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Work of the Experiment Station and Laboratories.

(Walter Maxwell, Director and Chief Chemist.)

TO THE TRUSTEES AND MEMBERS OF THE HAWAIIAN SUGAR PLANTERS' ASSOCIATION.

GENTLEMEN:—The work set forth in this report is a continuation of the statement of last year. Some results are given from experiments that have reached maturity, and explanations of new work are made.

RESULTS OF THE FIRST CROP.

The first series of experiments, commenced in the experimental field in 1897, have come to maturity, the crop having been taken off in April of this year. These experiments were arranged to bear on the supreme question of fertilization, which question will be considered in detail after presentation of the results now in hand.

The land of the experiment plats, whose chemical nature will be explained later, was thoroughly ploughed, and reploughed four times, during the nine months that it was in course of preparation for planting. The plats were all planted at the same time, and with the same seed, and the conditions of cultivation were strictly identical, this experiment comprising exclusively fertilizer tests. Twenty plats, each identical in size, were used, and the fertilizers applied were as follows:

PLATS 1 AND 2.

100 lbs. nitrogen per acre (as dried blood).
100 " potash per acre (as sulfate of potash).
100 " phosphoric acid (as double superphosphate).

PLATS 3 AND 4.

100 lbs. nitrogen per acre (as sulfate of ammonia).
100 " potash per acre (as sulfate of potash).
100 " phosphoric acid (as double superphosphate).

PLATS 5 AND 6.

100 lbs. nitrogen per acre (as nitrate of soda).
100 " potash per acre (as sulfate of potash).
100 " phosphoric acid (as double superphosphate).

PLATS 7 AND 8.

100 lbs. potash per acre (as sulfate of potash).
100 " phosphoric acid (as double superphosphate).

PLATS 9 AND 10.

100 lbs. nitrogen per acre (1-3 as nitrate, 1-3 as ammonia, 1-3 as blood).
100 lbs. potash per acre (as sulfate of potash).

PLATS 11 AND 12.

100 lbs. nitrogen per acre (1-3 as nitrate, 1-3 as ammonia, 1-3 as dried blood).
100 lbs. phosphoric acid per acre (as double superphosphate).

PLATS 13 AND 14.

100 lbs. potash per acre (as sulfate of potash).

PLATS 15 AND 16.

100 lbs. phosphoric acid per acre (as double superphosphate).

PLATS 17 AND 18.

100 lbs. nitrogen per acre (1-3 as nitrate, 1-3 as ammonia, 1-3 as dried blood).

PLATS 19 AND 20.

No fertilizer.

As seen, each test is in duplicate. The duplicates, however, are made on another variety of cane. The odd numbered plats were planted with Rose Bamboo, while the even numbers represent tests with Lahaina cane. This duplication gives confirmation to the results, and at the same time furnishes data showing the different behaviour of the varieties in identical conditions. The weights of cane of the several plats, and of the two varieties, are given in the table below. These weights, and all calculations, are expressed as "per acre" for uniformity and convenience. The actual size of each plat was one-twentieth acre. Between each plat two rows of cane were grown which did not belong to the tests. These rows acted as *policemen*, their business being to prevent the roots of the cane in the actual tests reaching over to steal the fertilizers on each side of them. In weighing, the cane was cut and weighed immediately. In cutting, care was taken to cut the cane low enough, so that no weight was left which was made up of tops that would be worthless for sugar-making. As an illustration of this case, Mr. Hewitt, of Kau, was at the station when the weighings were being made, and he said, "Why, Doctor, you are going against yourself; the weight should be greater than you make it."

WEIGHT OF CANE PER ACRE.

Plat.	Rose Bamboo.	Plat.	Lahaina.
1....	188,280 lbs.	2....	157,040 lbs.
3....	194,040 "	4....	157,600 "
5....	175,200 "	6....	156,960 "
7....	189,600 "	8....	150,640 "
9....	192,800 "	10....	171,600 "
11....	184,080 "	12 ..	156 000 "
13....	182,400 "	14....	160,160 "
15....	152,800 "	16....	136,160 "
17....	180,080 "	18....	164,000 "
19	148,000 "	20....	133,760 "
Mean.	178,732 lbs.	Mean .	154,392 lbs.

The above table sets forth the great variations in weight of cane produced per acre under the action of the different fertilizing elements. Before examining these results further, data will be given showing the amount of juice, in the cane, the sucrose in the juice, from which can be derived the sugar per acre yielded by each plat.

ANALYSIS OF JUICES.

Rose Bamboo

Plat.	Density by Brix.	Sucrose in Juice.	Glucose in Juice.	Purity of Juice.
1.......	18.64	16.15 Per cent.	0.23 Per cent.	86.64
3.......	19.26	16.70 "	0.24 "	86.70
5.......	18.52	15 90 "	0.31 "	85.85
7.......	18.96	16.55 "	0.28 "	87.28
9......	18.62	16.50 "	0.21 "	88.61
11.......	18.15	15.70 "	0.30 "	86.50
13.......	18.50	16.02 "	0.17 "	86.60
15.......	18.44	16 12 "	0.25 "	87.42
17......	18.34	16.10 "	0.24 "	87.78
19.......	18.85	16.80 "	0.23 "	89.12
Means	18.65	16.25 Per cent.	0.25 Per cent.	87.13

Lahaina.

Plat.	Density by Brix.	Sucrose in Juice.	Glucose in Juice.	Purity of Juice.
2 ...	18.93	16.80 Per cent.	0.33 Per cent.	88.76
4....	19.03	16.80 "	0.41 "	88 28
6....	19.15	17.10 "	0 31 "	89.29
8....	18 37	16.28 "	0 38 "	88.62
10....	18 83	16.68 "	0 37 "	88 58
12....	18.81	16.40 "	0 52 "	87 18
14....	18.98	16 68 "	0 51 "	87.88
16....	19 66	17.65 "	0.33 "	89 77
18....	19 58	17.55 "	0.34 "	91.41
20....	20.09	17.80 "	0.23 "	90.44
Means	19.24	17 07 Per cent.	0.37 Per cent.	88.56

From the data in the tables it is seen that the density, sucrose, and purity of the juice were low for Hawaiian conditions. These circumstances were general in last years' crop in many districts of the islands. The chief cause was that the cane did not reach maturity at the usual season. The experimental plats, instead of flowering (tasseling) in November, kept green and growing right up to March. A few seed-heads came out late in November, on the appearance of which the irrigation was stopped for three weeks; but as only about 0.1% of the cane looked like tasseling (the sticks that tasseled were exclusively the late suckers, or sticks that were only eight months old) the water had to be put on again to save the cane from drying up. The results were that the cane kept on growing; a heavy weight of cane was produced, but of less than the average quality.

SUGAR PER ACRE

ROSE BAMBOO

Plat.	Cane Per Acre.	Sucrose in Cane	Sugar Per Acre.
1	188,280 lbs.	14 54 Per cent.	27,375 lbs.
3	194,080 "	15.04 " "	29,189 "
5	175,200 "	14.32 " "	25,088 "
7	189,600 "	14.91 " "	28,149 "
9	192,800 "	14.87 " "	28,669 "
11	184,080 "	14.15 " "	26,047 "
13	182,400 "	14.43 " "	26,330 "
15	152,800 "	14.52 " "	22,186 "
17	180,080 "	14.53 " "	26,147 "
19	148,005 "	15.14 " "	22,407 "
Means	178,732 lbs.	14.64 Per cent.	26,158 lbs.

LAHAINA

Plat.	Cane per Acre.	Sucrose in Cane.	Sugar per Acre.
2	157,040 lbs.	15.03 Per cent.	23,603 lbs.
4	157,600 "	15.04 "	23,687 "
6	156,960 "	15.40 "	24,014 "
8	150,640 "	14.56 "	21,933 "
10	171,600 "	15.03 "	25,791 "
12	156,000 "	14.67 "	22,885 "
14	160,160 "	15.03 "	24,072 "
16	136,160 "	15.79 "	21,499 "
18	164,000 "	15.71 "	24,780 "
20	133,760 "	15,90 "	21,257 "
Means	154,392 lbs.	15.21 Per cent	23,352 lbs.

Special note is made of plat 5, Rose Bamboo cane: The nitrogen applied to this plat was in the form of nitrate of soda. Twelve hours after the first application of the fertilizer was made, a rainfall of 2.75 inches fell very suddenly, when the nitrate was largely washed out. On plat 6, Lahaina cane, the same fertilizer was applied, but twenty-four hours after the rainfall, and the result is excellent. This is a clear illustration of the liability to waste of nitrate of soda. The same result occurred in a second example.

Note is also made of plat 8, Lahaina cane: Through a large part of the ground where this plat happened to be a large ditch had previously run, so that the soil was found not to compare strictly with that of the bulk of the field which is very exceptionally uniform.

Concerning any exceptional results that can have proceeded from the nature of the seed from which the cane was grown, it is remarked that the Lahaina seed was uniformly good, every plat being from the first a full stand. The Rose Bamboo seed, however, was not so good. The cane, which had been in transport several days between cutting and planting, was fermented; consequently in some of the Rose Bamboo plats replanting had to be done to get a full stand. After these special explanations are made, attention is turned to the very palpable results of the tests as a whole. In the first place, the similar behavior of the several fertilizers upon the duplicate plats, and on the two varieties of cane, is very striking. This duplication is of great value.

In noting the action of the several elements it is observed that in no case does phosphoric acid furnish any actual increase. The increased production from the separate applications of nitrogen and potash is not only large, but from the action of each element it is practically the same, whilst the combined action of nitrogen and potash, both on the Lahaina and Rose Bamboo, is extremely marked. The respective actions of the several elements are seen at a glance in the following table, which gives the average of action upon the two varieties:—

Action of Elements	Sugar per Acre
No Fertilizer	21,832 lbs.
Phosphoric Acid	21,892 "
Potash	25,201 "
Nitrogen	25,463 "
Nitrogen and Potash	27,230 "
Lowest Yield (plat 20)	21,257 "
Highest Yield (plat 31)	29,189 "

It is to be understood that the above figures mean the total sugar that is produced per acre, and not the amount that would be obtained in manufacture: Not more than 86% of this total sugar goes to market, even from our very best mills, and in many cases the loss is enormously more. In further observing upon the yield, it must be again explained that the soil was almost in a virgin state, and had been well cultivated. It is seen that where "no fertilizer" was applied the yield was over ten tons per acre. It is here added, however, and to save error, that the rattoons on the "no fertilizer" plats (19 and 20) are very backward and yellow, whilst the plats (17 and 18) by the side of them are a deep green color, and the cane nearly a foot higher. On the "no fertilizer" plats the yields will soon fall to five or less tons per acre, even with good cultivation and the same allowance of water; and, on the other hand, there are other plats where the joint action of cultivation, irrigation, and fertilizers is going to produce yields probably higher than any that are recorded in the above tables. It now appears possible that the land space of one acre can be made to accommodate sixteen to eighteen tons of cane sugar. Such possible results are essentially bound up with the questions of fertilization, cultivation, rational irrigation, etc. Some of which questions have now to be considered in detail.

FERTILIZATION.

In the previous paragraphs it has been seen that certain fertilizing elements had little or no action on the crop, and that other elements gave a large increase of yield. To get at anything like an understanding of these results it is necessary to look into the composition of the soil, and also ascertain what elements, and in what proportions, the cane crop is taking out of the soil for its support and growth. In the first place then, a statement will be given showing the bodies that make up the absolute composition of the soil, just as it is in the field. A further statement will show the probable amounts of certain elements that are immediately ready for the use of the growing crop, as indicated by a method of analysis specially worked out for use on Hawaiian soils.

EXPERIMENT STATION SOIL.

(Absolute Analysis.)

Soil. Elements.	Formula of Elements.	Per cent. of Elements.	Soil per Acre to the Depth of 15 Inches.
Moisture	H_2O	9.526 Per cent	416,750 lbs.
Combustible Matter	?	9.347 "	413,181 "
Insoluble Silica	SiO_2	15.660 "	685,125 "
Soluble Silica	SiO_2	17.058 "	746,287 "
Titanic Acid	TiO_2	2.460 "	107,625 "
Phosphoric Acid	P_2O_5	1.050 "	45,937 "
Sulphuric Acid	SO_3	0.164 "	7,175 "
Carbonic Acid	CO_2	0.080 "	3,500 "
Chlorine	Cl	Trace	....
Ferric Oxyd	Fe_2O_3	23.630 "	1,033,812 "
Ferrous Oxyd	FeO	5.515 "	241.281 "
Aluminum Oxyd	Al_2O_3	12.540 "	548.625 "
Manganese Oxyd	Mn_3O_4	0.145 "	6,343 "
Lime	CaO	0 861 "	37,669 "
Magnesia	MgO	0 821 "	35,921 "
Soda	Na_2O	0.175 "	7.656 "
Potash	Na_2O	0 581 "	25,419 "
Nitrogen	N	0.149 "	6,519 "
Totals		99 862 Per cent.	4,368,825 lbs.

The weight of "soil per acre" is based upon the determined weight of one cubic foot of soil just as it was found in place in the field.

The "depth of 15 inches" is taken as the basis, as that is the depth to which it is possible to plough the station soil. Beneath that depth a raw subsoil is uniformly found, composed of lava fragments, small boulders, and black sand.

In plant-growth, the elements that are considered of the most vital importance, and which are supplied in fertilizers, are four, and these are found in the station soil, in each acre of soil to the said depth (15 inches), as follows:—

Lime	per acre	37,669 lbs.
Potash	" "	25,419 "
Phosphoric Acid	" "	45,937 "
Nitrogen	" "	6,519 "

These are the total amounts of the said elements contained in one acre of soil, fifteen inches deep. These figures, however, do not tell us what proportions—how many pounds per acre, are at once available for the growing crop. The method of analysis which gave the above results could not answer the latter question, and this made it necessary to work out some more sensitive method which could more nearly tell us just what amounts of these elements are contained in our very various soils ready for the immediate crop. It is not the only question—How much potash is in the soil? But there is the further and more vital question—How much of this can the crop make use of? Such a method has been adopted by the Experiment Station, the nature of which is fully described in a previous publication—"Lavas and Soils of the Hawaiian Islands." According to this new method, the amounts of the elements in the Station Soil, which probably are at once ready for the use of the crop are as follows:

		Per Acre.
Lime	(To depth of 15 inches)	1,788 lbs.
Potash	"	830 "
Phosphoric Acid	"	180 "
Nitrogen	"	245 "

The practical value of any such method can only be known by first ascertaining the amounts of the elements that are taken out of the soil by the crop, and then the weight of the crop produced. Therefore, in the effort to furnish very exact data bearing upon these questions, and upon the supreme question of fertilization in its fundamental principles, detailed data, covering the production of the crop whose results have already been, will now be presented.

WHAT THE CROP REMOVED FROM THE SOIL.

During the course of the growth of the crop, the cane leaves, which were taken off at the several times of trashing, were weighed, the weights being reduced to water-free material. The total cane leaves, with the total cane, give the grand total of the crop produced, and removable from the ground. The roots are excluded as they could not be weighed without destroying the next crop. The weight of the roots, compared with cane and leaves, is very small, being only about 4%. Before coming specially to the mineral matter, a general review of the composition of the cane may be given.

COMPOSITION OF THE FRESH CUT CANE.

Variety	Water	Sugar and Other Organic Matter	Mineral Matter	Fibre	Totals
	per cent	per cent	per cent	per cent	per cent
Rose Bamboo.	73.35	16.13	0 65	9.8	100.00
Lahaina	71.24	17.80	0.48	10.48	100.00

The point to be noted here, after allowing for the small difference in water content, is the higher content of the Rose Bamboo in mineral matter when compared with the Lahaina. These data relate to the cane only, and to the fresh cane just as it was cut. In the following figures the fresh cane is reduced to a water-free basis, thus showing the total solid matter contained in the composition of the cane; and by adding the total solid matter contained in the cane leaves, the solid matter used in the building up of the crop of one acre of cane is ascertained:

SOLID MATTER IN THE CANE AND LEAVES.

DRY MATTER	Rose Bamboo.	Lahaina
	Dry Matter produced per Acre	Dry Matter produced per Acre.
Cane	47,632 lbs.	44,403 lbs.
Leaves	52,800 "	52,620 "
Totals. . . .	100,432 lbs.	97,023 lbs.

Contrary to what it has been common to think, the solid matter of the leaves is very considerably greater than that of the cane.

The chemical examination of the dry, solid matters of the cane and leaves, in the first place, has resolved these into Organic and Mineral parts—

ROSE BAMBOO.

MATTERS.	CANE		LEAVES	
	Per cent	Pounds per Acre.	Per cent	Pounds per Acre.
Organic	97.53	46,455	90.132	46,581
Mineral	2.47	1,177	9.868	6,219

LAHAINA.

MATTERS.	CANE		LEAVES	
	Per cent	Pounds per Acre.	Per cent	Pounds per Acre.
Organic....................	98.32	43,658	90.754	47,142
Mineral........	1.68	745	9.246	5,478

A further brief table will put these data before us more clearly, and in giving the sum total of the dry substance of the crop, will show the relative proportions that came from the soil, and from the air and water respectively—

RELATIVE PROPORTIONS OF THE CROP THAT CAME FROM THE SOIL AND THE AIR.

SOURCES OF THE MATTERS.	Rose Bamboo. Per Acre.	Lahaina. Per Acre.
From the Air	93,036 lbs.	90,800 lbs.
From the Soil	7,396 "	6,223 "
	100,432 lbs.	97,023 lbs.

While the data in the last table are necessary to an understanding of the sources from which the materials forming the crop are drawn, it is the material drawn out of the soil that commands our special attention. It is shown by the analysis that the mineral matter (ash content) in the cane is very much less than that in the leaves, which fact is brought again clearly before us in the following table—

MINERAL MATTER.	Rose Bamboo.		Lahaina.	
	Per cent.	Pounds per Acre.	Per cent.	Pounds per Acre
In the Cane	2 470	1,177	1 680	745
In the Leaves ..	9.868	6,219	9.246	5.478

It is thus seen that the dry matter of the cane is much poorer in mineral matter than that of the leaves, and that the elements taken out of the soil are chiefly present in the "trash." Before speaking of the results that will follow from different ways of disposing of the trash (leaves), it is necessary to look into the composition of the large amounts of mineral matter taken out of the soil by the crop in order to see just what is being removed, and in what proportions?

As there were strong scientific reasons for believing that not only the quantities of mineral matter in the cane, and in the leaves, would be very different, but that the composition of the ash in these two parts of the cane plant would also vary very notably, examinations were made of the ash in the cane, and of the ash in the leaves, which are now given, the analyses being very exhaustive—

COMPOSITION OF MINERAL MATTER IN THE CANE.

ELEMENTS	Rose Bamboo		Lahaina.	
	Per Cent	Removed per Acre	Per cent	Removed per Acre
Silica	40.73	479 lbs	39 35	293 lbs.
Titanic Oxyd ...	1.11	12 "	1.63	12 "
Phosphoric Acid	7.04	83 "	6.81	51 "
Sulfuric Acid ...	4.98	57 "	6 89	52 "
Carbonic Acid ..	1.45	17 "	1.20	9 "
Chlorine ...	2.41	28 "	0.67	5 "
Iron Oxyd	5.21	61 "	7.66	56 "
Alumina	4.01	47 "	6.77	50 "
Manganese Oxyd	0.43	5 "	0.45	3 "
Lime.	6.09	71 "	6.76	50 "
Magnesia...... ..	3.24	38 "	3.28	24 "
Soda	1.66	19 "	2.41	17 "
Potash	22.04	258 "	16.29	121 "
	100.40	1175 lbs.	100.17	743 lbs.

Before making any comments on the data contained in the above table, a further table is given showing the composition of the mineral matter in the leaves. It has been found that the total mineral matter in the leaves varies at the different ages of the cane, and that the composition of the total mineral matter also varies. The following data furnish an average of the composition of the ash at four stages of development of the cane—

COMPOSITION OF MINERAL MATTER IN THE LEAVES.

ELEMENTS	Rose Bamboo.		Lahaina.	
	Per cent.	Removed per Acre.	Per cent.	Removed per Acre.
Silica	58.50	3,632 lbs.	58 44	3,195 lbs.
Titanic oxyd	1.12	69 "	1.38	75 "
Phosphoric acid	1.32	81 "	1.26	69 "
Sulpuric acid	5.85	363 "	5.54	303 "
Carbonic acid	0.10	6 "	0.12	6 "
Chlorine	2.73	169 "	2.64	144 "
Iron oxyd	4.40	273 "	3 58	195 "
Alumina	0.75	46 "	1.84	99 "
Manganese oxyd	1 29	80 "	1.26	68 "
Lime	4.84	301 "	4.79	262 "
Magnesia	3.33	207 "	3.30	180 "
Soda	1.78	110 "	1.33	71 "
Potash	14.19	882 "	14.74	807 "
	100.20	6,219 lbs.	100.22	5,477 lbs.

The last two tables place before us the compositions of the ash of the cane, and of the leaves; and they furnish a complete statement of the proportions of the several elements (excepting the nitrogen) actually removed from the soil by the crop.

The most striking factor, in respect of the amount of the element removed, is the silica: In the cane, 40% of the total ash, or 386 lbs., and in the leaves, 58.5%, or 3,413 lbs., is silica. The amount of soluble silica in the station soil is 17.05%, or no less than 746,287 lbs., per acre to the depth of 15 inches. Therefore, the matter of silica, from the standpoint of soil exhaustion, may be dismissed, merely congratulating ourselves that the amount in the soil is so large, in view of the huge quantities required by the cane. In the soils of America and Europe the amount of soluble silica is only about one-third of that found in Hawaiian soils.

The four elements on which attention has to be concentrated are Lime, Potash, Phosphoric Acid and Nitrogen. The nitrogen is not given in the tables showing the elements in the ash of the cane and leaves. This is due to the circumstance that the nitrogen goes off with the organic matter in burning the cane or leaves to get the ash. We explained in the report last year that "when the trash is burnt in the field all the nitrogen is lost."

NITROGEN REMOVED BY THE CROP.

WATER FREE MATERIALS.	Rose Bamboo.		Lahaina.	
	Nitrogen Per cent.	Nitrogen removed per Acre.	Nitrogen Per cent.	Nitrogen removed per Acre.
In the Cane	0.28	133 lbs.	0.27	119 lbs.
In the Leaves.......	0.53	279 "	0.42	221 "
Totals..........	....	412 lbs.	....	340 lbs.

We will now bring together the proportions of the four vital elements that were actually removed by the crop per acre—

AMOUNTS OF THE VITAL ELEMENTS REMOVED PER ACRE.

ROSE BAMBOO

MATERIALS	Lime	Potash	Phosphoric Acid	Nitrogen
In the Cane	71 lbs	258 lbs	83 lbs	133 lbs
In the Leaves	301 "	882 "	81 "	279 "
Totals..........	372 lbs	1140 lbs	164 lbs	412 lbs

LAHAINA

MATERIALS	Lime	Potash	Phosphoric Acid	Nitrogen
In the Cane	50 lbs	121 lbs	51 lbs	119 lbs
In the Leaves	262 "	807 "	69 "	221 "
Totals..........	312 lbs	928 lbs	120 lbs	340 lbs

The data set forth by the above table tell us exactly the amounts of the four vital elements which the crop at the Experiment Station removed from the soil per acre. In order to grasp the meaning and significance of these data more easily we bring them side-by-side with the total amounts, and the available amounts, of the said elements in the soil. To the amounts of available elements, already given on a previous page, are now added the amounts of the respective elements that were added to the soil in the water used for irrigating. The water applied during the total season of growth was 1,250,055 gallons per acre. This volume of water contained 196 lbs. of lime; 78 lbs. of potash; 9 lbs. of phosphoric acid, and 1½ lbs. of nitrogen.

ELEMENTS.	Total amounts in Soil per Acre	Directly available per acre	Removed per Acre	
			R. Bamboo	Lahaina
Lime	37,669 lbs	1,984 lbs	372 lbs	312 lbs
Potash	25,419 "	908 "	1.140 "	928 "
Phosphoric Acid	45,937 "	189 "	164 "	120 "
Nitrogen	6.519 "	246½ "	412 "	340 "

In the first place, comparing the amounts of the elements "removed by the crop" with the amounts found to be "directly available," attention is at once drawn to the elements Potash and Nitrogen: We see that both the varieties of cane took more nitrogen, and more potash from the soil in building up the crop than our special method of soil analysis had found "directly available." But we have also seen, on a previous page, that nitrogen and potash were the two elements in the fertilizers applied that gave such large results in sugar per acre. Each of these elements, when applied separately, largely increased the yield; and when the two elements were applied together the maximum yield was reached. We bring certain further data together in a brief table—

ELEMENTS.	Directly available in soil per acre	In Fertilizer added per acre	Removed by Crop per Acre	
			Rose Bamboo	Lahaina
Phosporic Acid	189 lbs	100 lbs	164 lbs	120 lbs
Potash	908 "	100 "	1,140 "	928 "
Nitrogen	246½ "	100 "	412 "	340 "

It is seen that the crop taken off took with it not only all the soluble nitrogen (soluble in distilled water) that was found in the soil, but also the 100 lbs. that was added in the fertilizer. And the second crop (rattoons) now growing indicates that this was certainly the case. Of course, some of the insoluble organic nitrogen is slowly becoming soluble, but the plats where no nitrogen has been applied to the rattoons the cane is very yellow and backward; whilst the plats alongside, that have received nitrogen in the fertilizers, the cane is a dark green color, and about one foot taller. It is a clear case of Nitrogen-hunger.

Respecting the apparent agreement between the amounts of the elements said by our new method (aspartic acid method) to be available in the soil, and the actual amounts found by the crop, the data afforded by any one instance are altogether too inadequate to enable us to judge of the value of the method. The indications in this example are satisfactory; but this matter will be discussed more fully under the head of Soils, and with the aid of more abundant data.

If we compare the total amounts of nitrogen and potash in the Station soil with the amounts taken out by the first crop of cane, then certain facts are put before us of a startling nature. There are 6,519 lbs. of nitrogen in the soil of one acre to a depth of 15 inches, which is the full depth of tillable soil, and the first crop took out 366 lbs. (average of the amounts taken by the two varieties of cane). This shows that seventeen crops, of the same size as the first crop, would take out every pound of nitrogen that the soil contains if no nitrogen were applied. And the potash—there are 25,419 lbs. of potash in one acre, as aforesaid. The first crop of cane took out 1,034 lbs.; so that twenty-four crops, of the same size as the one just taken off, would not leave a pound of potash in the ground. Nature, however, does not let successive crops take the elements out of the ground with such ease until every pound is gone. As the more soluble is removed it becomes more difficult for the crops to get at the less soluble, and the crops begin to "fall off." This is already happening in the Experiment Station on the non-fertilized plats.

At the Station, the leaves are all taken from the cane in order to weigh, and to find out the mineral matter in the trash; but the trash is cut up into lengths of three or four inches, partially rotted, and then put back on the land, so that the mineral matter found in the leaves is returned to the soil again. The mineral matter in the cane only gets back in part to the soil, and the loss has to be made good by larger additions of the lost elements in the shape of fertilizers. The non-fertilized plats do not receive any fertilizing element—even the trash is not put back—in order to see the results of such treatment.

What is happening on the Experiment Station is happening, and must continue to happen, on plantations where the same things are being practiced. The analyses show that about four-fifths of the total potash taken out of the soil by the crops is found in the leaves or trash. If then the trash is "burnt off" in a windy district most of the mineral matter can be blown away and lost, as the managers say is the case on the windward side of Hawaii. Two-thirds of the nitrogen taken out of the soil is found in the leaves; and, by "burning off," the whole of it is lost in the air. If the trash should be hauled off the land for fuel, or other uses, why it is not necessary to state further what the result is, and must be, as the plats at the experiment station are showing. On the other hand, if the trash is carefully returned to the soil, then the loss from that source is nothing. Also the one-fifth of the potash, and the one-third of the nitrogen removed from the soil in the cane does not need to be lost. The chief part of these two elements is in the juice, and goes through into the molasses, so that if the mud press-cake and the molasses are returned to the land the loss here is very small. Two years ago, Ewa Plantation Co. sent a sample of molasses to the laboratory. This sample represented 3,816,506 lbs. of molasses, and the nitrogen and potash in them were equal to 85 tons of nitrate of soda, and 133½ tons of sulfate of potash, the whole of which was put back on the land in the irrigating waters. But we see what had been the direct loss if these molasses had gone out into the sea, which is frequently the case.

It has to be clearly understood, however, that if we save, and return to the land, every pound of trash and molasses, etc., which savings are within our control, there is still a great depletion of lime, potash, and nitrogen going on that we cannot prevent. In dry districts this source of loss is small, unless it is caused by excessive irrigation; but in wet districts, and on the thin upland soils of most districts, the loss from leaching is enormous. By an actual comparison of the amounts of lime and potash that had been removed from the soil by a known number of crops, with the amounts of those elements that had been taken out of the soil since the land had been under cropping, comparing this with virgin soil, it was seen that twelve times the amount of lime, and twice the amount of potash, had been lost by leaching, in comparison with the amounts removed by the crops. This is our great trouble, the leaching of the soil by rainfall; and it should act as a warning to irrigating plantations not to do by costly irrigation what the rainfall plantations would give much to prevent.

In closing the chapter on *fertilization*, a further table is given showing the relative amounts of the vital elements that were taken out of the soil of the Experiment Station per ton of sugar grown.

ELEMENTS USED BY THE CANE PER TON OF SUGAR GROWN.

ELEMENTS	ROSE BAMBOO	LAHAINA.
	Amount per Ton of Sugar	Amount per Ton of Sugar
Lime..................	28.61 lbs.	26.72 lbs.
Potash................	87.10 "	79.48 "
Phosphoric............	12.61 "	10.28 "
Nitrogen	31.69 "	29.12 "

Varieties differ in their requirements of the elements. The Rose Bamboo is a voracious feeder. These varieties will be more fully shown by us next year, as we are comparing fifteen varieties in order to note the comparative strain that they put upon the soil per ton of sugar made.

It is remembered also that the above data are from the experiment field: But the same variety of cane takes differing amounts of the elements out of different soils and waters. In our report (1895) we showed that the cane grown near the sea at Niulii contained more salt than the cane one mile from the sea in the same field. In 1896, we found at Mana that cane, which was receiving water containing double the amount of salt contained in other water applied to same kind of cane near by, contained just double the salt found in the cane where the sweet water was applied. Last year we found a sample of molasses containing 7% of salt. But the amounts of salt spoken of were killing or ruining the cane. Where much salt (soda) is found in the cane the potash is likely to be below the normal. Cane grown in other countries, and in other conditions, varies greatly from ours in its composition. We are striving, however, to establish standards for our guidance in conditions here. In conclusion, the experiments and results that have been set forth warn us what the results will be if we neglect to return to the soil what the crops are removing. Also the analyses of the mineral matter taken out of the soil by the crop tell us the relative proportions in which the elements are being required. Taking these data together, and with an ascertained knowledge of the amount of the available elements in our different soils, we are altogether better prepared to make rational advices in fertilization, and to say for each soil what the fertilizer should be.

IRRIGATION.

At the same time that the twenty plats of cane, spoken of in the first part of this report, were being grown with the aid of irrigation, eight more plats of the same varieties of cane were being grown without irrigation, and with rainfall alone. We shall not go into details concerning the non-irrigated, but merely state that they were grown on the land close by, and under all conditions the same as the irrigated plats, excepting the application of water. The object of these *dry* experiments was to try to obtain data bearing on special fertilizers helpful in localities and conditions of drouth. The season was very dry, the rain that fell falling almost wholly during two months of the coolest season. The results in sugar were as follows:

WITH AND WITHOUT IRRIGATION.

Cane	Number of Plats	Sugar per acre
Irrigated................	20	24,755 lbs
Non-irrigated	8	1,600 "
	Difference.	23,155 lbs

This "difference" is enormous! It is evident from the results that cane cannot be grown economically, if at all, in climatic conditions such as those in the location of the Experiment Station without irrigation. The question naturally follows: "How much water was necessary in the irrigation to produce those results? In answer to this it is stated that not only is the rainfall recorded, but that every gallon of water used in irrigation is accurately measured. Without such an exact control of the water it would be impossible to draw any conclusions concerning the action of different fertilizers or other agents. We therefore give a table showing the rainfall during the months that the crop was in growth, and the quantities of water applied by irrigation covering the same period. The quantity of water applied is expressed by inches, the same as in the case of the rainfall. Instead of giving the full data of each application, the applications are given for each month, and the corresponding rainfalls.

WATER USED IN PRODUCTION OF THE CROP.

MONTH	Monthly Rainfall	Water Applied (Rose Bamboo)	Water Applied (Rose Bamboo)
1897—July	0.63 inches	3.0 inches	3.0 inches
August	1.02 "	2.5 "	3.0 "
September	4.12 "	1.0 "	1.5 "
October	2.07 "	3.5 "	3.5 "
November	2.11 "	3.0 "	2.0 "
December	0.88 "	2.5 "	3.5 "
1898—January	6.18 "	....	....
February	8.04 "	....	1.0 "
March	10.39 "	....	....
April	1.21 "	2.0 "	1.0 "
May	0.84 "	4.0 "	4.5 "
June	2.60 "	2.0 "	2.0 "
July	0.94 "	5.5 "	5.0 "
August	1.58 "	5.5 "	5.5 "
September	0.88 "	6.5 "	6.5 "
October	1.75 "	4.5 "	4.5 "
November	1.32 "	1.0 "	1.0 "
	46.56	46.5	48.0

It is merely an incident that the water applied is so near in volume to the rainfall. The rainfall was 46½ inches during the 17 months, or 32½ inches per year, which is about the average yearly rainfall. This rainfall, of course, fell uniformly over the non-irrigated and irrigated plats alike. The sugar produced by aid of this rainfall alone was only 1,600 lbs. per acre. The addition of 47 inches of water by irrigation, the applications being made strictly according to the apparent necessities of the cane, gave the *extra production of 23,155 lbs. of sugar per acre.* The water used to make this extra production of 23,155 lbs. was, in round numbers, one and one-quarter million gallons per acre. From these figures it is seen that to produce— (1) 1 extra ton of sugar, 107,944 gallons of water were used. (2) 1 extra lb. of sugar, 540 lbs. of water were used.

In the work of irrigation upon the plantations the rule adopted, and followed wherever the supply is enough, is *one million gallons per day to irrigate and take care of 100 acres.* This volume amounts to *five million gallons per acre* to produce the crop. In the example of the Experiment Station just given, *one and one-quarter million gallons produced the crop*; which shows that *one million gallons per day took care of 400 acres.*

The great difficulty in irrigation is the distribution. On plantations, the water furrows vary from 30 feet to 45 feet in length. Now, in order to get a part of the water down to the off-end of the furrow a big quantity has to be used. The result is that the end of the furrow next to the feeding ditch gets double the average, whilst the off end receives only about half its due. At the Experiment Station the furrows are in sections, each 10 feet long, and each section receives the same volume of water. This cannot be done to the same extent on plantations; yet some modifications must be made in the plantation practices, or given bad results will follow, some of which are already apparent in certain localities.

SOME RESULTS OF OVER-IRRIGATION.

In the report of last year, page 22, some results were given bearing upon the question as to how much water can be applied without loss by drainage; and showing the great loss of fertilizing elements from the soil where such drainage takes place. The results from those tests, which were made with the lysimeter, were not completely satisfactory, due to the circumstance that the prepared drains did not represent the conditions of the *soil in place*. Certain of the results were very exact and valuable, but not all of them. For that reason another series of *irrigation tests* were begun this year, and are now proceeding. These consist simply of plats, of three rows each, to which different quantaties of water are added weekly. There are observation holes at the end of the rows in order to note whether water is draining away or not. In one series (Div. E) No. 21 plat receives one inch of water per week; No. 23 plat, two inches per week; No. 25 plat, three inches per week. In a series (Div. F) one plat receives one inch of water weekly; a second plat, two inches per fortnight; and a third plat, three inches every three weeks. The purpose of this series of tests is to observe the results from different modes of distributing the water in application.

Certain results on *Div. E* from the different quantities of water applied have already been noted:

(1) The cane seed receiving *one inch* of water per week came up four days ahead of the plat receiving three inches per week.

(2) The young cane receiving three inches per week came up less evenly, looked yellow, which yellow color was very striking after each application of water.

(3) The cane receiving one inch per week commenced suckering five days earlier than the plat receiving three inches.

(4) Today, the cane being 15 weeks old, the plat that has received one inch of water per week has still the lead.

The effect of the different quantities of water on the germination of the seed is further seen by the following data (the seed was plant cane, 11 months old, and perfectly fresh, and every eye sound; and each piece of seed bore three eyes):

WATER APPLIED.	No. of Plat	Pieces of Cane Planted	Pieces of Cane that Grew	Pieces of Cane that did not Grow
One inch per week....	21	802	706	96
Two inches per week..	23	802	698	104
Three inches per week	25	802	628	174

From plat No. 21, no water has drained out. From plat No. 23 a notable quantity of water drained out below the *observation hole*, at a depth of four feet, and sank down into the black ash subsoil. From plat No. 25, fully one-half of the water applied (three inches per week) drained out and was lost.

On October 1, the number of canes in the respective plats were as follows:

Plat	Water Applied	Canes in the Plat
No. 21...............	One inch per week.........	1995
No. 23..............	Two inches per week	1701
No. 25..............	Three inches per week . .	1599

These tests will be continued, but there is nothing more to relate until final results are obtained in the form of the cane and sugar produced.

All observations made, so far, strongly indicate that in irrigation generally upon these islands too much water is being used. Just about four times the volume used at the station on the last crop is being used on plantations where enough water is available. So far, the worst results that follow excessive irrigation are not yet generally visible, although in certain localities the bad results were so apparent that the managers have finally cut down the water to one-half the amount previously used. There is one circumstance that prevents the worst results from over-irrigation being felt at once: It is the fact that irrigation water, in distinction from rain water, contains certain fertilizing elements, and in very considerable amounts. We have already shown that the one and one-quarter million gallons of water used at the Experiment Station, per acre, contained 196 lbs. of lime, 78 lbs. of potash, 9 lbs. of phosphoric acid, and 1½ lbs. of nitrogen: Therefore four (4) times that volume of water applied per acre must carry with it four times the above amounts of the fertilizing elements to the soil. The trouble, however, as our irrigation tests have shown, is that this vast volume of water put on does not stay in the ground, but drains out, carrying the elements with it that itself contains, and leaching out the stored up elements of the soil. Actual analyses of soils show that this is the case. We have before us analyses of soils from plantations that have grown good crops: The second analyses of the same fields indicate that the lime, potash, and nitrogen have fallen off, and some of these soils are now amongst the poorest in "available elements." These plantations have been heavy irrigators, and are still using vast volumes of water. As already said, these large volumes of water are carrying fertilizing elements *out of the soil*, and smaller amounts *into the soil* of certain kinds. The elements most easily washed out of the soil, when it is in a form available for the cane, is nitrogen. The irrigation waters, however, contain no nitrogen, or only 1¼ lbs. per million gallons. This element costs nearly three times as much per pound as any of the other elements.

Without water we cannot do anything in given districts and conditions. The excessive use of water, wherever it has been practiced, has led to results worse than the results of moderate dryness. What the final results to the soil will be in given localities where excess of water is being used cannot be said yet. Irrigation is such a recent thing in most localities on these islands; and only three or four crops have been taken off some lands where heavy irrigation is practiced, and this period is too short for the worst, and the permanently bad results to have become strongly evident.

SEED AND PLANTING.

In last year's report attention was called to results from different distances of planting. The purpose of these tests was to observe whether less seed could be used without detriment to the stand and the crop. The actual results will not be available until the tests are complete, and the crop comes off, which will be in the spring of the coming year. Since the first observations were stated, the cane has been counted twice, so that the number of canes per row at the different dates can now be seen:

Plat No	Cane Variety	Mode of Planting Seed in the Row	Canes per Row of 107 ft. 1898 Oct 1	1899 May 1	1899 Oct 1
1..	Lahaina ..	Two continuous cut canes in row.....	880	260	301
2..	R. Bamboo	" " " " " "	788	410	536
3..	Lahaina ..	One " " " " "	836	260	288
4..	R. Bamboo	" " " " " "	816	379	529
5..	Laheina ..	One eye per six inches...............	894	264	296
6..	R. Bamboo	" " " " "	990	341	483
7..	Lahaina ..	" " " twelve inches...........	765	278	285
8..	R. Bamboo	" " " " "	830	377	490
9..	Lahaina ..	" " " eighteen inches.........	708	275	290
10..	R Bamboo	" " " " "	645	279	329
11..	Lahaina ..	One continuous uncut cane in row....	655	310	311
12..	R. Bamboo	" " " " " "	690	344	326
13..	Lahaina ..	Two continuous uncut canes in row ..	637	272	283
14..	R. Bamboo	" " " " " " ..	590	309	410

Leaving the above series until the final data are available, a further series of seed experiments may be spoken of. In this series, one number of plats were planted with pieces bearing only one eye, whilst a second number of plats was planted with pieces each one bearing three eyes. All this seed was from plant cane, 11 months old, and of the best quality. We give the results of each set of plats, which, so far, are as follows:

RELATIVE NUMBER OF PIECES THAT GRE '.

LENGTH OF THE SEED	Pieces Planted	Pieces that Grew	Pieces that Died
One Eye to the Piece	1968	1901	67
Three Eyes to the Piece....	2411	2036	375

From these figures it is seen that the vitality of the short pieces, bearing only one eye, was greater than that of the long pieces.

RELATIVE NUMBER OF EYES THAT GREW.

LENGTH OF THE SEED.	No. of Eyes Planted	No. of Eyes that Grew	No. of Eyes that Died
One Eye to each Piece.	1968	1901	67
Three Eyes to each Piece..	7233	2536	4697

From these figures it is seen that 1901 pieces of cane, bearing 1901 eyes, produced relatively as many canes as 2411 pieces of cane bearing 7233 eyes. Out of the 7233 eyes, 4697 died. This is the same as can be seen on every plantation. A month ago, when talking this question of seed over with Mr. Lidgate, after saying to him that frequently not more than one eye grew in a piece of cane containing many eyes, we found on examination that the number of eyes to the average piece of cane was seven; and that less than one and one-quarter of the eyes grew. Were each piece of seed cut in to, we will say, only two pieces, then the eyes that would grow would probably be double in number. Think of the mass of useless, rotting cane in the row where 4,697 eyes out of 7,233 died. And most of the seed that does not grow is found to be attacked with butyric fermentation, which sours the soil strongly.

We have advised others not to act upon the indications of the tests at the Experiment Station until final results have been obtained. Some, however, have tried *one eye pieces* in planting. Mr. J. A. Scott, Hilo Sugar Co., planted a few sticks of cane sent to him by the Experiment Station, using *one eye* seed, in this case at our suggestion. The seed was 5 days old when planted. Mr. Scott says "it did not grow." The Laie plantation planted several acres with *one eye* seed, and states "it appears as full a stand as where the old amount of seed was used." Mr. McLennan writes "there are already three shoots up from the seed planted with *one eye*, for each shoot where the seed was pieces with several eyes." He added further: "We have packed less than one-half of the seed this year to our outside fields that we have done before." Still, we urge others to go slowly, and not to change their methods without, in the first place, making tests on a small scale. At the same time, the immense savings in seed, packing, and labor that will be found if the method of planting that we are speaking of can be adopted, justify a very full and fair test. If in some case it is found, as in Mr. Scott's case, that the seed with one eye does not grow; that must not be conclusive: Why, every year re-planting has to be done in soils where the conditions are both wet and dry, because the seed, bearing five to ten eyes, has not grown. The conditions being equal in all other respects, then the indications, so far, are that seed with one eye is more likely to grow than the same seed in longer pieces, bearing several eyes.

VARIETIES.

In the report of last year it is stated that thirteen standard varieties of cane were placed in competition under the same conditions of cultivation, fertilization and irrigation. Other varieties are being brought into the competition, but are not yet advanced enough to comment upon. Concerning the yielding properties of the respective varieties nothing definite can be said until the cane has reached maturity, and the weights and sugar contents have been taken. The canes in the rows have been counted three times, and from the figures we are able to note the great differences between the varieties in respect to their power to sucker and produce canes. The length of the rows is 107½ feet, and the data express the number of canes per row at the different dates:

NUMBER OF CANES PER ROW OF THE VARIETIES.

VARIETIES.	October 1 (1898)	May 1. (1899)	October 1. (1899)
Lahaina	644	267	319
Rose Bamboo	737	248	340
Yellow Caledonia	681	253	254
Yellow Bamboo	501	276	297
Fiji Purple	1052	322	490
Striped Singapore	918	325	353
Big Ribbon	708	379	307
Louisiana Tibboo Mird.	857	328	441
" Striped	853	276	373
" Purple	1077	307	411
Demarara No. 117	748	367	412
" No. 95	950	366	584
" No. 124	498	175	175

Until these tests with varieties are matured, there are no further comments that require to be made.

SOILS.

In last year's report attention was given to the question of soil analysis. It had been found that the common method of analyzing soils, which is in use in all countries, was of very small assistance in guiding us in the matter of fertilization. Soils known to be poor, and bearing poor crops, according to the old method of analysis, were as rich in the elements of plant food as soils distinguished by their fertility and big crops. It was clear, from these circumstances, that there was something wrong, and our persuasion was that the fault laid in the method. The old method consists in using a very strong mineral acid to dissolve the soil constituents. This strong acid dissolves a very large part of the total soil; showing, in a large degree, the general composition of the soil. This is its great defect, that it dissolves too much, while it lacks the definiteness of our *absolute method*, which takes account of the total composition of the soil. The action of the old method, however, is specially great upon Hawaiian soils, on account of their basic nature, as compared with its action on old soils (of America and Europe) because of their highly siliceous nature. Now, for the reason that the old method acts so powerfully on soils, dissolving the greater part of their constituents, it is not a method that can tell us how much there is in a soil, of the several vital elements, that is actually and immediately ready for the use of the cane or other crops. For this reason we set about working out a method that would give us a more approximate knowledge of the state of availability of the vital elements, or, in other words, a means of informing us about how many pounds of lime and potash were present in an acre of land, to the depth that the soil of each particular field or locality can be ploughed, and from which the cane can draw its food. For it is very clear that in order to ascertain how many pounds of any element are available per acre we not only need to know the per cent. amounts of the elements in the soil, but the depth of the actually tillable, and food-yielding soil. This is extremely various: At the Experiment Station it is fifteen inches. On the Ewa plantation the ground is plowed and turned over to a depth of thirty inches. There are other lands where no change can be observed in the nature of the soil down to a depth of three feet. On the other hand, the upland soils of most plantations are relatively very thin. There are districts where the soils are so thin that the ploughing is not deeper than six inches; and where also the yellow, dead subsoil, into which the cane roots will not enter, is struck at even four inches deep. All these factors are considered by our present system of estimating the food elements available in our different soils, by our new method (Aspartic Acid Method) of which we now give some results:

ELEMENTS PER ACRE IN SOILS YIELDING 1 TO 4 TONS SUGAR PER ACRE.				ELEMENTS PER ACRE IN SOILS YIELDING 5 TO 10 TONS SUGAR PER ACRE			
No.	Lime	Potash	Phos. Acid	No.	Lime	Potash	Phos Acid
1	284 lbs	220 lbs	21 lbs	1	698 lbs	700 lbs	36 lbs
2	192 "	208 "	16 "	2	909 "	290 "	86 "
3	105 "	60 "	26 "	3	452 "	976 "	32 "
4	119 "	180 "	28 "	4	825 "	1325 "	20 "
5	404 "	143 "	27 "	5	1064 "	765 "	45 "
6	406 "	150 "	26 "	6	480 "	1112 "	23 "
7	376 "	100 "	22 "	7	1310 "	352 "	58 "
8	212 "	128 "	24 "	8	404 "	262 "	57 "
9	380 "	193 "	25 "	9	1005 "	235 "	29 "
10	311 "	123 "	25 "	10	1068 "	326 "	24 "
11	273 "	106 "	26 "	11	752 "	393 "	28 "
12	313 "	84 "	25 "	12	1253 "	331 "	20 "
13	245 "	67 "	24 "	13	1019 "	425 "	30 "
14	360 "	71 "	50 "	14	691 "	338 "	40 "
15	266 "	64 "	45 "	15	687 "	342 "	38 "
16	210 "	42 "	75 "	16	825 "	337 "	41 "
17	208 "	52 "	20 "	17	556 "	305 "	35 "
18	136 "	40 "	19 "	18	1507 "	817 "	140 "
19	132 "	74 "	21 "	19	1790 "	1175 "	50 "
20	172 "	113 "	27 "	20	1092 "	595 "	45 "
21	236 "	75 "	27 "	21	3474 "	458 "	24 "
22	224 "	110 "	30 "				
23	87 "	90 "	25 "				
24	76 "	69 "	20 "				
25	93 "	48 "	20 "				

The mode of calculation of the "pounds per acre" has been fully described in a previous publication. The analyses given in this table are of soils where the actual yields of sugar per acre are known. We are also familiar with each field from which the samples were taken. In fact, no samples are examined and reported upon unless we know the locality and have examined the *soils in place*. The figures do not need much comment. The method of analysis adopted by us is not perfect, in the sense of explaining or duplicating the actual processes which go on in the soil whereby the soil materials are rendered available in the exact proportions required by crops. It may be that we shall never come exactly to a knowledge of Nature's most secret secrets. The results of the method, however, are in full agreement with the actual results of the field. In every instance where the analyses say that the lime and potash are low, the crop says the same thing. As we have already said, it may be impossible for any man to devise a method that shall be applicable and perfect in every respect; but this method, by reason of its results being in such remarkable agreement with the actual results of the field, is proving to be a guide to us in the matter of fertilization such as we have not previously had. In the columns under the head of soils that have yielded from "1 to 4 tons sugar per acre," the instances where the lime is low, and the potash falls below 100 lbs. to the acre, these, almost without exception, represent lands that have to be laid out for rest, as they "will not pay to crop" in their present state. The analyses state why they have given out; and what elements must be restored to bring them back into use again. We do not comment upon the findings of phosphoric acid for the reason that these are remarkably low in all the soils. This is in keeping with what we have stated from the first—"the phosphoric acid appears to be bound up with the iron and other bodies, so that it is generally unavailable." But the phosphoric acid required by the cane is also very small: To make 10 tons of sugar per acre in the Experiment Station field, only 100 lbs. of phosphoric acid were needed; whilst to make the same amount of sugar, 800 lbs. of potash were taken out of the soil and used. We are only acquiring definite data upon the question of the relative amounts of the elements that the cane takes out of Hawaiian soils; yet before we had our present definite knowledge, the fertilizers we were advising were very different from what had previously been furnished. Five years ago, the fertilizers in most common use contained 15% to 20% phosphoric acid; 3 to 8% potash, and 2 to 3% nitrogen: We have advised, and are still advising 8% phosphoric acid; 6% nitrogen, and from 4% to 12% potash, with liberal applications of coral or burnt lime, the form of the lime being determined by the rainfall, and state of the soil. The question of lime, which extends also to the supply of potash, is of crucial importance; and in certain districts of these islands the further economic cropping of the lands is depending upon just how seriously the question is going to be regarded and dealt with. In 1896 we stated in the report of that year, "the analyses show that in the wet districts, and from the mauka (uplands) lands of most districts, 40% of lime, 16.5% of potash (but only 2% of phosphoric acid) have been removed by cropping, which is shown by comparing the analyses of the cropped lands with those of the virgin soils of the same localities." Only three weeks ago one plantation sent down for examination soils from fields "that were giving out." The manager, at our request, sent samples also from virgin spots in the same fields, the places where the samples were taken having been selected by the manager and the writer one week previously. As a result of the analyses, by our new method, it was shown that the cropped soils contained 40% less available lime, and 36% less available potash than the virgin soils from the same fields. As the manager states. "We know now what must be done." These elements that have been lost to the soil must be restored; or there can only be one end to the matter so far as large areas of land in given districts are concerned.

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PROFESSOR MAERCKER ON THE NEED OF LIME.

(From an Address delivered before the Sugar Beet Growers of the Province of Posen, Germany.)

We make occasion to give some abridged statements of Professor Maercker on the question of lime. Dr. Maercker is the director of an experiment station in Saxony, Germany, and is a special authority upon sugar beet production; as well as being a privy councillor of the German Emperor and Government in matters relating to agriculture. On the question of *lime* Professor Maercker says: "A further and, indeed, the most important condition of all for the successful cultivation of the sugar-beet is the presence of a sufficiency of lime in the soil; without this, the hope of a good and profitable yield of sugar cannot be realized." Again, he says: "I therefore hold the solution of the question, whether your soils are poor or rich in lime to be a most important one." Finally, Professor Maercker says: "I consider, gentlemen, this to be one of the most valuable uses of your newly established chambers of agriculture. The Agricultural Council of the Kingdom of Saxony has caused to be carried out a systematic examination of the lime requirements of all the typical kinds of Saxon soils, so that we may know with accuracy what is the store of lime in any particular field."

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No further explanation is needed for including the statements of Dr. Maercker at this place. He also comments upon the use of other fertilizing agents, and whilst advising its use, guards against the indiscriminate use of nitrate of soda, and its consequent results. We pointed out last year that nitrate of soda can act as a terrible *lime-robber*. In fact, next to the fatal results of wasting, or carrying off the trash, the two most sure causes of soil exhaustion, in their combined action, are the excessive use of nitrates, and excessive irrigation.

LABORATORY WORK.

The analytical work has continued to be done by C. F. Eckart, and by Firman Thompson. Mr. Thompson entered the service of the Experiment Station January 1 of this year. He is a graduate of the University of Michigan, and came here from the experiment station of New York.

The work of the year has comprised the examinations of soils, waters, sugar cane, cane ash, sugars, molasses and fertilizers. The soil work, embracing over 100 analyses, has been chiefly done by the "new method." Several plantations having already determined to begin a systematic control of the state of availability of the soil constituents of their several fields. Several analyses have also been made by the "old method" where data were required in connection with the opening up of new plantations.

FERTILIZERS.

During the year, 159 fertilizers have been received and analysed. It has to be said that the great bulk of the fertilizers sold under guarantie come up to the requirements. There are, however, very marked exceptions, and the number of these exceptions has been more numerous during this year, than occurred in the whole course of the three previous years, In fact the number of cases where the findings of the laboratory have been below the guarantee have been so numerous that the work of the chemists has been increased one-sixth beyond what it should have been; since all samples, concerning which a dispute may occur, are analysed in quardruplicate, and this entails double the labor and chemicals in such cases. The findings of the laboratory not only show the necessity of a vigilant control of fertilizers in the interest of the plantations, it is also due to those manufacturers of fertilizers whose goods are more uniformly in agreement with the guaranties that the relative qualities of the fertilizers upon the market should be known by the purchasers.

In the course of the year several complaints have come to this Bureau from managers of plantations that they have not received any analyses of their fertilizers. We therefore wish to explain that every fertilizer received is analysed, and the results sent to the "sender" of the samples. Most of the samples received come through the respective agents, and the laboratory does not necessarily know who the manufacturer of the fertilizer is, nor to what plantation the goods are going. In fact we have stated that the laboratory would rather not know any of these circumstances. It is enough for our purpose that each sample shall bear a number, and the name of the agent, by which it will be identified here. Managers who may send samples direct to the laboratory, which has been done this year, can state the plantations' name on the sample. Plantations that are importing "straight goods," and mixing themselves, are doubtless aware of the equal necessity of controlling these straight goods. Samples of sulfate of ammonia received from abroad have been found to be 4% off in ammonia, and nitrate of soda containing less than 14% of nitrogen. There can be greater risk in the use of "straight goods" than is even likely to exist in buying mixed fertilizers, sold under guarantie, from well-known manufacturers.

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THE ANNUAL MEETING.

At a recent meeting of the trustees of the Hawaiian Sugar Planters' Association, the date for the annual meeting of the members of the Association was fixed as November 20 and 21, (Monday and Tuesday) to begin at 10 o'clock a. m., each day, at the rooms of the Association on Nuuanu street, Honolulu. It is hoped that every member of the Association and every one interested in cane planting and sugar manufacture will make an effort to be present, and assist as much as possible to increase the usefulness of the Association.

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The present number of this Monthly is largely taken up with the reports of Dr. Maxwell, director of the Experiment Station, giving the results of the year's investigations in various branches of the service. They are issued in advance of the annual meeting in order that planters and others interested may peruse them and be able to discuss the various points to which the Doctor calls attention. In this way his suggestions may be confirmed, or criticized by the experience of those who have had opportunity to work on the same lines of investigation, and are therefore able to speak intelligently. We hope to see a full attendance at the sessions to be held on the 20th and 21st of November.

NOTES ON CURRENT TOPICS.

The German Sugar Manufacturers' Association offers two prizes of 8,000 and 10,000 marks respectively for the construction of successful beet diggers and toppers. Applications should be addressed to the President of the Association, Privy Councillor Koenig, Berlin w. Kleiststrasse 32, on or before August 15th, 1901.

The largest shaft ever made in the world has just been turned out by the Bethlehem Iron Company. It is for the 8,000 horse power steam Corliss engine at the Albany Street Station of the Boston Elevated Railway, in Boston, and weighs 170,000 pounds. The shaft is 27 feet 10 inches long, largest diameter 37 inches, and end diameters 34 inches. Its axial hole is 17½ inches in diameter.

One day recently a ship load of foreign sugar entered the port at New York City. The duty on that one shipload paid in gold was $206,000. It was bought by the American Sugar Refining Co. This is how Uncle Sam gets his money to run the government, and this is how our sugar is protected by increasing the price of sugar in our own market. This is the reason why every voter ought to be a Republican.

The Georgia convict farm worked by old men, cripples, women and young boys, has eight hundred acres planted to cotton; eight hundred to corn; fifty to pinders; four hundred to oats; five to beans; five to onions and beets; five to cantelopes; twenty-five to wheat; twenty-five to sorghum; ten to sweet potatoes; ten to cabbage; ten to watermelons; one thousand to peas; one to rice. The crops of all kinds are said to be unusually good.

An entirely new fruit has come into market, that is, fresh figs from Rhode Island. Their especial novelty consists in the locality from which they come. We have had fresh figs from abroad and from California much earlier in the season, but never before have they come from the Eastern part of our country; and, strange to say, these are by far the best figs we have had. Rugged New England has beaten that wonderful climate and soil of California.

Havana, Sept. 24.—Congressman R. B. Hawley, representing American capitalists, has purchased the Tinguaro sugar estate, one of the largest in Cuba, in the province of Matanzas. The estate includes 20,000 acres, which, with other large properties along the south coast that Mr. Hawley is arranging for, will, it is expected, produce 100,000,000 pounds of sugar. A large part of the land purchased is virgin soil, upon which $1,500,000 will be expended, including the cost of improvements.

The death of the well-known Henri L. Vilmorin of France is reported by recent advices. He and his father became noted by their successful efforts to improve the sugar beet in the selection of the choicest plants as mother beets for producing seeds. In this way, year by year, the richness of the beet has been greatly increased, and Europe has been furnished with a rival that now supplies all Europe with its product. The Vilmorin seeds have long been considered as among the very best, though there are others nearly as good.

The Director of the Experiment Station expects to leave for Queensland on Dec. 6th. Dr. Maxwell goes in response to the Government of Queensland which has asked him to visit the colony to inspect their conditions, and advise the Agricultural Department of the Government in the matter of establishing Experiment Stations and Laboratories. Dr. Maxwell expects to be absent about ten weeks or so.

Florida has enough unoccupied land to produce the entire American supply of sugar; this, without using one acre of her rich drained area, or the Everglade basin, a territory that alone could supply the whole world. Much has been recently said about Cuba, her wonderful climate and rich soil. Much stress has been laid on the fact that cane rattoons for years, etc. Much of this is exaggerated. Seldom do canes grow more than six years profitably in Cuba; while frequently cane rattoons in Florida profitably for four years or more.

A Manila paper states:—"A Chinese, named Yee Ah Hing, said to be a wealthy tea merchant of Formosa, intends to see if tea culture can not be profitably carried on in the Philippines. Conditions for the successful growth of tea plant are said to be fully as favorable here as in Ceylon. It is claimed that Yee Ah Hing is negotiating for a large tract of land on the island of Negros and will go into the business of raising tea there on a big scale." Indian and Ceylon tea seedsmen should be on the alert to turn this new field to account.—Ex.

The increase in the foreign demand for American manufactures is one of the most gratifying of the many favorable conditions which combine to make 1899 a record-breaking year in almost every line of trade and commerce. In August the exports of manufactures were $34,158,777, against $25,806,485 for the same month in 1898. The total for eight months ending August 31, 1898, were $201,446,606, constituting 26.34 per cent. of the total exports of domestic products; while for the same period in 1899 they were $246,228,916, or 31.70 per cent. of the total exports.

Willett & Gray's Statistical says, concerning the world's production of sugar: "It is, of course, too early to form anything like a close estimate of the outturn of the new crops, but, from the latest report at hand, after allowing for increases in the beet crops, based on larger sowings, and improved prospects for some cane crops against decreases in Java, Australia, and Mauritius, the present indications point to a net increase in the world's production of 300,000 to 400,000 tons. A good part of this will be necessary to make up the present shortage in world's stocks and leave but little to supply the normal increase of consumption. We may, therefore, even expect smaller stocks at the end of the next campaign. With such an outlook, prices should continue to rule high next year."

The German, French, and Austrian sugar journals continue to publish a number of articles respecting the new processes of refining, clarification and manufacture, which are so well known under the name of Say-Gramme, Ranson, etc., and more than one method of using the runnings from the centrifugals for re-introduction into the juices before or during evaporation. The utmost that can be said of these up to now is that they are all more or less on their trial, and that essential details are often suspiciously wanting, so that the greatest caution must be exercised in adopting any of them until more definite results are shown. These remarks are not intended to apply to certain American patents such as the Deming and Lillie systems, the reports respecting which are uniformly favorable, still less to that of Grosse, which certainly seems to offer distinct advantages.—Sugar Cane.

THE SUGAR WAR.—"Unless there is an improvement in the sugar market within the next few weeks, it would not be a surprise to hear that all the leading refineries had closed up for the winter. This action, on the part of the refineries, would tend to depress further the raw sugar market and prices on the refined product would go down proportionately. When the American Sugar Refining Company was formed, it was believed that it would be master of the situation always, but the increase of the independent refineries of late years has brought about such a formidable opposition that just now the trust is at its wit's end to know how to handle its opponents. The independents have become too powerful to crush, and thus far have met all the moves of the trust, and in most instances discounted it. The Arbuckles, as leaders of the opposition, are quoting granulated sugar 1-16 per pound lower than the trust's lowest price. Thousands of dollars have been lost by the refineries during the recent cut-rate war on prices, and where the independents lose a dollar the trust is out $15; the losses of the latter by the two last reductions aggregating millions of dollars. All the iron-clad agreements of the trust have been knocked out one after the other, and the grip of the trust upon the wholesale grocers is becoming rapidly a thing of the past. —N. Y. Journal of Com.

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A NEW INVENTION.

We have received a circular from Messrs. Froboese & Phillips calling attention to a device invented and patented by them, which is to serve as an attachment to vacuum pans in sugar boiling houses. The following extract shows its operation:

"With its assistance the sugar boiler is enabled to overcome the almost continually crowded condition in the boiling house during the grinding season; and especially when cane of a low purity is crushed, it will give the sugar boiler a better control over his pan and prevent the forming of new or false grain which is so detrimental to the centrifugaling process. It often happens in the boiling house, and generally too at times, when time is at a premium, that the progress of the vacuum-pan is delayed and it takes from one to two hours longer to finish a strike than it usually does. This is caused by the adhesion of lime and other impurities to coils, and the sugar boiler in a case of this kind is utterly powerless to hasten matters; now by the use of regulator the forming of scales is prevented and the mass of sugar or molasses is kept in increased motion and activity. The regulator is a contrivance to save time, and consequently money, in sugar mills, and will undoubtedly prove a great benefit to the sugar manufacturer; it is easily applied and operated and will not incur any additional running expenses."

If the claims made by the inventors are maintained, without countervailing drawbacks, this regulator certainly should find favor with sugar boilers, for quick work in the boiling house is all-important.

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HAWAII'S NEW PLANTATIONS.—THE KONA SUGAR CO., LIMITED.

Several new sugar estates have been incorporated during the present year—1899—some of them with large capital and embracing sections of land which heretofore have not attracted capitalists, and probably never would have done so, were it not for the annexation of the Islands to the Great Republic. This political change has imparted increased confidence both here and abroad, but more especially in America, from whence most of the capital is derived. As very little is known of these new enterprises, we purpose gathering such facts as are obtainable regarding them, for publication, commencing with the Kona Sugar Co., whose lands are located on the highland back of the village of Kailua, on the island of Hawaii.

Any one who has sailed along the Kona coast, or ridden through the rough *a-a* region that stretches from Mahukona on the north to Kau on the south, would never believe that a sugar plantation could be successfully established anywhere in that mountain region. Some thirty years ago, Judge C. F. Hart, who then resided in Kona, commenced a small sugar plantation near the government road, where, among piles of stone, he had fine patches of cane, fifty acres or more. A small mill of two or three rollers propelled by twelve horses, did its work after a rude fashion. Two or three seasons were sufficient to show that it could not be made a paying business. Later on, others tried the experiment and failed to make it a success.

During the past two or three years, search has been made in the forest above the government road, which has resulted in finding extensive tracts of good land for cane.

When cleared off, this land, which was supposed to be stony, has proved to be a rich, dark loam, comparatively free from stones, and capable of being cultivated for sugar cane. This soil, the deposit of centuries, is comparatively free from stones. When the dense growth of vines, shrubs and trees is cleared off, which is easily done, this rich land is readily worked and makes the finest of cane land, free from grass and noxious weeds, which in other localities require great labor to eradicate. It is in this favored locality that the Kona Sugar Company, which was incorporated in November, 1898, has obtained by purchase and lease several thousand acres of land, which is abundantly supplied with rain, that falls almost daily during the cane growing season from April to November—the season best adapted to its rapid growth, while the four winter months are comparatively dry. Five years have now demonstrated beyond a doubt that cane will grow here and mature in from twelve to fourteen months, without irrigation.

The experimental stage of cane growing in Kona has passed, and the richness of the juice has been tested beyond a doubt. So abundant is the supply of rain water that the reservoir which has been constructed is constantly overflowing, and is able to furnish all the water required for fluming the cane to the mill, a distance of three or four miles. The mill is now being erected on a fine location about a quarter of a mile back of the village of Kailua, and will be connected with the landing by railway. It will thus be seen that there is no carting of cane to the mill, as this is all done by fluming. All the wood required for fuel will be flumed in the same way, while the heavy traffic between the mill and the wharf at Kailua is done on the railway. For economy of labor in transportation, few if any plantations here can surpass this. The harbor of Kailua has been declared by a United States engineer and inspector to be the safest on Hawaii, excepting only Hilo. Any one who has lived on Hawaii, and driven over its stony roads, or landed in the surf at its rough landings, will realize the superior advantages which this new plantation has in these respects.

The mill, which is now being erected, is a five-roller plant, capable of turning out 25 tons of sugar per day. This will be replaced by a larger mill before the end of two years, as a more powerful one will have all it can do by that time. The increased acreage of cane has surpassed all expectations to such an extent as to require an enlargement of the plans first adopted, and for this, additional capital will be required. At present the outlook is very encouraging for large crops, increasing in size year by year, with comparatively small additional cost. The first crop, to come off early next year, will be about 200 acres. The cane is very fine, large and tall. As seen with a glass from the deck of the steamer in passing it is the admiration of everyone. It stands very heavy and looks like a forest of young trees. It is surprising to find such large and handsome cane in Kona, at an elevation of 1,200 to 1,400 feet, where people thought it was too rocky for cane to grow, and where the land was supposed to be fit only for coffee and lantana.

And now a few words about the field work, and the system of co-operation. The Kona Sugar Company employs no cane laborers and has no shipped men in its employ! Contracts are entered into directly with the cultivators, who plow the land, plant and cultivate the cane. Land, seed and tools are furnished to them, and advances made sufficient to enable them to properly carry on the work. The planter gets half the sugar, the company half. Work progresses without regard to hours, and no lunas are often needed, as it is the interest of the planter to get the largest possible yield from his cane field. So far the system has worked well, and to the satisfaction of all interested. This is certainly a new departure, and we trust that the company's expectations will be realized. If there is any district on Hawaii where natural surroundings favor the experiment, that district is Kona. With a large local population, and a class of laborers interested in the success of the plantation, it may prove to be such. Messrs M. W. McChesney, wholesale grocers of this city, are the agents.

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THE GREAT MIDNIGHT FIREWORKS.

We remind our readers that this is the month for the great meteoric display which occurs every thirty-three years or to be more exact thirty-three years and one day. It was our good luck to be among the few in Honolulu who witnessed this grand sight in 1866, from four to five o'clock in the morning. Nothing like it is ever seen on any other occasion. Myriads of meteors or leonids flying in every direction to and from the zenith to the horizon and vice versa. Efforts will be made this year to photograph the display, and probably some good pictures of it will be taken. The books tell us that there is one main collection of these leonids, and while passing through this belt, it is impossible to count them. This was the display we witnessed in 1866. Then there are several smaller collections or belts—not so numerous—the stars in which can be counted. It is impossible to foretell which will be seen here this year. These showers are met one day later in each cycle of 33 years. In 1833, the display took place November 13. In 1866, on November 14, and this year it is set for November 15. An alarm clock, if set for 3 a. m., will be sure to rouse any one who wishes to see the heavenly fireworks, provided the show opens on time.

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THE EWA PLANTATION.

A meeting of the shareholders in the above corporation was held in this city last month to consider what action should be taken to make provision for harvesting the next crop of cane without loss, the present estimate of it being 30,000 tons of sugar. The present nine-roller Cora mill, although it is among the largest, most perfect and powerful in operation in the country, has not been able to handle the last crop, which, had it been ground promptly, would have yielded 24,000 tons of sugar. The loss, from inability to promptly do the increased work demanded of it, has been estimated at over $80,000.

In former days, when planters had crops of three, four or five thousand tons of sugar to make each year, it mattered very little with what speed the mill worked, if it only finished in time to allow the field work to be taken up. But now the mill is by far the more important branch of the service. The mill must do its work promptly and thoroughly, or loss will be the sure result.

Sugar cane tassels here in November or December, and is considered fully ripe then. During the following four or five months, both the cane and its juice generally keep in good condition for the mill work. After that period, the rind of the cane becomes very hard and tough, and the juice rapidly sours. Here is where the loss in late grinding comes in, as the crushing operation requires greatly increased power, while the quantity of juice is less, and the operation of grinding it slow and often vexatious. It will thus be seen that the loss in mill power, as well as in the boiling house, is largely increased by this overlate work, while the amount of sugar obtained is correspondingly decreased. The mill on every plantation here should be able to finish grinding in four or five months from the start.

When the facts were laid before the meeting, the opinion was unanimous that if the plantation was to have large crops, (and they will probably continue to increase), it must be provided with the necessary machinery to take care of them. A full and clear satement of details was presented by the manager, as to what he considered necessary to be done, supported by facts which could not be questioned. After a full discussion, the decision of the shareholders present was unanimous in approval of the proposition presented.

Among these are a new mill, a cane shredder, an enlargement of the mill building, which is to be fireproof, additional pumps, etc. The grinding capacity of the mill will be increased to 160 tons of sugar daily. The present monthly expenses of the plantation are over $70,000, and will probably be increased somewhat when the new machinery is installed. The crops for 1900 and 1901 are expected to be 30,000 for each year, if the cane proves to be equal to that of the past season.

At the meeting referred to, the directors were authorized to issue bonds for $500,000, at six per cent interest, to carry out the improvements required by the increased operations of the plantation.

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EDITOR TOWSE ON HAWAII.

From one of his interesting letters, published in American papers, we extract the following, which will interest readers at home as well as abroad:

Obviously so rich a country as Hawaii is a heavy, almost extravagant consumer. The imports are growing, not only on account of increase in population, but as well by reason of the establishment of new sugar plantations and extension of the old estates. While the common labor for the fields and mills is from China and Japan very largely, the use of American and European goods is well-nigh exclusive. The Japanese are an enterprising, aggressive people at trade, but only to a very limited measure have they succeeded in placing goods in the islands. They have failed signally with beer, coal, ready-made clothing, dried fish, tea and canned vegetables. With silks and china they compete with and defeat the Chinese. For a time a Japanese wine called saki was brought in large consignments, but the local authorities wisely legislated against it in favor of California wines, and the villainous saki has all but disappeared from the list of drinks. It is a rice brew that, when used cold, ferments in the stomach, and produces a stupifying drunk. During its run it played havoc with natives, and soldiers and sailors. The Japanese warm their saki, and appear to get on first rate with it. A rice brandy called samshu is used by the Chinese, and no other race dares to adopt it.

In Honolulu, with its 35,000 people, there are eight saloons. The Government allows no more. Half of these are owned by wholesale houses. While the duty on whiskey is $4.50 a gallon, all the men in liquor business are piling blocks of gold on top of their fortunes. At present not a little saloon stock is brought from Germany, France and England. The duty on cigars is the uniform rate of $10 a thousand, and the American brands are rare. Smoking is cheap. Manila cigars are astonishingly inexpensive, and everyone uses them. Other really cheap things in the islands are clothing, shoes and laundry. All wear tailor-made suits, cut by white men and manufactured by Chinese. The cloth is English. Shoes are cheap for the reason that the mystery of houses in the United States selling to the foreign trade lower than to the home business is observed in Hawaii as in Europe. The imports of drugs from countries other than the United States are large. Enormous quantities of chemicals are used in the two large fertilizing works, and in the great amount of disinfecting done in a place with an inadequate sewerage system.

It is clear, then, that when the American tariff laws are extended to the islands, the exports from the Mainland will jump, beautifully, to the immediate and handsome increase of the general volume of trade of the United States. Several particular lines will be especially benefitted.

There is but a single house in all Hawaii selling a decent grade of ready-made clothing, and this firm has the goods more as a side line than a leader. In the islands are any number of general stores, but nothing like a department house.

The second export of Hawaii is rice. Its cultivation is in the hands of Chinese alone, and they plant, cultivate and harvest the crop just exactly as it has been handled in China 5,000 years or more. In two years three full crops are taken off, and the fourth planting is well under way. Some of the farmers pay as much as $30 a year an acre for rent of rice land. The soil is broken with a harrow, drawn by a water buffalo. The cutting is done with a sickle, and usually the threshing is done by native ponies tramping out the cuttings on a bed of cement. It is a marvel that machinery has not been introduced for the cultivation of rice, but the white men, engrossed with sugar, are content to simply mill and sell the rice for the Chinese after leasing them the land.

American cigars will accompany to the islands American drugs, chemicals and liquors. It is but natural to suppose that in time the molasses, which is now practically refuse from the plantations, will be utilized chemically. A little of it is run back on the fields for fertilizer, but in most cases it makes a stream into the sea. With the installation of American steam plows on one of the new sugar estates is cemented the assurance that all machinery for plantations that is not prepared in Honolulu must come from the United States. Up to this year the steam plows, which cost thousands of dollars a set, have come from England. It is due to the firm of Brewer & Co. and Mr. W. C. Gregg that this change is brought about. It may be that in time machinery can be devised for the cutting of sugar cane. The sticks are now hacked down by hand. Here is an opportunity for the inventor. It was in Hawaii, by the way, that the "centrifugal," which gives the raw sugar its last drying, was hit upon by a genius who still lives, but who, like all of his clan, profited little by his invention. [Mr. D. M. Weston, who invented the centrifugal in Honolulu in 1854, which has revolutionized the production of sugar, died a few years ago in Boston, Mass., where his widow and son are still living, and enjoy the benefit which his invention secured.—Ed. Planters' Monthly.]

The insurance men of the country are many and entirely capable. Cane and sugar at all stages are covered against all dangers.

In Honolulu there are a number of modern retail grocery and family supply houses, but the caterers to a majority of the people are Chinese. They work hard, sell closely, are satisfied with small profits and do well. Their dislodgement will be difficult.

The foreign element of Hawaii is of the sturdiest pioneer class. The colonies have the friendliest relations. On the Fourth of July the Britishers, Germans and Portuguese join the Americans in shouting for Old Glory. On the Queen's birthday the Americans, Germans and Portuguese doff their hats to the Union Jack. On the birthday of the German emperor, or of Bismarck, all other nationalities join the Germans in celebrating. The Hawaiians take part in all festivities. The Portuguese, Chinese and Japanese have several big holidays every year. But the day that brings out everyone is June 11, birth anniversary of Kamehameha I, the Napoleon of the Pacific, the Hawaiian chief, who started from his small district on the island of Hawaii and conquered the whole group and consolidated, all ruling into one government.—Ed Towse, President Hawaiian Commission Greater American Exposition, 1899, in Trade Exhibit.

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THE WEST INDIAN SUGAR QUESTION.

In the London Times recently, appeared an interesting article on this subject, from which we take the following extracts:

So much has been written lately about bounties and countervailing duties on beet sugar and their effects that the real disease which threatens extinction to our West Indian sugar industry is apt to be overlooked. The true cause of the decay of an industry conducted under great natural advantages is to be found in the wasteful antiquated methods of production which are still clung to by our West Indian planters in the face of rivals who have brought highly-cultivated intelligence and the best appliances to bear on the improvement of their processes. A century ago beetroot contained only about 4 or 5 per cent. of saccharine matter, and only about half of this was converted into sugar crystals by the crude methods then in use. The root has been so much improved in Germany by judicious cultivation that it now contains 14 or 15 per cent of saccharose, or about double what it contained only as recently as some 30 years ago; while processes of manufacture have been so developed that a very high proportion of this is converted into crystallized sugar, and German manufacturers have, on an average, required only eight tons of beetroot to make one ton of sugar.

Most of the improvements made in the manufacture of the cane sugar in the last few decades have not been developed from within, but adopted from the beet sugar makers. These factory improvements, however, have been only partially introduced in our West Indies, and even the best appointed establishments there require ten or more tons of cane to make one ton of sugar, while the average in the islands, if we take old and modern factories together, runs to 13 or 14 tons of cane. In fact, many of the mills require nearly or quite 20 tons of cane to make a ton of sugar, and that of inferior quality. In a well-managed, up-to-date factory only about 7½ tons of cane or even less are required per ton sugar of 88 per cent. titre. Both in cost of manufacture and in cost of cultivation our West Indies compare unfavorably with other cane-producing countries. Most of the factories still employ the open pan system, described two centuries ago by the Dominican Pere Labat, under which more than half the sugar contents are lost. In Barbados there is not one triple or multiple effect, not one double or triple crusher, and there are only eight vacuum pans in 441 factories. In Jamaica only two estates have vacuum pans, while there are innumerable small establishments, most of which make a little sugar each, with apparatus that might almost be rivalled by the use of the domestic mangle and frying-pan. In Trinidad and Demerara, no doubt, very great advances have been made in machinery, but, on the other hand, the land is cultivated, mostly, in great plantations, instead of by means of the farming system, which, when properly conducted, all recent experience shows to be the best both in feet and in cane growing countries.

What can be done in the way of economical and profitable production of cane sugar may be shown in Queensland, notwithstanding some serious disadvantages. The principal factors of success in Queensland are the employment of the best machinery and reliance for supply of cane on the farmer, who is displacing the old-fashioned planter by producing cane more cheaply; machinery which extracts, not the 48 to 76 per cent. of the saccharine contents of the cane, as in our West Indies, but 90 per cent. Farmers who obtain and keep their own freehold farms work alongside their sons or a few hired laborers in the fields, and, besides other advantages, thereby avoid the cost of supervision, which on at least one estate in the West Indies has been put at 16s. per ton sugar. The price for cane per ton varies from 7s. 6d. to as high as 14s. 9d. (obtained in circumstances to be described later on), cut and delivered at the mill. The former price may be described as a fair paying return for a farming and laboring class who certainly require and enjoy a very much higher standard of living than the laboring population of the West Indies. The average price is about 10s., varying in many cases on a prearranged sliding scale governed by the market price of sugar.

In this way favorable or adverse market results are shared between the grower and manufacturer.

Men are encouraged by landowners, whether individuals, companies, or the Government, to buy and settle on land with a view to becoming cane farmers. The (Australian) Colonial Sugar Co., for example, have a system under which land is sold to carefully selected working men on terms generally requiring only a nominal cash deposit and further payments deferred over a series of years.

The Queensland Government about ten years ago built two central mills and practically handed them over to the management of the surrounding farmers. These have, in the interval, paid the Government 5 per cent. interest per annum on the money advanced, have repaid more than half of the principal, and have paid themselves highly profitable prices for cane up to 14s. 9¼d. per ton; but they make a ton of sugar out of between seven and eight tons of cane, and they do not bring their cane eight or nine miles to the mill on donkey carts. The success of this experiment induced the Legislature recently to extend it. An Act was passed under which the farmers of district could form a joint stock company, and borrow the whole money (from £30,000 to £60,000) required for erecting a mill on the security of mortgages of their farms to the amount of the advance (the Government also holding the mill as collateral security), and were required to repay the amount in 15 years by annual instalments with interest. Eleven mills have been erected under this Act at a cost of nearly half a million and have been in operation during the last one or two seasons. It is premature to speak as to what the financial results may be, but at least the indirect benefits will be considerable. Official statistics give the sugar production of Queensland for 1897 at 97,910 tons made from 783,000 tons of cane, or almost exactly eight tons cane to one ton sugar. Last season the production increased to 164,000 tons, the increase being spread over company, private, and Government assisted mills.

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QUEENSLAND'S SUGAR INDUSTRY.

The Australian Colonies have recently voted to unite under one confederate government, to be called the Australian Federation. The constitution of this new republic has not yet been adopted, and it may be two or three years before it goes into operation. Whenever it does so, one of its provisions will forbid contract labor in either of the states of the Union. This may at once make illegal the present system of contract labor, which now prevails on the Queensland sugar plantations—the same as on Hawaii. There is consequently some anxiety as to the effect that it will have on the industry there, which is, as yet, hardly on a paying basis, the average yield of sugar per acre having been in 1898 about two imperial tons—4,480 pounds, though the average for eight years has been only 1.64 tons. The Queensland planters will not have the great benefit which planters here have—a sure market, protected by a high tariff, but must compete with Asiatic and beet sugars, unless they can secure from the Australian Congress a protective tariff that will exclude foreign sugars. At present Queensland and New South Wales can manufacture all the sugar required for home colonial consumption in Australia, though some dark sugars are now imported for the refinery.

It may be stated here that although the average yield in Queensland for the past eight years has been about 1.64 tons per acre, yet the last crop (of 1898) averaged two imperial tons per acre, which, although an improvement on previous years, is an unsatisfactory yield compared with that of some other countries.

The last issue of the Queensland Sugar Journal (Sept. 15) has an article devoted to the new conditions which the sugar planters will meet under the confederacy, as regards the labor question. It will be noticed that there is some similarity between the conditions in Queensland and Hawaii. Both will be affected by the change of government, as relates to laborers.

"Queensland has decided to join in the federation of Australian colonies, the agricultural districts along the tropical coast line being principally responsible for the majority secured in favor of the Commonwealth Bill. There will probably be some delay before the necessary formalities are concluded which will actually create the Federal Parliament and the Federal Government, but these will be out of the way during the next twelve months. We have therefore now to put the past behind our backs and face the future. Until the first policy is announced at the opening of the Federal Parliament we cannot yet say how soon we may be called upon to do without colored labor, nor can we tell how soon we may expect the benefits promised under a protective tariff. It may be taken for granted, however, that the benefits cannot be expected for another three years at the soonest, and probably the colored labor question will also stand in abeyance for the same time. Now then is the sugar grower's opportunity and duty to proceed at once to so strengthen his position that he may be enabled to reap the advantages of the tariff, and counteract the disadvantages of the loss of colored labor. The task before him is no easy one, and it is none too soon to at once commence to discuss the best methods to be adopted to secure the safety of our industry. The question of marketing our sugars in such a way that we shall secure the full benefits of the tariff, despite the fact that when the tariff comes into force we shall probably find that we produce considerably more than the Federated colonies consume, may be divided into two sections, the formation of a sugar trust, between present refiners and the few makers of plantation sorts, or the establishment of a co-operative refinery which will include all the Government central mills, and so secure a large quantity of raw material, for which the very highest possible price will be paid to the manufacturers. Sugar manufacturers should hold the key to the position. They cannot fear the competition of Java raws under Federation, and by standing together they should be able to force the refiners to maintain prices of refined under fear of losing a large quantity of raw material and having to face another competitor. Exactly how the Trust should be formed is an open question, but it is assuredly certain that it will have to recognize the paramount claim of the manufacturers and therefore the farmers to the bulk of any increased benefits obtained by the tariff protection.

"The other question which Federation has given rise to, and which also must receive the closest attention from all thoughtful sugar producers, is the best method of strengthening the sugar industry, especially in the tropical portions of Queensland, with a view to enabling it to continue to prosper and progress after colored labor has been withdrawn. We do not for a moment suppose that at the end say of three years or four, there will not be a colored laborer available, but we may take it as certain that the recruiting of islanders from the South Seas will become a dead letter within that time. That another class of colored labor will be permitted is not to be believed for a moment, and sugar growers may as well make up their minds at once to face the future under entirely new conditions. Briefly from Mackay northwards we shall require at least eight to ten thousand European laborers to gradually fill the places of the colored laborers during the next three or four years, unless we can find some means to do without manual labor altogether or largely reduce the quantity required. Practically if we could get over the difficulty of cane cutting the loss of colored labor would not appear to formidable, but this difficulty is by no means an easy one to surmount. Efforts to cut cane by machinery have been made over and over again, and from the day of its inception the Sugar Journal has consistently advocated further attempts in that direction. Large rewards for the invention of a successful cane cutting machine have from time to time been offered in other countries, but so far success has never attended any of the efforts made.

We see no reason why the State or the Federal Government should not offer such a reward in Australia. It would simplify the labor question in a manner few people can conceive. We can plant by machinery already on flat country, and our present methods of cultivation could be simplified still further by suitable implements, which certainly do not appear difficult to obtain. Some of our stoney scrub lands have already been cultivated with stone and stump jumping implements, and these could doubtless be further adapted to all branches of hill work. In such ways the amount of ordinary field labor required would be reduced to a minimum, which perhaps the white labor market could supply. When, however, it comes to harvesting the cane the difficulty really appears at first glance almost insurmountable. In New South Wales cane cutters get from half a crown to three shillings at the outside for cutting and loading cane, while in North Queensland paying at least ninepence a ton more it is found most difficult to get men for the work. In fact genuine efforts have been made to cut the crops with white labor and these, altogether apart from the expense, have so far been unsuccessful. In one year on the Northern rivers the cane cost over five shillings per ton for harvesting, a rate which can only land the most successful cane farmer in debt, and would mean, if of general application, the extinction of the industry. If there is to be an increase in the present average of cost of harvesting cane, it must be accompanied by an improvement in the quality of the cane, thus enabling the mills to pay higher prices for their raw material, and supply the farmer with the wherewithal to pay the higher rates than those now ruling. Machinery, if even to cut and top cane only, would go a long way towards solving the difficulty. If the amount of cane cut and topped in a day by one man and a machine is double or treble that done by one man with a cane knife then higher wages per day could easily be paid, while the farmer would get his work done as cheaply as, if not more so than, at present.

"There are many other points besides those immediately connected with the labor and market questions which, in view of Federal legislation, become more urgently in need of attention than hitherto. We can only briefly touch upon them this month. They include the further centralization of our factories, so as to secure still greater output of sugar under the one roof, the increased improvement in the work of the mills, the better cultivation of the cane, especially with a view to its improved sugar qualities, and the addition of smaller industries so as to secure a more permanent white laboring population in the sugar districts. The lack of rail communication, coupled with the distance of the tropical sugar districts from large centres of population, has much to do with the difficulty of obtaining labor, especially as employment only offers as a rule for about six months in the year. If other industries supplied employment for labor for the first half of the year, then we should be less dependent upon outsiders than at present. The industry will never be safe until each district is almost entirely self-dependent for labor. The few points we have raised we commend to the earnest attention of all interested in the welfare of the sugar industry, and we shall be glad to hear further suggestions as to the wisest course to pursue in the difficult times which are not many years removed from us."