor.	Date of observation.	Composition of juice.		
		Sucrose.	Reducing sugars.	Purity.			Sucrose.	Reducing sugars.	Purity.
	1902.	*Per ct.*	*Per ct.*			1902.	*Per ct.*	*Per ct.*	
E. M. Eunice	Nov. 17	16.79	0.30	86.10	L. E. Miller	Dec. 8	16.55	0.43	.....
W. J. Booth	....do	13.66	1.29	80.83	Do	....do	13.64	1.35	81.67
L. Anthony	Nov. 21	10.68	2.09	64.33	W. N. Keton	Dec. 10	14.57	.99	83.25
T. J. Colson	Nov. 25	12.01	1.48	.....	P. L. Hatcher	Dec. 11	10.20	2.55	70.34
Do	....do	8.96	3.81	63.10	Do	Dec. 12	11.32	2.25	70.34
J. L. Stephens	Nov. 26	15.29	1.06	89.95	W. H. Boatwight	Dec. 13	15.57	.50	.....
S. F. Miller	....do	10.49	3.07	73.36					
J. J. Wilkinson	Nov. 28	10.79	2.11	67.02	Average	.....	12.83	1.64	75.82
N. G. Lang	....do	9.60	2.37	67.13					
W. S. Chancey	Dec. 4	15.08	.66	88.18					

CANE GROWING IN THE VICINITY OF QUITMAN, GA.

By J. M. STARR, *Special Agent.*

Around Quitman cane seems to be grown only as an incidental crop. Most farmers who run from 3 to 10 plows plant from 4 to 8 acres of cane. The small farmer with one horse or mule plants from three-fourths acre to 1½ acres. There is a distinct tendency to increase the acreage planted around Quitman, and many farmers have expressed the intention of planting at least 40 per cent more in 1903 if the seed cane comes through the winter well. The farmer who grows cane on the largest scale is Mr. McRae, who lives about 12 miles from the town. It is estimated that the amount of sirup handled at Quitman for jobbing purposes will be approximately 4,500 barrels. The average price which the farmer receives is 25 cents per gallon.

Three kinds of cane are grown in this locality, viz, purple cane (two varieties, big short-joint cane, and small long-joint cane), ribbon cane (two varieties, red striped and green striped), and green cane. The purple cane is most extensively grown for sirup making, and the ribbon cane is the next in importance. The small red cane grows as tall as the ribbon variety, but does not stand so thick and is generally thought to be sweeter. The green cane is not much grown for sirup making. It is very soft and tender, and the seed cane does not keep so well through the winter as the other varieties.

Almost all farmers who plant several acres of cane use cotton seed and commercial fertilizers containing nitrogen. Many of the cane growers use fertilizers that contain too much ammonia, which results in red, strong sirup. In the freshly cleared land, where there is considerable decayed organic matter in the soil, acid phosphate is the principal fertilizer used. The small farmers who plant only about an acre or two of cane use cow-pen manure and cotton-seed meal. About 30 bushels of cotton seed are used per acre and from 400 to 800 pounds of commercial fertilizer. When cotton seed is applied it is used as bedding for cattle before planting time. A deep furrow is plowed, in which the fertilizer is placed. The seed cane is cut into pieces of three joints each and dropped into the row about 3 inches apart and covered with a lister. After the cane comes up some farmers put in an additional amount of fertilizer at the sides of the row, and when the cane is laid by another application is sometimes made in the middle of the row. When the fertilizer is put in the row before planting it is usually mixed with the soil by running a plow through it before the seed

cane is planted. The cultivation is of a simple character, since as soon as the cane gets a start it shades the ground and prevents the growth of weeds and grasses.

The weight of the cane per acre on the farm of Mr. McIntosh, 9 miles north of Quitman, was determined on November 26. The cane from 1 acre weighed 61,215 pounds, equivalent to 30.6 short tons. The number of canes in 1 load were counted in order to determine the average weight of each cane. The load contained 960 canes and weighed 2,112 pounds, which will make the average cane weigh 2.2 pounds. In computing for 1 acre, this gives as the total number of canes 27,825 +. This weight of cane makes from 16 to 20 barrels of sirup, averaging 33 gallons each. It requires a mean of 7½ gallons of juice to make 1 gallon of sirup. The average product per acre in the vicinity of Quitman may be safely placed at 14 barrels of 33 gallons each per acre, which amounts to 462 gallons.

One of the principal items of expense in the sirup industry is the seed cane, since very little dependence can be placed in the stubble crop. One acre of cane will plant from 4 to 10 acres, according to the amount grown, but much depends on how the seed keeps through the winter. Freight rates from Quitman are very high also.

If the grower can find out how to make sirup that will not ferment he can hold his product until there is a good price for it. The dealers will then advertise and handle the goods twelve months in the year instead of three, and there will be a great increase in price and acreage. This would render the adulteration of sirup with glucose unprofitable.

The following analytical data were obtained on the samples collected at Quitman and in the vicinity:

TABLE XVII.—*Composition of cane juices sampled at Quitman, Ga.*

Proprietor.	Date of observation.	Composition of juice.			Proprietor.	Date of observation.	Composition of juice.		
		Sucrose.	Reducing sugars.	Purity.			Sucrose.	Reducing sugars.	Purity.
	1902.	*Per ct.*	*Per ct.*			1902.	*Per ct.*	*Per ct.*	
E. J. Young	Nov. 4	8.85	2.51	65.07	Mabbett Bros	Nov. 20	11.18	1.73	76.57
Avera Bros	...do	10.58	2.32	72.97	Avera Bros	Nov. 21	12.34	1.75	79.10
Do	Nov. 5	11.89	2.02	78.22	Do	Nov. 24	12.94	.80	73.94
Do	Nov. 6	10.24	1.75	76.98	Do	Nov. 25	13.39	1.04	84.74
Do	Nov. 7	11.42	1.89	76.63	Do	Nov. 28	14.33	.66	85.80
Do	Nov. 8	11.87	1.91	77.58	Do	Dec. 1	12.75	1.13	84.44
Do	Nov. 10	10.99	2.07	73.75	Do	Dec. 2	10	2.32	71.43
Do	Nov. 11	10.60	2.47	74.65	W. Renifroe	Dec. 11	12.41	1.35	80.59
Do	Nov. 12	11.33	1.94	77.07	Do	Dec. 12	12.48	.88	86.02
Do	Nov. 13	11.20	1.35	77.24	H. Turner	...do	13.04	1.19	82.01
Do	Nov. 14	11.20	2.05	76.19	Mr. Harrell	Dec. 15	16.71	.54	.....
I. Mabbett	...do	11.41	1.94	77.62	W. Renifroe	Dec. 16	11.50	1.57	79.86
Avera Bros	Nov. 17	11.91	1.89	79.38	H. Turner	Dec. 18	11.83	1.62	76.33
Do	Nov. 18	12.37	1.89	77.80	Mr. Adams	Dec. 19	13.85	.77	81.87
Do	Nov. 19	12.18	1.35	78.58	Do	Dec. 20	12.15	1.24	77.38
E. J. Young	...do	11.74	1.55	79.86	Average	.....	11.95	1.60	77.97
Avera Bros	Nov. 20	11.61	1.71	77.40					

CANE GROWING FOR SIRUP MAKING IN ALABAMA.

By THOMAS BRAGG, *Special Agent.*

The greater part of the observations in Alabama were made at the farm of Mr. George W. Black, near Geneva. The land on which the cane was grown is of the sandy type with a red clay subsoil, and has been in continual cultivation for about

sixty years. The previous crops were principally cotton and corn. Thirty-five acres of the purple variety of cane were planted by Mr. Black, 10 acres being reserved and bedded for seed and no care whatever taken of the stubble.

The cane was planted March 1 and cultivated about the same as corn. It was fertilized with 50 bushels of cotton seed and 600 pounds of guano per acre. The cane was cut about December 1, piled in rows, and left in the field until grinding began, when it was stripped and hauled to the mill.

The yield of cane and sirup per acre could not be obtained, as there were no scales available at the factory. However, 6 acres of the cane land were measured off, and it was found they produced 1,980 gallons of sirup, or an average of 330 gallons per acre. The farmers in this section greatly prefer the sandy lands for cane, as they find that the sirup from the cane grown on sandy lands is lighter in color than that produced on the dark bottom lands, and also that the juice contains a larger per cent of sugar. It is also claimed that it is difficult to obtain a good stand of cane on the bottom lands owing to the cold, damp nature of the soil.

The purple variety of cane is better adapted to the conditions in this section than the other varieties. The farmers think that it is hardier and that while the ribbon and green varieties produce a lighter sirup than the purple cane, the yield of sirup is smaller.

The following table gives the analyses of juices from farms in the vicinity of Geneva:

TABLE XVIII.—*Composition of cane juices sampled in the vicinity of Geneva, Ala.*

Proprietor.	Post-office.	Date of observation.	Composition of juice.		
			Sucrose.	Reducing sugar.	Purity.
		1902.	*Per cent.*	*Per cent.*	
Mr. Tucker	Lafayette	Nov. 10	8.91	3.17	62.30
Do	do	Nov. 11	8.37	3.53	58.54
Selman factory	do	do	8.03	3.87	57.77
Do	do	Nov. 12	7.56	3.93	55.18
Mr. Cooper	Opelika	Nov. 14	11.03	2.38	72.10
Mr. Beasley	Auburn	Nov. 18	10.70	2.76	69.48
Mr. Culver	do	Dec. 1	14.39	1.09	87.20
Mr. Black	Geneva	Dec. 23	14.31	.89	87.25
Do	do	Dec. 30	13.34	.80	82.34
Do	do	Dec. 31	14.44	.87	88.04
		1903.			
Do	do	Jan. 1	13.50	1.10	83.01
Do	do	Jan. 3	13.82	.91	85.84
Do	do	Jan. 6	14.19	.99	88.69
Do	do	Jan. 7	13.58	.99	82.80
Do	do	Jan. 9	15.27	.68	89.30
Do	do	Jan. 10	14 77	.74	89.10
Average			12.26	1.73	77.43

These data show that the greater part of the cane juice sampled in Alabama, especially that from Geneva, is of a fine quality, having a comparatively low percentage of reducing sugar and a high purity. In this connection it must be remembered that the samples of juice were not representative of a single cane, but were taken from a large volume of expressed juice, which represented the regular mill juice. The smallest amount of juice from which a sample was taken was 600 gallons and the largest 1,600 gallons.

GROWING SUGAR CANE FOR SIRUP MAKING IN MISSISSIPPI.

By E. E. Hudson, *Special Agent.*

The making of cane sirup is not carried on extensively in this section of the country because there is no good market for sirup here. There are only two or three mills that make sirup to put on the market, and these are not very large ones, averaging about 800 gallons per day. The majority of the planters have their own mills and make sirup only for private use. The best quality of sirup made this season was from cane grown on sandy bottom land. This depends altogether, however, on the season. If it is a wet season the pine uplands produce the best quality of cane, but when the season is very dry the bottom lands give the best crop.

The varieties of cane planted here are the white and the red or Cuban cane. The white cane, however, is not very hardy and therefore is not planted very extensively. Some of the planters, if the winter is not very severe, allow their stubble to remain in the ground, covering it over with earth to preserve it, but if there is a hard freeze during the winter they plow the stubble up and plant seed cane.

Cotton seed and cotton-seed meal are used altogether for fertilizing the cane. Sometimes stable manure is used, but not often, as it is thought to detract greatly from the sweetness of the cane. The following table shows the quality of the juice sampled at Mississippi factories, together with the character of the land on which the cane was grown:

Table XIX.—*Composition of cane juices sampled in the vicinity of Magnolia, Miss., and character of soil.*

Proprietor.	Post-office.	Date of observation.	Composition of juice.			Character of soil.
			Sucrose.	Reducing sugar.	Purity.	
		1902.	*Per ct.*	*Per ct.*		
Coney Sirup Works	Magnolia	Oct. 29	12.94	1.44	85.14	Upland sandy loam (drought).
E. J. Hurst	do	Oct. 30	12.18	1.27	74.26	Upland.
D. G. Lambert	do	Oct. 31	10.86	1.94	67.04	Black sandy loam; made land.
W. J. Lenore	do	Nov. 4	9.62	3.66	61.27	Upland.
V. F. Coney	do	Nov. 5	9.44	2.23	75.52	Pine upland.
W. Brint	do	Nov. 7	12.77	1.72	80.32	Light sandy loam.
Fernwood Sirup Works	do	Nov. 8	9.87	2	82.25	Pine upland; highly fertilized.
Lampton Sirup Co.	do	Nov. 10	11.69	1.99	75.42	Black sandy soil; stiff red clay subsoil.
J. A. Johnston	do	Nov. 11	12.96	1.62	80	Sandy, bottom land.
N. McGee	do	Nov. 12	15.51	1.19	.....	Sandy, bottom loam.
F. M. Lee	Walkers Bridge	Nov. 13	11.51	2.19	76.23	Do.
C. W. Lang	Magnolia	Nov. 14	11.51	1.60	72.40	Pine upland.
J. A. Cutraer	do	Nov. 15	13.75	1.31	89.29	Bottom river land.
Klondike Farm	do	Nov. 17	8.70	1.64	57.24	Upland, sandy loam.
H. Dunnerway	Fernwood	Nov. 18*	11.83	2.25	75.35	Bottom land, sandy loam.
J. A. Cutraer	Magnolia	Nov. 19	11.84	2	72.65	Pine upland.
Bridges Sirup Works	Bridges	Nov. 21	13.59	1.48	81.86	Bottom land, sandy loam.
A. Fitzgerald	Fernwood	Nov. 24	12.10	1.97	77.56	Pine upland.
J. B. Slade	Magnolia	Nov. 25	15.21	.61	87.91	Very high, sandy, pine upland.

TABLE XIX.—*Composition of cane juices sampled in the vicinity of Magnolia, Miss., and character of soil*—Continued.

Proprietor.	Post-office.	Date of observation.	Composition of juice.			Character of soil
			Sucrose.	Reducing sugar.	Purity.	
		1902.	*Per ct.*	*Per ct.*		
H. Prescott	Magnolia	Nov. 26	11.28	1.29	64.46	Pine upland, clay loam.
R. M. Frith	do	Nov. 29	13.96	.63	85.64	Sandy hill land, clay subsoil.
D. F. Vaughn	do	Dec. 3	11.64	.86	75.82	Bottom land, sandy loam.
E. J. Hurst	do	Dec. 4	11.65	.89	73.74	Do.
Allen Bros	do	Dec. 5	15.39	.84	.....	Do.
H. O. Allen	do	Dec. 8	15.49	.84	.....	Do.
Allen Bros	do	Dec. 9	17.62	.31	.....	Do.
Simmons Bros	do	Dec. 10	17.93	.30	.....	Do.
D. G. Lambert	do	Dec. 11	14.07	.74	86.32	Pine upland.
Average			12.75	1.46	76.41	

GROWING SUGAR CANE FOR SIRUP MAKING IN FLORIDA.

By GEORGE E. WALKER, *Special Agent.*

Much Japanese cane is being planted in the vicinity of Huntington, Fla., and it is highly praised, but none of it has been ground as yet. The interest in cane growing in this locality is increasing, and a much larger acreage would be planted in cane were it not for the difficulty of fencing out the wild hogs.

In consequence of dry weather in the early spring a good stand of cane was not obtained on the high pine land, and this fact, combined with the depredations of hogs running at large, left only enough cane for the seed requirements on our own farm, and consequently we were dependent on the outside supply to meet the demands of the factory. The demand, however, for seed cane (for Georgia principally) was so great that it paid better to sell seed cane than to make it into sirup. For this reason many carloads of cane were shipped from Huntington which it had been expected would go to the local factory, and thus the successful operation of the mill was rendered impossible.

The following table shows the composition of the juice extracted from cane grown at Huntington and at Kissimmee:

TABLE XX.—*Composition of cane juices sampled in Florida.*

Proprietor.	Post-office.	Date of observation.	Composition of juice.		
			Sucrose.	Reducing sugar.	Purity.
		1902.	*Per cent.*	*Per cent.*	
I. Braddock	Huntington	Dec. 30	11.94	1.39	76.05
Do	do	Dec. 31	13.10	1.41	76.17
Average			12.52	1.40	76.11
		1903.			
S. L. Lupfer	Kissimmee	Apr. 4	17.30	.24	88.70
Do	do	do	16.60	.36	89.50
Average			17.00	.30	89.10

SUMMARY.

Collecting the averages of each set of analyses the comparison shown in Table XXI is obtained.

TABLE XXI.—*Summary of analytical data on cane juices.*

Town and State.	Composition of juice.			Number of samples.
	Sucrose.	Reducing sugar.	Purity.	
	Per cent.	*Per cent.*		
Cairo, Ga	11.42	1.68	77.49	27
Guyton, Ga	10.50	2.24	70.69	32
Waycross, Ga	12.83	1.64	75.82	16
Quitman, Ga	11.95	1.60	77.97	32
Geneva, Ala	12.26	1.73	77.43	16
Magnolia, Miss	12.75	1.46	76.41	28
Huntington, Fla	12.52	1.40	76.11	2
Kissimmee, Fla.[a]	17.00	.30	89.10	2
Average	12.03	1.82	75.99	.....

[a] Excluded from average.

From the above averages it is seen that the canes have a fairly constant composition in all of the localities where investigations were made. The canes at Guyton had the lowest content of sucrose, the highest content of reducing sugar, and the lowest purity; all the others run very close together. A comparison of the other analyses with the samples from Kissimmee, Fla., is not permissible. Only two of the samples sent from Florida (Huntington) were mill juices. The average of these two, as will be seen by referring to the table, agrees very closely with that of the samples from the other localities. At the beginning of April, 1903, two samples of canes were sent from Kissimmee, which had been growing all winter untouched by frost. The sucrose in these samples had increased about 4 per cent and the reducing sugars were only about one-fifth as great as in the Huntington samples taken earlier in the season. The purities were 13 points higher than those obtained during the milling season.

The data in general are most instructive in showing the average composition of the canes of the localities inspected. When special canes are selected, as has been the case in previous years, the analyses naturally show very much better results. The real object in view, however, is to obtain as exactly as possible the average composition of the canes as they are delivered to the factories for commercial purposes, and this is what has been accomplished by this investigation.

The data show that the manufacture of sugar on a commercial scale from such canes would probably not prove successful. The content of sucrose is quite as high as that of the canes used for sugar making in Louisiana, but the manufacturing season is shorter. Such canes

worked by the best modern appliances would yield about 180 pounds of merchantable sugar per ton, of which from 140 to 150 pounds would be high grade, first sugars, and the rest low grade, second and third sugars. For sirup making, however, these canes are of excellent quality. The high quantity of reducing sugar, which interferes with sugar manufacture, is no bar to sirup manufacture; on the contrary it is an advantage, as the reducing sugar is quite as sweet and palatable as sucrose and has a much lower coefficient of crystallization. Hence its presence in the product, while impairing neither its appearance nor its taste, improves the selling qualities of the sirup by diminishing the tendency to crystallization.

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