THE

PLANTERS' MONTHLY.

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The price of sugar in New York at latest date Sept. 14, was 6.50 for 96 deg. Cuban basis.

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According to Willett & Hamlen's latest circular of August 29, the total stock of sugar in all the countries, shows a shortage of 250,362 tons, as compared with the same date 1888.

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The new diffusion plant for the Hamakuapoko Mill, manufactured by the Union Iron Works of San Francisco, has been landed at Kahului, and is now in process of erection at Hamakuapoko, to be completed in time to take off the new crop of 1890. This will be the third diffusion mill erected in these islands.

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Three large sugar plantations are soon to be started—one at Makaweli, on Kauai, one at Pearl River on this island and the third at Honolua, Maui. The two former require water to be provided at very heavy cost, that on Maui has abundance of rain and river supply. No better locations can be found on these islands than those named, but the three enterprises will call for an outlay of at least two or three millions of dollars.

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We call the attention of our readers to the *Louisiana Planter and Sugar Manufacturer*, which is unquestionably one of the most valuable periodicals published in the interest of sugar planting. Every number contains articles which we would like to re-publish, but cannot for want of space, but at the same time we wish every planter could peruse them. Cane planting and sugar manufacture demand experience in those who take hold of it, more perhaps than any other business, and this can only be obtained personally after years of labor, or by adopting the experience of others, as given in periodicals devoted to the subject. Hence the value of first-class sugar periodicals—which are worth many times their cost. The *Louisiana Planter* can be procured through the Hawaiian News Agency of this city.

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EXTRAORDINARY DIFFUSION SUCCESS AT KEALIA.

Prior to Col. Spalding's departure to Paris, as one of the Hawaiian Commissioners at the Exposition, we endeavored to obtain from him the statistics relative to his success in taking off this year's crop with diffusion; but found him unable to furnish a full statement in such complete form as he wished it to appear. He however promised that they would be given to the public as soon as possible after the crop was taken off.

In this issue, page 421, we publish a detailed statement of the work of Kealia, by Mr. J. N. S. Williams, who furnished this diffusion plant from Germany, and superintended its erection. The first year's work, in 1888, was not satisfactory on account of several breakages and also from the knives not working satisfactorily. These defects have been remedied, by putting in stronger pieces of machinery, and in providing entirely new knives for cutting the cane, which have worked like a charm, and for which, we understand, a patent has been taken.

On page 424 will be found the result of an interesting experiment, in which two hundred and sixty-two tons of sugar were turned out, which averaged 307 1-5 pounds of sugar to each short ton of cane diffused, a result which will be received with some degree of astonishment by those who have maintained that the merits of diffusion have been over-estimated. And this large yield, it is thought, will be still further increased by better work during the next crop, while the cost will be greatly reduced by the introduction of apparatus which will enable the mill to burn all the bagasse, and probably to rely chiefly on it as fuel, dispensing with coal and wood, at least in part.

Any planter who knows how much sugar his mill now extracts from every 2,000 pounds of cane that he grinds, can easily calculate how much he loses annually on his entire crop with the roller mills. If cane planters hope to compete with beet sugar, they must adopt the most thorough and scientific, as well as less expensive mode of extraction and manufacture practiced by beet sugar factories. As Col. Spalding truly says, "no planter is rich enough to do without diffusion." As a pioneer in diffusion in Hawaii, he is entitled to all the credit which justly belongs to one who has taken all the risk on himself.

ESTIMATED CROP OF BEET ROOT SUGAR

For the present campaign compared with the actual crop of the three previous campaigns. (From Licht's Circular.)

		1888–89	1887–88	1886–87	1885–86
Germany	Tons.	990,000	959,166	1,012,968	838,131
Austria	"	525,000	428,616	523,059	377,032
France	"	470,000	392,824	485,739	298,407
Russia	"	510,000	441,342	487,460	537,820
Belgium	"	140,000	140,742	135,755	93,690
Holland	"	45,309	39,280	36,098	28,818
Other countries	"	55,000	49,980	49,127	46,075
Together	"	2,735,000	2,451,950	2,730,206	2,219,973

ESTIMATE OF PRINCIPAL CANE SUGAR CROPS.

		1888–89	1887–88	1886–87	1885–86
Cuba	Tons.	500,000	610,000	608,900	705,400
Porto Rico	"	65,000	60,000	86,000	64,000
Trinidad	"	55,000	60,000	69,000	49,200
Barbados	"	60,000	60,000	65,000	44,000
Jamaica	"	28,000	30,000	21,000	17,000
Antigua and St. Kitts	"	25,000	26,000	25,000	25,000
Martinique	"	45,000	39,000	41,000	33,000
Guadaloupe	"	55,000	50,000	55,000	37,000
Demerara	"	115,000	110,000	135,000	111,800
Reunion	"	25,000	32,000	32,000	35,000
Mauritius	"	125,000	120,000	101,800	114,200
Java	"	340,000	396,000	363,950	365,950
British India	"	60,000	55,000	50,000	50,000
Brazils	"	220,000	320,000	260,000	186,000
Manila, Cebu & Iloilo.	"	200,000	174,000	180,000	186,000
Louisiana	"	140,000	158,000	80,900	127,900
Peru	"	30,000	30,000	26,000	27,000
Egypt	"	35,000	35,000	50,000	65,000
Hawaiian Islands	"	125,000	100,000	95,000	96,500
Total of cane	"	2,248,000	2,465,000	2,345,550	2,339,950
Total of beet	"	2,735,000	2,451,900	2,733,900	2,223,600
Cane and beet	"	4,983,000	4,916,900	5,079,450	4,563,550

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The rapid progress which is being made on the Oahu Railway gives promise that it will be opened to Ewa by the close of this year. The rails have been received and the freight cars and engine. Four passenger cars from Oakland and two new locomotives from the Baldwin factory at Philadelphia will be landed here during the current month. Altogether it looks like business, and there can be no doubt the road will make business for itself and for the city and for all who are located along its route.

THE ANNUAL MEETING.

Planters and all members of the Planters' Society will bear in mind that the annual meeting will take place on Monday, October 28. It is hoped that there will be a full attendance of every one interested directly or indirectly in cane or other agricultural pursuits, as also in live stock, and that all such will strain a point to be present, even though it may interfere with their comfort or business plans. The meeting will doubtless possess more than usual interest, and the discussion of diffusion, labor, irrigation or water supply, as well as other questions, will open a wide field for the presentation of facts and theories, supported more or less by the experience and tests already obtained in this and other countries. The list of Committees will be found below, and if their reports are well prepared and calculated to throw light and experience on each subject presented, they cannot fail to be of value to all connected with our various institutions.

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TO PLANTERS.

The Secretary of the Planters' Labor and Supply Company has issued the following circular:

Office Planters' Labor and Supply Co.
Honolulu, September 7, 1889.

Dear Sir:—The following is a list of the Committees from whom Reports will be expected at the annual meeting to be held in Honolulu, on Monday, October 28, 1889.:

Labor—R. A. Macfie, R. D Walbridge, W. H. Rickard.
Cultivation—J. N. Wright, Chas. Koelling, O. Unna.
Machinery—G. C. Williams, R. Halstead, R. R. Hind.
Legislation—A. S. Hartwell, S. N. Castle, C. R. Bishop.
Reciprocity—H. M. Whitney, P. C. Jones, C. M. Cooke.
Transportation—W. Y. Horner, W. E. Rowell, A. Cropp.
Manufacture—Z. S. Spalding, H. P. Baldwin, O. Isenberg.
Live Stock—E. H. Bailey, J. H. Paty, A. S. Wilcox.
Forestry—E. C. Bond, G. N. Wilcox, H. M. Whitney.
Fertilizers—T. R. Walker, H. F. Glade, J. B. Atherton.
Varieties of Cane—W. H. Rickard, Chas. Notley, C. Koelling.
Fruit Culture—W. W. Hall, J. K. Smith, Warren Goodale.
Coffee and Tea—W. H. Purvis, L. A. Thurston, W. H. Rickard.
Tobacco—F. A. Schaefer, V. Knudsen, W. O. Smith,.
Ramie—Wm. W. Goodale, B. F. Dillingham, W. R. Castle.

Respectfully yours.
William O. Smith, Secretary.

In the *Sugar Cane* for July, 1889, we find the following letter from Colonel Spalding, relative to his diffusion plant at Kealia:

NEW YORK, May 3d, 1889.

MR. ERNST SCHULZE, *Agent Actien Maschinenfabrik of Sangerhausen, Germany.*

DEAR SIR:—I am sorry that limited time prevents my expressing upon paper the satisfactory results I have this season from the diffusion battery furnished by your company.

As soon as the season is completed I will have figures, showing results, sent to you; at present I will confine myself to simply saying that:

1st. We are working up an average of 300 tons of cane per day, making an average of forty-two to forty-five tons of dry sugar, of quality fully equal to any made by mill process.

2d. We do all liming in the battery, and do not use clarifiers or cleaning pans.

3d. Without changing our furnaces, and with more exhaust steam than we can use, we find one-sixth of a ton of coal to each ton of dry sugar sufficient extra fuel beyond the cane chips. These chips are dried by passing through the old cane mill and air dryer.

4th. By the use of molasses in the cells we are enabled to take off the juice from the battery at higher density than the normal condition of the juice in the cane. This has not been carried to perfection as yet, but promises to be a great feature in diffusion. When our experiments (as regards using molasses in the diffusion cells) are complete, I will give the results to the world.

In a word, no planter is rich enough to do without diffusion!

I am, yours truly,
(Signed) Z. S. SPALDING,
Pres. Makee Sugar Co., Kealia, Hawaiian Islands.

(At Kealia the cane juice averaged during the last season 11.5° Beaume.)

THE NEW DIFFUSION PLANT AT HANALEI.

Twenty-six years ago Mirrlees, Tait & Gleason supplied to the Princeville Mill, then owned by Hon. R. C. Wyllie, at that time Minister of Foreign Affairs, what was considered to be the finest sugar plant in the Hawaiian Islands, consisting of a three-roller mill, gearing and engine, and the open evaporating apparatus at that time in use.

Everyone spoke of the splendid works at Princeville and numbers visited the place to see for themselves what engineering could do to improve a property. Strange to say, very few improvements had, up to a few months ago, been made, and these consisted in placing a vacuum pan and centrifugal machines. The mill site is a favorable one, being on the banks of a river which offers cheap and convenient transportation for sugar and supplies, the cane fields being mainly on the upper lands, nearly the whole of the cane is flumed to the mill a short length of tram road bringing in the cane from the only field on the river bank ; water is plentiful and it is available at the mill-house under a head of 250 feet.

The diffusion experiments at Kealia, carried on by Col. Z. S. Spalding, proving eminently successful, both mechanicaly and financially, Mr. Chas. Koelling, the able and energetic manager of Princeville, about to make some changes in his machinery, decided to take the best that offered, and contracted with Mr. J. N. S. Williams, who is well known in connection with the experiments at Kealia, for the construction of a complete diffusion plant capable of turning out about twenty tons of sugar per twenty-fours, to be complete in every detail and to embody all the improvements in construction and manipulation indicated by the Kealia experience.

The machinery was built by the Union Iron Works of San Francisco, one of the best known firms of engineers in the United States, under the immediate superintendence of the contractor, Mr. Williams, who supplied all the drawings and specifications, and it consists of a battery of fourteen cells arranged in two lines, two slicing machines of a new design, cane elevators and carriers; a triple effect of the most modern construction, a four-roller mill with steel shafts and pinions, a mixer to hold twelve tons of masse cuite, centrifugals, shafting, etc., etc., and a small water-wheel for running the centrifugals when boilers are not in use.

The battery will be worked under a few inches of vacuum, and all the clarification and filtration will be done in the cells, thus *doing away with clarifiers, subsiders, cleaning-pans and filter-presses.* A juice is obtained by this system of working that is purer and more easily boiled than any that results from any system of crushing, when combined with the multifarious processes thus done away with.

The exhausted cane chips are passed through the four-roller mill and conveyed directly to the boilers for fuel. Economy in the use of direct steam has been one of the main points in the design of this plant ; the power required for vacuum pumps, slicing machines, centrifugals, elevators, etc., being taken from a high speed, automatic governing engine, which uses the steam in accordance with the work to be done, and reduces the losses by radiation and internal condensation in the engine cylinders to a minimum ; the vacuum pumps were built to order by the Blake Manufacturing Co. and are very fine, this firm also constructed the air compressor and duplex feed-pump.

Taken as a whole this plant, although a small one, is as complete of its kind as any that are likely to be erected, and the results from its working will be looked for with great interest and we wish Mr. Koelling all success in his undertaking.

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DOUBLE CRUSHING VERSUS DIFFUSION.

EDITOR PLANTERS' MONTHLY:

Dear Sir:—The coming season will see three diffusion plants in operation on our plantations, and the results of next season's experiments will, no doubt, demonstrate to mill and plantation owners the financial success or otherwise of diffusion in the Hawaiian Islands.

While this process has proved itself the only rational way of extracting the sucrose from the beet, as well as from sugarcane, still there are several points which require deliberate consideration. Manufacturers of diffusion machinery will guarantee us anywhere from ten to forty-five per cent more sugar with diffusion than with the present roller system. In proof of this they point to the fact that the exhausted cane slices from the cells contain only from .3 to .5 of one per cent of sugar, even a paltry one per cent of sucrose in the chips is apparently a small item ; still this same paltry one per cent means, perhaps, more sugar running off in the waste water, than is at present lost in the ordinary roller crushing, from the fact that the bulk of the cane chips discharged from the cells is double their original weight.

The question often confronts us, what is the real amount of sugar lost in the bagasse with our present apparatus? It is not an uncommon thing for mill-men to claim a higher percentage of sucrose in the juice from the second crushing than from the first, and a still higher percentage in the juice remaining in the bagasse, while in fact the results are exactly the contrary, as has been proven by Prof. Alexander, of Demerara, who has given this matter a great deal of attention with the following results:

1st. An extraction of 61.65 per cent of the weight of the cane in juice at 18.5 per cent sugars, from cane of 12.5 per cent fibre was found to give 78.55 per cent of the total sugar in the cane, the remaining juice in the bagasse being only 12.1 per cent sugar.

2d. An extraction of 74.3 per cent of the weight of the cane in juice from cane of 12.4 per cent fibre, was found to give 91.65 per cent of the total sugar in the cane, the remaining 13.3 per cent of juice left in the bagasse containing only 9.3 per cent sugar.

3d. An extraction of 75.1 per cent of the weight of the cane in juice from cane of 13 per cent fibre, was found to give 94 per cent of the total sugar in the cane, the remaining juice in in the bagasse containing only 7.8 per cent sugar. The above results were also corroborated by Prof. Wiley, U. S. Government chemist.

In order to satisfy myself on this point, I procured juice simultaneously from our three-roller and two-roller mills, at the same time put sufficient trash through to get juice of a third crushing with the following results:

The three-roller or first crushing juice was				17.5 per cent sugar.	
" two	"	second	"	" 15.5	" "
"	"	third	"	" 13.0	" "

It must be remembered that this was with no maceraction or water added to the trash between the mills—at the same time the juice and trash for the day's run was as follows:

Seventy-three per cent of the weight of the cane in juice and twenty-seven per cent of the weight of the cane in trash.

Now allowing the cane to be twelve per cent fibre the total juice per 100 lbs. cane would be:

1st mill	60 lbs. juice	@ 17.5 per cent sucrose	=10.5	lbs. sugar.
2d "	13 "	@ 15.5 " "	= 2	"
"	15 "	remaining in trash @ 13 per cent sucrose	= 1.95	"
Total juice	88	Total sugar	=14.45	"
Fibre	12=100 lbs. cane.			

In the above calculation, I have allowed that the remaining juice in the trash was thirteen per cent sugar, which is improbable and nine or ten per cent would be nearer the truth, however allowing the lost juice to contain 1.95 lbs. sugar, equal to 13.5 per cent of the total sugar in the cane of which diffusion under the most favorable conditions proposes to give us ninety-five per cent, which in this case is 8.5 per cent more sugar (while it would not exceed five per cent of the juice in the trash was calculated at ten per cent sucrose,) at the expence of additional fuel for evaporating fifty per cent more water from the juice, allowing the chips to be equal in evaporative efficiency to the trash as in our present system, while in reality the chips cannot be consumed without the aid of wood or coal. The saving of steam from clarifiers and cleaning pans, etc., is more than offset by the steam necessary for heating the chips, juice, and additional water in the cells. The above comparisons have been made with dry crushing, what is accomplished with maceration has been well ventilated through the press, and while a chemical analysis of chips and waste water, etc., makes an interesting display of mathematics, still an analysis in the shape of both sides of a cash account is decidedly more interesting, with a mill and diffusion battery side by side..

Yours truly, SUCROSE.

CORRESPONDENCE AND SELECTIONS.

REPORT ON THE MANUFACTURE OF SUGAR AT THE EVAN HALL, BELLE ALLIANCE AND SOUVENIR SUGAR-HOUSES, LOUISIANA.

BY L. A. BECNEL, CHEMIST.

To the McCall Bros.' Planting and Manufacturing Co. (Limited), Messrs. E. & J. Kock and Leon Godchaux:

[*Concluded from August Number.*]

Comparing the total loss by washing out, etc., between syrup and commercial masse cuite, on Evan Hall and Belle Alliance, with the same loss for 1887, we find that they were very much in excess during 1888. Although at this stage of the process the actual number of pounds of sucrose lost does not amount to a great deal even on a whole crop, it is always well to bear these differences in mind, in order to try and prevent them in the future. A few hundred pounds only at different stages of the process soon amount to thousands of pounds on a whole crop. It might not always be easy to remedy a loss by inversion, but a loss which to all appearances is due to wasteful practices can in our opinion always be remedied. Notwithstanding a generally more economical method of work in the sugar-house, this total loss by apparent waste between syrups and commercial masse cuite was in 1888 over fourteen times as great as that of 1887 for Evan Hall, and over thirteen times for Belle Alliance. In term of the percentage of the total sugar in mill juice this loss was:

For Evan Hall, 0.11 per cent in 1887 against 1.58 in 1888.
For Belle Alliance, 0.13 per cent in 1887 against 1.74 in 1888.

After following out the differences which existed between the quantities of sugar inverted between the different stages of process, we were enabled to note with pleasure that their sum total was very much less than for the preceding year. In this case also, notwithstanding the discrepancy that we have just called attention to, we are happy to call special attention to the fact that there has also been a very marked improvement in the matter of the total losses of manufacture, other than by inversion, both at Evan Hall and Belle Alliance.

Compared with 1887 we find that these were reduced by 66.32 per cent at Evan Hall and 59.73 per cent at Belle Alliance. Returning to our table of losses for 1888 we find that Belle Alliance lost a smaller percentage of its sugar by washing out, etc., than was done on either of the other places; and by calculation we find that Evan Hall's is 2.52 per cent and

Souvenir's 172.70 per cent greater. In a previous paragraph we discussed the relative amounts of sugar inverted both for the three places and for Evan Hall and Belle Alliance as compared with the results of these places for the crop of 1887.

In this instance also, it will be remembered that we noted a very marked decrease in the amount of sugar inverted during the process of manufacture—viz.: 32.44 per cent for Evan Hall and 20.00 per cent for Belle Alliance.

Having noted a decreased loss in both factors we may calculate on a marked improvement in the percentage of total loss by manufacture and inversion as compared with 1887. By reference to our records for 1887 we find that the total loss of manufacture and inversion amounted to 16.63 per cent of the sucrose in the mill juice for Evan Hall, and 13.05 per cent for Belle Alliance.

Our table of the losses for 1888 shows that the total losses which correspond to the above are as follows:

For Evan Hall	6.74 per cent.
For Belle Alliance	7.72 "
For Souvenir	14.82 "

Thus it will be seen that compared with each other the losses at Evan Hall have been decreased by 59.47 per cent of themselves. Although owing to the greater inversion at Belle Alliance as compared with Evan Hall for this year, the former place does not make as good a showing in the percentage of reduction of its losses, we can but feel elated over a reduction even as small as 40.84 per cent. There is here a brilliant prospect for Souvenir to improve during the coming season, for with proper appliances we can see no reason why in a single year her losses in per cent of sucrose in the original mill juice cannot be reduced by at least 40 per cent; nor do we see any reason why they may not be reduced to even a greater extent than were those of Evan Hall, providing the necessary apparatus is put in the sugar-house, and that every precaution be taken to prevent the unnecessary washing out of residues, no matter how limited in quantity or how worthless their appearance to the casual observer.

LOSS OF SUGAR IN BAGASSE.

The losses which we have thus far pointed out are by no means the greatest ones which are annually sustained. On the assumption that the cane contained ten per cent of woody fibre we find that the number of pounds of sucrose brought to the sugar-houses were:

For Evan Hall	4,565,695
For Belle Alliance	3,763,680
For Souvenir	2,081,118

If from the above we subtract the total number of pounds of sucrose in the mill juices the losses of sucrose in bagasse will be:

For Evan Hall	745,799
For Belle Alliance	715,354
For Souvenir	487,905

These quantities reduced to percentages show that for 100 parts of sucrose stored up in the cane at the time of grinding it, owing to the imperfect extraction of our mills, the loss of sugar in the bagasse amounts to:

For Evan Hall	16.34	per cent.
For Belle Alliance	19.07	"
For Souvenir	23.45	"

Before going any further with our arguments we wish to say that we do not believe the above estimate is entirely fair to Belle Alliance. We know by practical observation that cane of low tonnage per acre is a great deal harder than cane of high tonnage, owing to the greater quantity of woody matter which the former contains as compared with its total weight. In high tonnage cane there is a larger proportion of sap or juice; hence its superior softness. Our previous experience has taught us that under the same milling conditions the Belle Alliance mill was capable of averaging 75 to 76 per cent of juice from the cane ground during a whole season of fifty odd days, when the tonnage of the cane was twenty to twenty-four tons. Since dry, hard cane is less susceptible of yielding its juice than soft, sappy cane, we think that under the present circumstances it would be fairer to estimate the woody fibre of the Belle Alliance cane for 1888 at say 12.50 instead of 10.00, as above.

At 12.50 per cent of woody fibre the total sucrose in the cane ground at Belle Alliance was 3,658,218 pounds. Subtracting from this amount the 3,048,326 pounds contained in the extracted mill juice, the loss in the bagasse is 609,892 pounds, or 16.67 per cent of the original sucrose in the cane, which is a little in excess of the percentage of loss at this point, as per the extraction of 1887, on twenty-four tons of cane. Using this figure to represent the loss in the bagasse at Belle Alliance, our table of losses in bagasse per cent of the sugar stored up in the cane now reads:

Evan Hall	16.34
Belle Alliance	16.67
Souvenir	23.45

Compared with the results of 1887 we find that at Evan Hall this loss is 0.74 per cent greater, and at Belle Alliance also greater but by 4.31 per cent compared with Evan Hall for 1888, which shows the smallest loss; then we find that Souvenir shows an excess of 43.52 per cent.

These discrepancies are we think due solely to imperfect extraction, and can not only be remedied, but great reduction can be made in the above 16 per cent losses, by a proper and judicious use of hot water between the first and second mills of the three plantations, especially when cheap evaporation can be had by the use of good multiple effect evaporating apparatus.

We do not suggest saturation as the best method to extract large quantities of sugar from the sugarcane, but simply as a makeshift, in order to try and approximate the results of diffusion and to reduce the present enormous losses which are sustained in the sugar-houses, until such time as you may decide to adopt the latter process.

Reducing the losses of manufacture and inversion, which heretofore have been given in terms of the sugar in the juice extracted, to terms of the total sugar in the cane, and also correcting the sugar accounted for in the commercial sugar, commercial molasses and commercial masse cuites to the same standard of comparison, we are enabled to make the following expose of the distribution of the sucrose of each place, viz:

PERCENTAGE OF SUCROSE.	E. H.	B. A.	SVN'R.
Accounted for in commercial sugar	65.86	67.62	55.99
Accounted for in commercial molasses	12.16	9.26	9.22
Accounted for in commercial masse cuite	78.02	76.88	65.21
Lost in the bagasse	16.34	16.67	23.45
Lost by washing out, etc.	3.74	3.65	9.11
Lost by inversion	1.90	2.80	2.23
Total losses	21.98	23.12	34.79

Compared with each other we find that the total losses of the Belle Alliance sugar-house exceed those of Evan Hall by 5.19 per cent, and that those of Souvenir are greater than those of Evan Hall by 58.28 per cent, and 50.48 per cent greater than those of Belle Alliance, which proves conclusively that on the whole Evan Hall obtained the best general results, that Belle Alliance has a certain margin for improvement and Souvenir did not by far obtain the results that were practically possible.

As a kind of concluding argument we will now take up each factor showing a maximum of good work in point of view of results, no matter to which place it belongs, and we will make with them an estimate of what the results of each would have been under these conditions. We have already called attention to the apparent causes which produced the different results, and therefore base our estimate on the assumption that all the imperfections noted in the apparatus and processes were removed. Since, for reasons already given, we are unable to make a correct estimate of how much more sugar the process of thorough saturation would extract from the cane we will make an estimate for the best existing milling conditions.

Accordingly, the theoretical results of each place will be:

1. Since Evan Hall sustained the least amount of loss of sucrose in the bagasse, it must necessarily have recovered the greatest quantity of sucrose in its mill juice. We have seen the least proportion of sucrose lost in bagasse was 16.34 per cent of that originally contained in the cane ground. We therefore should have extracted by our milling process on each place the remaining 83.66 per cent.

2. We have seen that the least percentages of inversion between the different stages of the process per cent of the sucrose in the mill juice were as follows:

Between mill juice and syrups, Evan Hall	1.61 per cent.
Between syrups and first masse cuite, Evan Hall	0.35 "
Between first and commercial masse cuite, Belle Alliance	0.24 "

3. On the same basis of the total sucrose in the mill juice the least losses of manufacture other than by inversion—viz., washing out, tanks, etc.—were:

Between mill juice and syrups, Belle Alliance	2.20 per cent.
Between syrups and first masse cuite, Souvenir	0.41 "
Between first commercial and masse cuite, Souvenir	1.12 "

According to the above statement our total losses are:

Between mill juice and syrups	3.81 per cent.
Between syrups and first masse cuite	0.76 "
Between first and commercial masse cuite	1.36 "
Total	5.93 per cent.

These figures show that all three places under these conditions should have accounted for 100.00−5.93=94.07 per cent of the above 83.66 per cent in the commercial masse cuite.

When we were discussing the relative proportions of sucrose accounted for in the different grades of commercial sugar per cent of the total sucrose found in the first masse cuite we saw —1. That Evan Hall attained the best results in first sugars. 2. We found that in the sum total of first and second sugars Souvenir had done the closest work. 3. That in the total first, second and third sugars Belle Alliance accounted for the largest proportion of sucrose. As already stated these quantities were as follows:

In the first sugars, Evan Hall	70.01 per cent.
In the first and second sugars, Souvenir	85.29 "
In the first, second and third sugars, Belle Alliance	81.15 "

We accordingly conclude that per cent of the sucrose in the first masse cuite, the sucrose of our theoretical, commercial sugar, for the three places should be divided out as follows:

In the first sugar	70.01 per cent.
In the second sugar	85.29−70.01=15.28 "
In the third sugar	88.15−85.29= 2.86 "

From the foregoing data we conclude that the original sucrose of our cane should be divided as per the following table:

Sucrose in the cane	100.00	per cent.
Sucrose lost in the bagasse	16.34	"
Sucrose recovered in the mill juice	83.66	"
Sucrose lost between mill juice and syrup	3.19	"
Sucrose recovered in the syrup	80.47	"
Sucrose lost between syrup and first masse cuite	0.63	"
Sucrose recovered in the first masse cuite	79.84	"
Sucrose recovered in the first sugar	55.90	"
Sucrose recovered in the second sugar	12.20	"
Sucrose recovered in the third sugar	2.28	"
Sucrose recovered in total first, second and third sugars	70.38	"
Sucrose left in the molasses	8.37	"
Sucrose recovered in the commercial masse cuite	78.75	"
Sucrose lost between first and commercial masse cuite	1.09	"

By applying these figures to the estimated quantities of sucrose in the canes of each place, and by correcting them according to the polarization of the commercial sugars, we get the following quantities of first, second and third sugars, which ought to have been yielded by each place according to our premise:

FOR EVAN HALL.	ACT. YLD.	EST. YLD.
No. of pounds of first commercial sugar	2,606,122	2,613,747
" " second " "	459,411	600,620
" " third " "	39,608	112,990
" " total " "	3,105,141	3,321,357
" " " " " per ton	144.32	154.65
" " " " " per acre	3,378.72	3,614.10

FOR BELLE ALLIANCE.		
No. of pounds of first commercial sugar	1,963,374	2,090,405
" " second " "	495,797	490,443
" " third " "	116,859	95,315
" " total 1st, 2d, 3d sugars	2,576,030	2,676,163
Pounds total first, second and third sugar per ton	164.27	170.66
" " " " " " " acre	2,776.09	2,883.80

FOR SOUVENIR.		
No. of pounds of first commercial sugar	968,082	1,184,852
" " second " "	233,360	273,890
" " third " "	....	52,898
" " total 1st, 2d, 3d com. sugar	1,201,442	1,511,640
Pounds total first, second, third com. sugar per ton	130.13	163.72
" " " " " " " " acre	2,820.29	3,548.45

Thus we conclude, according to the best results of each plantation, without impoverishing the final molasses to a greater degree than was that of Belle Alliance, and estimating the excess of commercial sugar, according to the polarization of the different grades made on each place, also estimating the third sugar of Souvenir from an average of the polarization of that grade of sugar as per the Evan Hall and Belle Alliance data, the several crops show the following shortages as per our estimate:

	E. H.	B. A.	SVN'R.
No. of lbs. of first, second and third sugar	216,216	100,133	310,198
No. of lbs. of first per ton of cane	10.33	6.39	33.59
No. of lbs. of first per acre of cane	235.38	107.71	728.16

If there had been a sufficient number of cars in the hot room to permit the second molasses to be worked sufficiently close, so as to have impoverished them to the extent of raising the ratio of glucose and sucrose of the final molasses up to 140 to 150 per cent, or 145 per cent average, as was done in the case of a few experimental strikes, we would, according to the polarization of the third sugars of each place, probably have made about 220,594 pounds additional commercial sugar on Evan Hall, 116,503 pounds on Belle Alliance and 73,185 pounds on Souvenir. These quantities would increase our previous estimates to the quantities given in the following table, viz :

	E. H.	B. A.	SVN'R.
Total estimated increase in lbs. sugar	436,810	216,636	383,383
" " " " " per ton	20.30	13.81	41.52
" " " " " per acre	475.31	233.42	899.96

Thus it will be seen that with a proper mill extraction, economical and careful manipulation of the juices and with sufficient hot room capacity, with the same cane, Evan Hall could easily have made 164.62 pounds of commercial sugar per ton of cane, or 3,854.43 pounds per acre; Belle Alliance 178.08 pounds per ton and 3,009.51 pounds per acre, and Souvenir 171.65 pounds per ton and 3.720.25 pounds per acre of cane ground. Besides the advantages of making so much more sugar the above method would have offered the great advantage of reducing the quantities of molasses made.

If these crops had been taken off by means of the diffusion process, extracting in the diffusion juice say, 96 per cent of the original sucrose contained in the cane, we would then have 14.77 per cent more sucrose than can be found in our best milling.

Supposing that the handling of this juice is not any more economically or carefully done than in the case of our last estimates, losing 5.93 per cent of the sucrose accounted for in our original juices—granting this large percentage of loss, we think that we are making a very conservative estimate of the results which could have been obtained by diffusion by simply increasing our last estimates by 14.77 per cent. We accordingly find that the output in dry commercial sugar would have been at least :

	E. H.	B. A.	SVN'R.
No. of pounds of first sugar	2,999,797	2,399,158	1,359,855
" " second sugar	689,332	548,881	314,344
" " third sugar	382,854	243,104	144,706
Total pounds sugar	4,071,983	3,191,143	1,818,905
" " " per ton	189.25	203.50	197.00
" " " " acre	4,430.90	3,438.72	4,269.73

These figures show that in addition to the best results which we could obtain per ton and per acre, still granting a 5.93 per cent loss of sucrose from that contained in the juice, diffusion could, in the case of Evan Hall, easily give an additional 24.63 pounds per ton of cane and 575.47 pounds per acre. In the same way we find Belle Alliance's probable increase to be 25.42 pounds per ton and 429.21 pounds per acre, and Souvenir's 25.45 pounds per ton and 548.98 pounds per acre.

We have tried, in these last remarks, to separate the probable increased yield which would be due to a more careful and economical handling of juices in the sugar-house from those which should belong to diffusion proper, from the point of view of the increased extraction. In this way we are enabled to draw cautious conclusions, and are prepared to infer that the whole increase would not be due to diffusion when a part of it can, we think, be accomplished by more rational methods than some of those usually followed in our sugar-houses. Before dismissing this subject we desire to say that the above loss, 5.93 per cent of the sucrose in the juice, is very high, and that in the future, each stage of the process of manufacture will have to be watched even more closely, in order to try and reduce this factor to a minimum.

We would strongly advise the introduction of diffusion on the three places at as early a date as possible, but, on the other hand, as it is now impossible to adopt this process for the coming crop, we would most strongly urge the increasing of the hot-room capacities, as being, combined with care in boiling, an effective way of increasing our yields in commercial sugar. Care should also be had not to wash out even the smallest quantities of settlings of any kind, except through the regular channel, the filter-presses. Although a loss may appear unimportant from its limited extent at any one time, still it must be remembered that by the end of a season these few pounds, aggregated, soon come up to thousands of pounds and not unfrequently to hundreds of thousands of pounds. In order to remedy these evils we must in the future be careful in preventing these apparently small leaks, for they are, owing to apparent insignificance, a great deal more demoralizing than the larger ones.

FUEL.

Returning to the actual figures for the crop of 1888 we find that the next thing that must have our attention is the question of coal burned in order to produce the results already spoken of. In these figures we estimate the wood burnt to light fires, etc., and the bagasse as coal, because if the latter were not used as fuel we would have to replace it by its equivalent in actual coal. The same argument holds good at Evan

Hall, where some wood was burnt under the boilers. The data concerning this subject is as follows:

	E. H.	B. A.	SVN'R.
Barrels of actual coal burnt	12,505	15,849	12,331
Wood reduced to coal (bbls.)	8,000	48	108
Bagasse reduced to coal (bbls.)	14,942	10,890	6,412
Total	35,447	26,787	18,851
Barrels of coal per ton of cane	1.65	1.70	2.04
" " " 1000 pounds sugar	11.42	10.39	15.69

From the point of view of general results we see that Souvenir is susceptible of making very great improvements in its coal consumption.

Owing to the fact that the bagasse burners on each of the plantations are not of the same degree of efficiency we are unable to make any very reasonably close estimate of the relative values of the evaporating apparatus used from the point of view of the saving in coal. The only very accurate way of estimating the relative value of fuel-saving appliances is by ascertaining the relative quantity of water which a given weight of coal will evaporate under the circumstances. This we are unfortunately unable to do, because the conditions of work were such as to make it impossible for us to even estimate the quantities of water which were added during the process of manufacture, viz., in washing down the clarifiers at the centrifugals, in washing the sugars, in reducing the first molasses before cooking into seconds, etc. This is a great pity, and we would like to suggest that some arrangements be made in order that this water can be gauged, so as to permit us in the future to make accurate estimates of what the fuel burnt is accomplishing. We can, however, make a rough estimate of the saving in fuel by comparing the quantities of coal consumed per ton of cane in the same sugar-house but on different years. We prefer to base our estimate on the ton of cane, because we think that the results per thousand pounds of sugar are misleading, since the relative number of pounds of sugar per ton would affect this result.

Comparing the results given in the above table for Belle Alliance with the corresponding ones for 1887 we find that in 1888 it required the consumption of 0.26 barrels of coal less to manufacture one ton of cane into sugar and molasses. This would indicate that the use of a low pressure pan caused the saving of about 4,077 barrels of coal on a crop of the same magnitude as compared with the use of a high pressure vacuum pan, all other conditions being apparently the same.

Comparing Evan Hall's results of 1888 with those of 1886 we find that one ton of cane in 1888 required 0.37 barrels less coal than in 1886, showing an apparent saving of 7,961 barrels of coal on a crop of the same magnitude, attributable to the use of the Yaryan apparatus.

Summarizing, we find that with a triple. effect Evan Hall saved about 18.31 per cent of its fuel, and Belle Alliance 13.27 per cent with its low pressure vacuum pan. This leads us to conclude that on the same crops, with suitable multiple effect evaporators and low pressure vacuum pans, the saving in coal would, compared with open evaporators and high pressure vacuum pans, probably amount to the following quantities on a crop of equal magnitude as that of 1888, viz.:

On Evan Hall	12,665	barrels.
On Belle Alliance	9,038	"
On Souvenir	5,953	"

This shows that without making any changes in the bagasse burners to manufacture a ton of cane into sugar and molasses it would require the following additional quantities of coal over and above the estimated value of the bagasse as fuel, viz:

For Evan Hall	0.73	barrels.
For Belle Alliance	0.70	"
For Souvenir	0.70	"

Showing that Evan Hall's bagasse burner is about 4.30 per cent less efficient than either of the others.

In concluding these lengthy remarks on the results of your respective sugar-houses your chemist desires to express his appreciation of the facilities which you have given him in order to secure the necessary data for this report, and hopes that with whatever greater facilities you may think proper to give him in the future, both a maximum of production and a minimum in the elements of loss will be the results of closer investigations in your sugar-houses.

To my fellow-employees whose work I have criticised I desire to say that I have tried to be impartial in pointing out discrepances wherever they showed themselves, and have made theoretical estimates wherever I thought that these would in the future enable them by their co-operation with the laboratory to strive for excellency in results. I desire also to specially thank my assistants, Messrs. Chas. R. Gaines and Judson Crane, for their hearty co-operation and the creditable manner in which they discharged the duties which I had entrusted to their care.

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THE SUGAR TRUST.

We have no sympathy with any scheme which tends to unduly increase the price of any commodity which is in general use among the people. If it can be shown that the sugar trust has used the power of combination to advance the price of sugar unfairly, and thereby increase the living expenses of the people of this country, we will heartily support measures to suppress it; but we do not unite with the blind mob in howling down any organization or combination until it is shown that it is a wrong.

We have regretted to observe in a leading Republican paper what seems to be an unreasonable assault on the Sugar Trust. It declares that the price of raw sugar has been advanced from 4.44 cents per pound in 1887 to 7 cents at the present time, and that the refiners now receive 1.94 cents per pound additional for the granulated and 2.44 cents per pound additional for the crushed, instead of 1.50 cents and 1.68 cents respectively two years ago. The article then proceeds to charge upon the Sugar Trust the whole difference between the present price of sugar consumed in the United States and the price two years ago, amounting to $97,500,000.

We do not hesitate to say that this charge is unjust, and is more like the mischievous harangues of an irresponsible demagogue than the thoughtful, well-considered reflections of an intelligent, sober metropolitan editor.

The facts in the case are too well known to be disguised. For a long series of years the foreign price of raw sugar prior to 1884 remained nearly uniform, averaging from 4½ cents to 5 cents per pound, and the American price, with duty added averaging from 6½ to 7 cents per pound. Sometimes, in the course of 25 years, the average price would go below 6½ cents and sometimes above 7 cents. In 1872, for example, the average foreign price of raw sugar was over 5⅝ cents per pound, and with duty added cost in the United States about 7⅝ cents, or higher than the price to-day, which is charged to the manipulation of the trust. Since 1884 the extraordinary increase in the production of sugar has caused a rapid decline in price until in 1887 the average cost of raw sugar landed in the United States, duty paid, was less than 4½ cents per pound. The details of this increase and decline are thus stated in a recent report to the English board of trade, published in the London *Economist* of June 15:

"The increase of the production of sugar which was noticed as so remarkable in the report of 1884, has been even more remarkable since. It was stated in 1884 that in 1853 or thereabouts the total sugar production recorded, according to the circular of Messrs. Rueb & Ledeboer, was only 1,400,000 tons; in 1878, which was just before the sugar bounties committee in 1879-80, the total was just over 3,000,000 tons, and in 1882, the last year dealt with in the report of 1884, it was 3,800,000 tons. The increase to 1878 was 110 per cent. in 25 years, and in the following years, from 1878 to 1882, the increase was about 26 per cent. Now it has to be added that since 1882 there has been an increase to 5,500,000 tons in the last complete year, or, making certain corrections, to 5,200,000 tons, the amount being now nearly four times the total in 1853, when the statistics begin.

"The increase in production has been in all descriptions of sugar, but principally in beet sugar, which, from being an inconsiderable part of the total production, has come to be nearly equal in importance to cane. While in 1853 the production was over 1,200,000 tons cane to rather less than 200,000 tons beet, the production of beet on the average of 1886–'87 was 2,430,000 tons out of an average total of nearly 5,200,000 tons, while the production of cane was 2,750,000 tons. The production of beet has thus increased about 12 times, while cane sugar has little more than doubled, the result being that the two sources of supply are now nearly level with each other.

"In 1884, it was noted that the fall in sugar at that time was not greater than in the case of other staple articles, such as tea, wheat, cotton, wool, etc. Since 1884 there is no doubt there has been a special decline in sugar. In 1884 the decline in refined sugar from the 1861 standard was about 17¼ per cent. and in raw sugar 9¾ per cent., the decline in the other articles referred to ranging from about 15 to 38 per cent., but refined sugar now shows a decline of about 55 per cent., from the 1861 standard and raw sugar 48 per cent., while the decline in other articles ranges from 27 to 42 per cent., only."

The effect of this rapid decline in price was shown especially in a rapid increasing *per capita* consumption, so that at the close of the year 1887 there had been no material increase of the supply. A further effect growing out of a diminished supply in Cuba and the East is seen in a sudden and rapid return of the world price to the level which prevailed before the decline began. The report to which we have already referred notes an advance in the London price of raw sugar from under 14s. per cwt. in the beginning of 1889 to 22s. on the 24th of May, or more than 60 per cent. Since then a further advance has taken place.

With this evidence of the general advance all over the world, and no greater in proportion here than elsewhere, how is it possible to charge it upon the operations of the American Sugar Trust? The only advance which can with any reason be charged upon the trust is the increase of the difference above stated between the price of raw and refined—$\frac{44}{100}$ cent on the granulated and $\frac{59}{100}$ cent on the crushed, say half a cent per pound, or 25 cents per annum per head of our population, assuming that they all use only the refined sugar.

Whether this advance is reasonable is an open question. It is well known that the business of sugar-refining was, for many years prior to the organization of the trust, disastrous. Competition among the parties engaged in it resulted in loss, and combination to protect themselves and those in their employ would seem to be not only legitimate, but for the advantage of the community. For it is not desirable that any important industry should perish for want of adequate means of securing reasonable profits, and the community is as much interested as individuals in seeing such means adopted precisely as towns remit taxes or give bonds to induce the establishment of an important industry. At any rate, and advance of one-half a cent in the price paid the refiners for their work can hardly be made the ground for the charge of extortion, when it is known that at the old rates their business was going on at a loss.

The worst aspect of the assault on the sugar trust and its unfounded charges is its effect upon what promises to become one of our great national industries—the production of raw sugar. It has been known by German experience that it is possible for this nation to become independent of all other nations for its supply of sugar. Germany, with no better if as good advantages as we have in the United States has within a few years become an exporter instead of an importer of sugar. In fact, her production has been the prime factor which has reduced the price of sugar for all civilized nations. Although a return to old prices has now occurred no one familiar with the facts will deny that the advance will be of short duration. A falling off in consumption, together with increase of production following high prices, will speedily bring back the condition of last year with every prospect of permanency.

It is especially important at this critical period of the American sugar industry that no unjust prejudices should be excited, and that all who desire the establishment of a great industry among us, with its immense results for the general welfare of our people, should unite in forming a fair and just public opinion upon all branches of this sugar question. It affects our whole people, as almost no other question affects them, and they may be easily misled by unfair and unconsidered statements into a public policy which will in the future prove an incalculable injury.

The stocks of sugar in the chief European markets, May 1, 1889, were 604,000 tons, against 743,000 a year ago. This is a decline of nearly 20 per cent. On the other hand, the consumption of sugar in Europe for the year ending May 1, 1889, was 2,818,000 tons, against 2,657.000 tons the previous year. In other words, we find an increase of twenty per cent, in the consumption within one year.

It is noted also that the stocks of sugar in England and the United States were at the same time 200,000 tons less than they were a year ago. Besides this, Licht, the highest authority on the subject, reports the world's visible supply at 735,000 tons, against upward of a million a year ago.

The consumption of sugar in the United States increased remarkably with the decline in price during the past ten years. In 1877-78, when the price of raw sugar was 7¼ to 7½, the consumption was 36 pounds, *per capita.* In 1882-83 it increased to 45 pounds and in 1888 it was 55 pounds. We have here an increase of nearly 3 per cent, in the consumption of the United States *per capita* in ten years, owing chiefly to the decline in price.

Are not these facts ample to explain the rise in raw sugar without calling in the bugbear of the sugar trust and exciting popular prejudice against the continuance of protection of American sugar interests?—*American Economist.*

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RAILROADS IN INDIA—SIXTEEN THOUSAND MILES OF TRUNK LINES IN HINDOSTAN.

India has now sixteen thousand miles of railroad. It is as far from Calcutta to Bombay as it is from New York to Denver, and several trunk lines run across Hindostan from one city to the other. There are branches from these which go up the Himalaya mountains almost to the borders of Thibet, and others which shoot off to the Khyber Pass at the entrance to Afghanistan and not a great distance from the new Russian railway, which has been pushed on past Samarcand. The day will come when we can travel from London to Calcutta by rail, though this presupposes the cutting of a tunnel under the English channel. South India has many long miles of railroads, and the whole of Hindostan, which is half the size of the United States, has a railroad net covering it. The construction of these railroads has included engineering works fully as grand as the railroad making of the United States, and the keeping of them in order is more difficult.

WOOD EATING ANTS.

One of the great plagues of Indian railroad makers is the white ant. These insects eat every dead thing in wood form above ground. If a pile of wooden ties is left out over night an attack of ants will have carried it away by morning, and there is no possible storage of wooden ties. Such ties as are in the roads are saved from destruction by the vibration caused by the running trains, which scares the ants away. It is the same with telegraph poles and fences, and the result is that the ties of most of the railroads are made of iron. I have traveled about three thousand miles over all kinds of railways in India. The telegraph poles on many of the lines are hollow tubes of galvanized iron, about as big around as the average man's calf, so made that they fit into one another and form a pole about ten feet high. To these poles the lines are strung, and many of the roads use such poles throughout their entire length.

On other lines the telegraph poles are T iron rails, the same as those on which the car travels. Two of these rails are fastened together by bars about a foot wide and then this iron lattice work is set deep in the ground and the wire strung upon it. About some of the stations the fences are made of such iron rails, and through hundreds of miles along one of the rajah's railroads in Western India I found fences of barbed wire with sand stone posts. These stones are a foot wide and about four inches thick, and they stood about three feet above the ground. The wire ran through holes in them and the railroad men tell me that they are much cheaper than wood.

THE MAGNIFICENT DEPOTS.

I am surprised at the magnificence of the depots in India. Here at Bombay there is a finer railroad station than any we have in the United States. It cost about $1,000,000, and architecturally it is the peer of any building at Washington. At Calcutta there are small depots and even at the smallest of the towns you find well made stone buildings surrounded by beautiful gardens in which bloom all kinds of tropical flowers. Nothing about these stations is made of wood. The platforms are of stone filled in with cement, and the cars run into the stations on a plane about two feet below the floor, and so that the floor of the cars is just even with that of the depot. Each station has its first, second and third class waiting room, and everything in India goes by classes.

The cars are first, second, third and fourth class, and they are all on the English plan. They are about two-thirds the length of our cars and a trifle wider. They are not so heavy as the American passenger coach and they look more like wide, long boxes than anything else. Each of these cars is divided into compartments. In the first and second class there are only two compartments to the car, and the chief difference in these two classes is in the number allowed in the compartment. If you will imagine a little room about 10 feet long by 5 wide, with a roof 7 feet high, in the center of which there is a glass globe for a light, you may have some idea of the Indian first class car. You must, however, put two long, leather covered cushioned benches along each side of this room and at the ends of these have doors with glass windows in them, opening inward.

Over the cushioned backs of the benches there are windows which let up and down like those of the American street car, and which are of the same size. The car has none of the finish of the American Pullman, and though you are expected to sleep within it, there are no signs of bedding or curtains. At the back of it there is a lavatory, without towels, soap or brushes, and there is barely room enough for you to turn around in it when you are washing. The second class cars are much the same, and there may be one second class car and one first in the same coach.—*Frank G. Carpenter.*

VISIT TO THE SUGAR EXHIBIT AT THE PARIS EXPOSITION.

BY MR. GEORGE DUREAU.

[*Copied* from the *Sugar-Bowl* and *Farm Journal.*]

The study of the sugar industry at the Exposition can be carried to great developments. This industry is attached, as you know, not only to agriculture, but also to mechanism, chemistry, commerce and legislation. We would not dream of exhausting this vast subject in a conference of an hour, but it is evident that in order to visit the sugar exposition with interest and profit, it is indispensible to possess a general idea, a full sight of the condition of the sugar industry, also of its most recent progress. It is this view that I am desirous to give with the greatest possible brevity.

SUGAR SOURCES.

The first materials used for the extraction of sugar, that is to say, for manufacture, are: First, the sugar beet; second, the sugarcane; third, sorgho; fourth, maple.

BEET SUGAR.

The countries producing beet sugar are as follows: *In Europe*—Germany, France, Russia, Belgium, Austria-Hungary, Holland, Denmark, Sweden, Italy, Spain, Portugal and Roumania. *In America*—California, Chili, Canada, Nebraska and Kansas. *In Asia*—Japan.

CANE SUGAR.

The countries producing cane sugar are: *In the Indies*—Cuba, Porto Rico, Jamaica, Hayti, Islands of Lucayos, Martinique, Guadeloupe, Trinity, Barbadoes, Marie Galante, Sainte Croix, Antigua, St. Domingo, Monserat, Nevis, St. Christophe, Granada, St. Vincent and Tabago. *In the Guineas*—Demerara, Surinan, Cayenne. *In Asia*—China, Kingdom of Siam, Indies, Cochin-China (French) and Japan. *In Africa*—Reunion, Mauritius, Egypt, Mayot and Natal. *In America*—Louisiana, Texas, Florida, Brazil, Peru, Mexico, Argentine Republic, Venezuela, Guatemala and Honduras. *In Oceanica*—Java, Philippine, Australia and Hawaiian Islands. *In Europe*—Spain, which produces also beet sugar.

SORGHUM SUGAR.

The countries producing sorghum sugar are: The United States (notably Kansas) and Italy.

MAPLE SUGAR.

The country producing maple sugar is the United States of America.

As you see, the sources of sugar are very numerous, but what is the importance of each one of them? What statistics will enlighten us on this point?

In 1853–55, the total sugar production, both of cane and beet was only 1,243,000 tons. In 1886–87 it reached 5,187,000 tons—thus an increase of 300 per cent; but whilst the beet sugar proportion, compared to the total, was only 14 per cent in 1853–55, this proportion in 1886–87 had increased to 47 per cent. So that in the space of these thirty years the beet sugar production has progressed to an equal importance with cane sugar. We will see, later, which countries have contributed most to the development of the European production.

SERVICES RENDERED BY THE BEET SUGAR INDUSTRY.

In Europe there are 1,360 beet sugar factories, for the supply of which there is annually cultivated about 900,000 hectares of good land, from which area, which varies to a certain extent, according to price of sugar and beets, are harvested from 20,-000,000 to 250,00,000 tons of beets, which furnish, besides the sugar, about 8,000,000 tons of pulp, excellent food for hogs and cattle; 2,000,000 tons of scum of defecation, which is used for fertilizing, and 800,000 tons of molasses, from which is extracted sugar, alcohol or salines. The 1,360 factories pay to the cultivators more than 500,000,000 francs yearly, and spend annually in manufacturing expenses, coal, labor and sundries, more than 330,000,000 francs. You perceive that this aggregates to a considerable industry, which renders immense services to the countries in which it has been able to plant itself.

ORIGIN OF BEET SUGAR.

In 1747, Magraff, a German chemist, made known the existence of crystalizable sugar in the beet. (See *Sugar-Bowl* of December 31, 1887.—Ed.) In 1789, Archard, a German chemist, occupied himself with the culture of beets. In 1796 he erected a sugar factory in Silesia. (See *Sugar-Bowl* of January 28, 1888.—Ed.) Attention was again called to beet sugar on March 25, 1811. Napoleon ordered that 32,000 hectares be cultivated in sugar beets; funds were placed at the disposal of the Department of Agriculture; a decree of 1812 established five schools of chemistry for the manufacture of sugar, and four imperial factories were erected and manufactured the crop of 1812–13—2,000,000 kilogrammes of dark sugar. In 1836 there were 436 factories in the thirty-seven departments. In 1866–67, 441 factories existed in France, and produced 216,-800,000 kilogrammes; twenty-four departments had beet sugar factories.

From 1871–72, the European production takes a remarkable impetus. Here follows the comparison in the production of 1871–72 and of 1888–89. (See *Sugar-Bowl*, June 8, 1889.—Ed.) Germany has thus become first in the importance of production.

CAUSES OF THE DEVELOPMENT OF THE GERMAN PRODUCTION.

It could be seen by what preceded, how great is the German development since 1871-72. This phenomena is the result of a bounty system applied for a length of time in that country. The bounties allowed to German sugar are not direct; it results from a mode both of bounty and of the restitution to the exportation privilege. The bounty is based on the weight of beets to be manufactured, and the premium rate realized is furthermore raised in such a way that the manufacturer extracts from the root a larger sugar proportion. In 1840 the industrial yield varied between five and six per cent. In 1871-72, 8.28 per cent; in 1887-88, 13.77 per cent in dark sugar.

The bounties have stimulated the production and also exportation. Thus in 1871, Germany only exported 14,000 tons of sugar; in 1878-79, 138,000 tons; in 1884-85, 673,727 tons. The total export of German sugar in the last seventeen years reached 4,567,000 tons, representing a value of two thousand million francs.

Austria-Hungary had also, during that time, developed its production and exportation by the favor of a similar system. Then came a time, about 1884, when the French industry, threatened by the bountied opposition of Germany and Austria-Hungary, had to devise means to repulse the German and Austrian sugars, which were flooding its market. The French Parliament did not hesitate, and voted, in 1884, a law establishing a tax on the beet, at the same time a surtax of seven francs on bountied sugars, the results of which were immediate. Under this stimulant the yields of sugar in our factories have progressed, the cost price has lowered and the struggle become possible. Our industry possesses an excellent legislation that we must try to preserve, and it is found, thanks to the surtax, beyond the invasion of the bountied German products.

BEET SUGAR MANUFACTURE.

The principles upon which lay the manufacture of beet sugar are the following:

1. The cultivation of sugar beet in view of obtaining roots as sweet as possible.
2. The extraction of the sweet juice contained in the roots.
3. The purification of this juice: that is to say the elimination of the impurities, saline and organic matters, opposing the crystalization of sugar.
4. The concentration and cooking of the purified juices until crystalization.
5. The separation of the syrup crystals.
6. The treatment of this syrup in view of extracting a new quality of sugar.

The apparatus and processes employed in these operations are represented at the Universal Exposition.

CULTIVATION OF THE INDUSTRIAL BEET.

The most important operation, without contradiction, is the cultivation of the beet. It is important, first, to obtain a very sweet raw material. As the manufacturer only extracts the sugar, he simply withdraws the sweeter principle enclosed in the roots that the cultivator delivers to him.

It has been said, with reason, that the sugar formed itself in the field. It is at the development of this special faculty that the beets possess, that the agricultural and industrial progress must be aimed. The beet, in a wild state, contains but a small proportion of sugar. Its industrial treatment would not be remunerative, but the agriculturalist has succeeded in making this plant a rival to the sugarcane.

How could this result be obtained? How does the sugar form itself in the plant, and how can its elaboration be favored? For a long time the chemists and physiologists have studied the formation problem of sugar in the beet. Numerous theories have been furnished, but the study of this interesting problem has only been the object of very precise researches, undertaken by Mr. Aime Gerard, professor at the *Institut Agronomique*, in 1885; and this savant has been able to furnish a very clear demonstration of the property of each part of the plant, from the sugar formation point of view. These facts can be seen at the Exposition of the *Institut Agronomique* (*Quai d'Orsay*).

The beets studied by Mr. Girard have been gathered with care, intact, with all their leaves and with all their rootlets. Photography has reproduced with fidelity these beets. The chemical analysis and the weighing have established the composition and weight of their different parts, and finally, the results of the observation made during growth and after the crop, has led to the establishment of the exact *role* of the leaf, of the stock and of the foliage.

It is thus that Mr. Girard has demonstrated that the beet leaf is the sole seat of the formation of the cane sugar or saccharose (crystalizable sugar), and that this phenomenon is closely connected to the action of the solar light. The saccharose forms itself directly in the limbs under the influence of the solar light, and proportionately to the intensity of the same. If the day has been bright, the quantity of saccharose found in the leaves is considerable at the end of the day. During the night, about half of the saccharose formed by the leaves stores itself in the stock. A leaf of 500 gr. (66 per cent petioles and 33 per cent of limbs) can at the end of a sunny day inclose as much as two gr. of saccharose. As about half disappears during the night, you perceive that each leaf can each day send to the stock about one gr. of sugar already formed. For a period of 100 days (July 15 to October 25,) there is a storage of 100 gr. of sugar, corresponding for a root of 720 gr., to a saccharine richness of 13 to 13.5 per cent of sugar. The sweet matter of the sound, normal beet is totally formed by the saccharose.

The stock, you have just seen, serves to store the sugar produced by the leaves; and contrary to certain theories, its *role* is absolutely *null* to the point of view of the formation of the organic matter, and notably saccharose. The stem and the radicelles finally fulfil but one function: the *hydratation* and the *mineralization*—that is to say, the absorption and the transmission in the different parts of the plant of the water and the necessary mineral matters to the formation of the tissues.

The volume of soil in which each sugar beet can develop its underground organs is very extensive—about six to eight cubic meters. The superficial development of the comose attains one-fourth square meter at ending of the season, and is nearly equal to the surface developed through the atmosphere by the leaf stem. The comose measures about one mm. in diameter, and attains, at October 1st, about ninety-seven meters.

The preceding observations are in accord with certain proven facts. It is notably proven that beets rich in sugar and normally developed, are provided with heavy foliage and an abundant comose. It has been proven that the destruction of the foliage is a destructive producer, from a sugar producing point of view. The sunny season always gives crops more sweets than those during which the gloomy days have been frequent, etc.

It is in applying judiciously the principles established by science, that the agriculturist has been able to improve the saccharine qualities of the beet. What are then the conditions of a rational cultivation? These conditions are: 1. Deep plowing before winter. 2. Employment of manure before winter, and chemical fertilizers (nitrate of sodium, superphosphate of lime, chloride of potassium, etc.), before seeding. 3. Seeding in lines. 4. Frequent tillage. 5. Close seed plots. 6. Harvesting the moment of complete maturity, from September 20 to October 15, generally; and principally, *choice of the seed*, a point of capital importance. The raisers have, in fact, realized considerable progress in the selection of the industrial beet, and created new species endowed with great fixity, as you can convince yourself by visiting the Exposition.

Some estimate that choice of seed has a superior influence, and that this influence amounts to nine-tenths of the results obtained in quality. The nature of the seed has certainly a considerable importance, but to obtain this good yield in weight and in sugar, it is indispensable to observe all the directions that we have just enumerated.

In this regard it may be interesting to call your attention to the researches that Mr. George Ville is now pursuing. The eminent professor of the museum, Mr. Ville, hopes to be able to carry the beet's richness to 22 per cent, and the yield to 100,000 kg. to the hectare. This progress would constitute a true revolution. Should it come to be realized, France would gather on her 170,000 hectares seeded in beets a larger quantity of sugar than is now produced by all Europe; and the latter would furnish, in one year, enough to sustain the world's consumption during many years!

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CALIFORNIA STATE BOARD OF TRADE ON IRRIGATION.

The interest taken by the State Board of Trade in the approaching visit of the Senate Committee on Arid Lands to this State has been frequently mentioned in the *Rural*. A committee was appointed to prepare a comprehensive report on the condition and prospects of irrigation in California. This report has been prepared, and after revision by Mr. Estee and Gen. Chipman as a sub-committee, has been given to the printers. The following is a synopsis made from the manuscript of the report:

The questions presented are:

What is the physical condition of California, so far as it relates to irrigation?

What amount of irrigable land is there in the State?

What amount of water can be obtained for the purpose of irrigation?

What are the advantages of irrigation?

In this connection, does irrigation pay?

What is the condition of irrigation as at present practiced in California, and what interest has the National Government in the subject of irrigation on the Pacific Coast and in relation to all that extent of country known as the "arid region," which lies west of the Missouri River?

PHYSICAL CONDITION AND ADAPTIBILITY.

California lies between the thirty-second and forty-second degrees of north latitude; it has a coast line of over 900 miles, and in width is from 150 to 200 miles, and has an area of 157,-801 square miles. Two ranges of mountains extend north and south through the whole length of the State. The Coast Range, which lies just back of the ocean, parallels its shore line from one end of the State to the other. In some places this range of mountains rises in height to from 4,000 to 6,000 feet, and is cut up in every direction with small but fertile valleys, fed by canyons which carry living streams of water, flowing both inland and to the sea.

The other range is the Sierra Nevadas. Its sides are covered with timber and its summits with perpetual snows. Its average height is about 8,500 feet, while Mount Shasta, in the extreme northern end of the State, rises 14,400 feet above the level of the sea; Lassen Peak, 10,577 feet; Mount Whitney, 15,000 feet; and Mount San Bernardino, 11,600 feet. Along the Coast Range the rain is excessive in winter and heavy fogs prevail during the summer months.

In the Sierra Nevada Range there has fallen as much as eighty inches of water in a single season. The depth of snow in winter averages from eight to twenty feet.

Between these two mountain ranges is the valley of the Sacramento and the valley of the San Joaquin. They are in width from thirty to seventy-five miles, and their combined length is 450 miles. South of these lies another of surpassing beauty, which extends through the whole length of Los Angeles and San Bernardino counties, and in which irrigation has recently been largely and most successfully introduced.

TOPOGRAPHICAL ADVANTAGES

Will be noted when we observe that nearly every stream heading in the Sierra Nevada mountains comes from the snow belt and is supplied by the melting snows, which continue until July or August of each year.

The two great valleys before referred to are almost on a sea level. Sacramento, eighty-nine miles from San Francisco, has an altitude of thirty feet; Bakersfield, in Kern county, distant from San Francisco 314 miles, is 282 feet above sea level. Redding, 299 miles from San Francisco, has an altitude of 556 feet. In these plains is very little rolling land, and the advantage for irrigation is great. This condition extends from Mount Shasta to Tejon Pass, a distance of 500 miles. The two valleys of the Sacramento and the San Joaquin cover an area of about 12,000,000 acres of irrigable land. The drainage is effected through the Sacramento and San Joaquin rivers.

PECULIAR PRODUCTIONS

Is another reason why irrigation will soon be a great feature in our agriculture. For instance, there are planted in California 50,000 acres in orange and lemon trees; all these must be irrigated. Last year there were shipped east 1,850 carloads of oranges and lemons, and about 600 carloads were consumed at home. There are over 20,000 acres of olive trees. Last year there were produced in this State 3,400 cases of olive oil. There are 140,000 acres of land now planted in grapevines, and for the year 1888 there were produced 18,000,000 gallons of wine and 20,500,000 pounds of raisins and 1,000,000 pounds of dried grapes. There are about 1,000,000 prune trees, outside of the acreage planted during the winter of 1888-89.

In 1888 California produced 7,000,000 pounds of prunes, and there were imported into the United States for the same year over 70,000,000 pounds. In a very short time California will be able to supply the American market. There are 300,000 fig trees, and the figs are of the very best quality.

There are over 25,000 acres of land planted in almond trees, and this is yearly increasing. In 1888 California produced 180,000 pounds of almonds. The English walnut grows well in nearly all sections of the State. No mention is made of the peach, cherry, pear, apricot, nectarine, plum or apple. All these are grown in California in abundance. Add to these the strawberry, blackberry and raspberry, and we may observe the capabilities of this State for fruit culture.

FACILITIES WITHIN THE STATE

Is the most vital question we have to consider, because, however much irrigation may be needed in this State, if there is not an ample supply of water, it would be more than useless to attempt to carry on any extensive system of irrigation. Owing to the peculiar topographical situation of California, and the fact that for over 900 miles it borders on the Pacific ocean, the great ranges of mountains before referred to and their high altitude, there are a large number of living streams of water flowing from both these ranges of mountains into the valley below, and which make the water supply most abundant. Two of these streams are navigable rivers—the Sacramento for 200 miles and the San Joaquin for 100 miles. On the extreme southern boundary of the State is the Colorado.

STREAMS THAT MAY BE UTILIZED.

The principal rivers that flow into the Sacramento from the east are the Feather, Yuba, Bear, American and Cosumnes rivers; there are a large number of smaller streams which head in the snow belt of the Sierra Nevada Mountains, flow through the foothills across the Sacramento valley, and empty into that river. On the west side of the Sacramento valley no large rivers are tributaries, but there are a large number of creeks. Among the larger of these streams are Putah, Cache, Stony and Cottonwood creeks.

The San Joaquin valley is watered by a number of rivers. Among these are the Mokelumne, Calaveras, Stanislaus, Merced, Tuolumne, San Joaquin, Kaweah, Kings and Kern rivers. The combined water-shed of these rivers is 38,500 square miles.

The Mojave River can be successfully used for irrigation on the Mojave desert. The Mojave desert is a desert only in this sense: there is not rainfall enough to make grass and crops mature, but the soil is rich, the climate genial, and with water almost anything will grow with luxuriance. South of this is the Colorado River. It borders the Yuma desert. Wherever water has been applied on this desert the soil has proven productive. Much of this desert is below the level of the river, and some of it below sea level; and bringing water upon it would make this one of the most fertile places in the world. It is estimated that this river will successfully irrigate 1,000,000 acres of land.

THE RAINFALL.

The average annual rainfall at San Francisco is 23.5 inches. In the foothills of much of Northern and Central California the average rainfall exceeds thirty inches, increasing as you go north from the lower part of the San Joaquin valley, where it is about seven inches, until you reach the upper end of the Sacramento valley, where the annual rainfall is thirty-five inches. At San Diego it is 9.2 inches. In California fair crops can be raised from a rainfall of from ten to twelve inches, if it comes at the right time. The annual rainfall is not uniform one year with the other.

To illustrate: At Fort Redding, one year the rainfall was 37.4 inches, the next year it was 15.9 inches. At Sacramento the rainfall one year was 27.9 inches, while the next it was but twelve inches. At Fort Tejon one year it was 34.2 inches, the next year it was 9.8 inches. Clear Lake had one year a rainfall of 66.7, and next year only 16.2 inches. Visalia one year had 10.3 inches of rain, the next year but 6.7 inches.

In the coast counties north of Monterey there has never been a failure of crops. South of Monterey, for the years 1868, 1869, 1870 and 1871 there was a noticeable drought; stock-raisers were compelled to drive their stock to the mountains or drive it north. From Tulare to San Diego in 1871 the country was almost barren of verdure. Except in favored localities there was no grass for stock; thousands of sheep, horses and cattle were lost.

IRRIGABLE LANDS.

According to survey, the area of land in California which may be readily irrigated is about 7,650,000 acres. This does not include the so-called swamp and overflow lands. But should we include these and the low foothills, there would be about 12,000,000 acres of irrigable land in the State. We should now add 1,000,000 of acres to the above estimate, which would include Mojave and Yuma deserts, Sierra and Honey Lake valleys, making 13,000,000 acres of irrigable land in California.

The area of watershed outside of the lands to be irrigated is estimated at about three and a-half square miles to each square mile of land to be irrigated.

IS IRRIGATION ADVANTAGEOUS?

The advantage of irrigation is two-fold; first, the water is applied at a time when the ground is in such a condition that the grain or the fruit trees will get the full benefit of all that is run upon the land; and second, where irrigation is practiced there are no droughts.

In California, from about the middle of May until the last of October, we have no rains. During this period grain is harvested.

The use of water is often more valuable to fruit growing than for small grains. Fruit is more valuable, and the irrigation of orchards is more readily accomplished than the irrigation of the small grains. The practice is to run water in small ditches between the rows of trees about once a month, commencing in June and ending in September. Then after allowing the water to flow through these small ditches, put in the cultivator, stir up the ground anew so that the evaporation will not be rapid and the ground will not settle down and become hard.

RESULTS OF IRRIGATION.

Los Angeles and San Bernardino counties are conspicuous illustrations of what irrigation can accomplish. The population has more than quadrupled in a single decade; lands which sold ten years ago at from $5 to $25 per acre now sell at $100 to $1,000 per acre. In Placer county water has for some years been used for the irrigation of orchards and vineyards. Orchards of every variety of fruits and vineyards of every variety of grape, and nuts of all varieties, the fig and olive, all flourish in the foothills of Placer county.

The foothill country about Oroville, where water has been introduced, is no less conspicuous for its luxuriant tree growth. Within the last four years 1,500 acres of orange orchards have been planted, and these trees seem to be thriving well. Fresno, once a veritable desert, is now a garden of luxuriance and beauty. Within the past few years a town has been built, which has a population of over 10,000.

Ten years ago the lands of Fresno sold at from $3 to $20 per acre; now the same land with water on it, sells from $75 to $750 per acre, all due to irrigation. Kern county is another conspicuous landmark; more than 80,000 acres of land is being irrigated in that county.

Everywhere in California, during the summer months, garden vegetables are raised by irrigation. In the fall, winter and spring months, in most parts of the State, they require no irrigation, except such as they get from the natural rainfall.

So with strawberries; this fruit is universally irrigated. In Santa Clara county alone, it is claimed there are 1,500 acres of land cultivated in berries, all of which are irrigated; and that there are over 500 acres cultivated in garden vegetables, which are also irrigated. Even in northern counties like Napa, where the annual rainfall is almost three times as great as in some parts of Southern California, yet strawberries, other small berries and garden vegetables, during the summer months, are universally irrigated.

IRRIGATION IN NORTHERN CALIFORNIA

The Sacramento valley contains large areas of bench lands lying above the bottom lands of the river, in Shasta, Tehama, Butte, Colusa and other counties, all within reach of the water flowing down the Sacramento River and its tributaries. The creeks flowing from the Sierras are generally constant and unfailing, though diminishing in quantity through the summer.

Nature has built a reservoir in Lassen county, called Eagle Lake, covering an area of 35,000 acres, and in many places over 1,500 feet deep. A tunnel 7,000 feet long would tap the lake twelve feet below the surface, and by an additional open tunnel of like length the lake could be tapped twenty feet below the surface. It has a water-shed of 400,000 acres in the regions of our heaviest rains and snowfall. Its elevation is 5,115 feet.

Willow creek was probably once its outlet and through subterranean passages now receives its first escaping waters. This creek runs through Willow creek valley and into Honey Lake valley.

The Susan River has a water-shed separate from that of Eagle Lake and about as large. It flows into Honey Lake valley; very fine storage sites are to be found near the source of this stream.

The irrigable lands of Lassen county are not far from 500,000 acres, and east of these lands, in the State of Nevada, is an area of like extent. The lands are rich, sandy loam, productive with water, but comparatively useless without. Here there is a region of nearly or quite 1,000,000 acres of public lands capable of sustaining a large population.

A rough calculation shows that in Eagle Lake there is already stored enough water to irrigate 500,000 acres of land, and at the head of Susan River, comparatively cheap reservoir sites are available to store water sufficient for a half million acres more.

North of this region lies Madelin plains, a large area of good lands if irrigated.

In Modoc county like areas are lying idle and useless, yet capable of high cultivation and sustaining a large population.

OWENS VALLEY IN INYO COUNTY.

Inyo county is especially adapted to irrigation, particularly Owens valley. From Olancha to the head of Round valley, 100 miles, a strip of country from four to six miles in width is susceptible of irrigation. There are from 300,000 to 400,000 acres of land entirely worthless without the use of water. The Owens River carries, during the summer months, water enough to place at least a surface depth of fifteen inches upon an area of 300,000 acres of land, without preparing catchment reservoirs. Less than 12,000 acres of land are now cultivated in Owens valley.

LOS ANGELES AND ORANGE COUNTIES.

In Los Angeles and Orange counties the length of the ditches is hundreds of miles, irrigating many varieties of soil and crops. The area of actually irrigated land in the two counties is in the vicinity of 150,000 acres. The sources of the irrigating water supply of these counties are the rivers Los Angeles and San Gabriel in Los Angeles county, the lower part of the Santa Ana in Orange county, the upper part being in San Bernardino county.

THE FACILITIES FOR STORAGE.

The storage of water in the canyons may be effected by throwing dams at favorable places across the mouths of such canyons or basins as have the least wash and afford the largest capacity, and possibly of leading the water into them from adjacent streams.

Reservoirs on the bench lands may be constructed by excavating, and at much less expense than those in the canyons, and be of much safer character. There are a number of reservoirs of both kinds, of capacity varying from a few thousand to a billion gallons. One on Mormon creek is of more than the latter capacity.

The waters of the San Gabriel River would suffice to irrigate all the great valley below, coast plain beyond and the intervening range of hills to their very tops. The waters of Millard canyon and the Arroyo Seco could be made to flow over the San Rafael hills and those in and adjoining East Los Angeles. So with the San Dimas, the Santa Anita, Eaton, Tejunga, Pacoima, San Fernando, Mormon Creek, Verdugo and Santiago, whole flow in the aggregate is enough to supply all the lands between them and the ocean many times over; also the Mojave, where most of the land still belongs to the Government; Big and Little Rock creeks, Oak creek and some others, most of which show surface water only in the rainy season, if those waters are husbanded, as there are abundant facilities for doing; and in the Newhall region, the Santa Clara, the San Francisquito and the Castaic may be made to greatly increase the productiveness of the valley and the wealth of the county.

The number of acres of good land which require irrigation is, south of the mountains, 460,900. North of the Sierra Madre range, Los Angeles county shares with Kern and San Bernardino in the great Mojave desert. In these three counties, one-half of this is probably arid beyond redemption; one-half of the remainder is too rough and mountainous to be valuable for cultivation, but the remainder is mostly highly fertile soil, lying favorably for the application of water. Of this vast territory Los Angeles county possesses 250,000 acres which can be made to comfortably sustain a population of 100,000 people.

It is stated that the lowest summer flow of the Mojave River is about 5,000 inches. The average flow for six months in the year, the winter and spring months, is 20,000 to 30,000 inches; during May, June and July more than 10,000, and for the rest of the season more than 5,000 inches. Of this the Hesperia Land and Water Company has filed a claim of 5,000 inches. The Hesperia Company irrigates about 300 acres of land, and is flooding 15,000 acres for the purpose of preparing it for cultivation with the use of less water than it would otherwise require; the remainder, properly cared for, will redeem a half million acres of now absolute desert.

SITES FOR STORAGE RESERVOIRS ARE ABUNDANT.

The land is mostly Government land and the profits thereon would pay for enormous and elaborate works. Big and Little Rock creeks, which debouch upon the desert plain at higher elevation west of the Mojave River, are wholly within Los Angeles county. Their flow in winter is thousands of inches, and in summer is sufficient, as at present handled, to irrigate several hundred acres. Facilities for storage on these creeks are as abundant as on the Mojave. It is capable, under irrigation, of producing luxuriant and profitable crops. Artesian well-boring has proved successful in places, but the expense is great. We have an engineer's report with regard to Little Rock creek. He finds ample winter flow to furnish irrigation water, if stored, for 270,000 acres, allowing one inch to five acres. He allows for thirty inches of evaporation and finds sites and gives estimates for two reservoirs, the larger one having a capacity of 644,000,000 gallons, and to cost $135,000. There is reported from the same locality 800 acres to which water is applied; 200,000 acres irrigable, one-half of which belongs to the Government; fourteen miles of ditches. Value of irrigable land, $50 per acre; non-irrigable land, $1.15 per acre; the number of artesian wells in the region, seven, with an average depth of 340 feet and average flow of twelve inches. The counties of Los Angeles and Orange have an area of 4,812 square miles, or

3,079,680 acres. Their population is fully 150,000 souls, and there are nearly 90,000 acres of good land that requires no irrigation.

The land now irrigated is about 150,000 acres, and this is the basis of maintenance of 113,000 people.—*Rural Press.*

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DIFFUSION IN THE HAWAIIAN ISLANDS.

The sugar making season 1888–1889 now being over, the writer takes pleasure in laying before the readers of the PLANTERS' MONTHLY the results of the working of the new diffusion machinery in use by the Makee Sugar Company at Kealia, Kauai.

Before going into actual figures and facts deduced from work, it may be well to trace the development of the diffusion process from the crude methods in use before its introduction.

Almost everyone is aware that the fostering system of governmental aid adopted by the first Napoleon is what brought the sugar beet forward, a rival to sugarcane; and all who are interested in sugar know the position held by the cane as against the beet; the former is behind; beet sugar to-day controls the market in London, and the cane sugar business of the world, instead of being on a sound basis, is in a somewhat precarious position; instead of controlling the market, it is itself controlled, and that by a rival possessing no natural advantages, as the beet-root requires more machinery, more treatment, and more skilled labor to extract the maximum of sugar from it; it requires more care in its cultivation, and is a more exhaustive crop on the land on which it is grown, necessitating rotation with other crops.

The original machinery used to extract the sugar from cane is so well known that it is needless to refer to it here, except to remark that the powerful five-roller mills of to-day are but developments of the wooden mills of the Chinese, the principle of working remains the same; but in beet sugar factories the first machinery used were presses, which expressed the juice from the beets, which were first reduced to a pulp by suitable means; analysis showed that a large percentage of sugar was left after simple pressing, and it was found that by moistening the squeezed pulp, and re-squeezing, a further proportion of sugar was obtained; and thus was developed the maceration process of extracting sugar from beet root; centrifugal machines arranged to deliver juice from one to another were used, these machines were charged with beet pulp and water was driven through the pulp by means of the centrifugal force generated by the speed of the machines. These processes required more or less force to extract the sugar, and this caused the admixture of much impurity in the resulting juice. Maceration being partial diffusion it only required a knowledge of the laws of chemistry, backed by mechanical genius, for Julius Robert to invent the diffusion battery, which was so successful from the start, that it immediately supplanted maceration, that having already taken the place of the presses, and diffusion is today the means whereby the beet, with all its disadvantages, has hustled the sugarcane into a corner, and only allows it a second place in the markets of the world. The broad principle of diffusion in its application to both sugarcane and beet root is the same, and while to a casual observer, the machinery used in the process for cane appears similar to that used for beet, a close inspection will show that the methods of handling the fresh and exhausted chips, the slicing of the cane, the manipulation of the battery and the treatment of the juices, are distinctly different from those adopted in beet factories. Dialysis, or the principle of diffusion stated briefly, is the observed fact, that crystallizable substances in solution will pass through a vegetable membrane in the presence of water, while gummy, or non-crystallizable substances will not; and this fact being clearly understood, it explains the reason why the diffusion of megass resulting from the crushing of cane, has never been more than a partial success, if a success at all, because the whole of the cells containing the saccharine matter are ruptured and in consequence the contents, crystallizable and otherwise, are taken into the juices just as in the maceration process for beet root.

The machinery in use at Kealia was built by the Actien-Maschinen-Fabrik of Sangerhausen, Germany, a firm justly celebrated for the excellence of their beet root machinery. Space will not permit of a detailed description of the machinery in use at Kealia, and to relate the numerous difficulties that were encountered when the machinery was first started would be useless for the purposes of this article.

The crop was commenced os December 31st, 1888, and was continued with but few intermissions until the end of July, 1889, during which time 5,537 tons of sugar were made. Four analyses per day of cane, juice, exhausted chips and sugar were made by a competent chemist employed for the purpose by the plantation, and as the average weight of a diffusion cell full of chips is known, it follows that a close check is kept upon all waste, and as a matter of fact the whole of the sugar present in the cane can be accounted for to within a small percentage.

In March last a method of clarifying the juices in the battery was found, and from that time the use of clarifiers, subsiders, cleaning-pans, filter-presses was abandoned, the juices being drawn directly from the battery into the quadruple effect, and there concentrated to a syrup standing 30 Beaume.

By this method of working it becomes possible to do the extraction, clarification, filtration and concentration without the juices under treatment coming in contact with the air for one moment, and there exists, as far as our present knowledge extends, no other method by which this very desirable way of treating juice can be attained.

REPORT OF MILL WORK 1888-89, KEALIA MILL.

Sucrose in cane, highest	16.72	per cent.
" " lowest	14.99	"
" " average	16.02	"
Glucose in cane, highest	1.179	"
" " lowest	0.52	"
" " average	0.69	"
Average fibre by test	10.00	"
Average Brix, cane juice	20.12	"
" " diffusion juice	15.58	"
" sucrose cane juice	17.80	"
" " diffusion juice	13.48	"
" quotient cane juice	88.46	"
" " diffusion juice	86.52	"
Cane worked up in pounds	77,628,950	
Total sucrose in cane worked up in pounds	12,436,158	
Lost in exhausted chips 0.72 per cent on cane in pounds	558,928	
Total sucrose taken into house in juice in pounds	11,877,230	

Sugar obtained	A 7,849,545 lbs.	at 97.7 per cent pol.	7,669,006	sucrose.
Taken from acct	B 1,713,873 lbs.	at 91.0 per cent pol.	1,559,624	"
Sales	C 1,511,286 lbs.	at 89.0 per cent pol.	1,345,045	"

Commercial sugar..11,074,704 lbs. Pure sugar.....10,573,675 lbs.
" " .. 5,537 tons.

Returns per 100 of sucrose in cane worked up	85.02 lbs.
Returns per 100 of sucrose in juice evaporated	89.03 lbs.
Loss in manufacture including sugar obtainable in molasses from third drying per 100 of sucrose	10.97 lbs.

Sucrose in the foregoing calculations is to be understood as meaning chemically pure sugar, and glucose is the non-crystalizable sugar in the cane when cut.

It will be noticed that Dr. Wiley's method of deducting one and one-half times the glucose in the cane from the total sucrose, and calling the remainder "available sugar," has not been followed in the foregoing calculations, the reason being that this method of working out results is not susceptible of satisfactory proof, and it seems to the writer that returns based upon the total sucrose in the cane, neglecting the nullifying effect of glucose, [although these returns will not appear so well upon paper] is the only basis upon which to make comparisons of results by different processes. The bald statement of so many pounds of sugar per ton of cane, is of no interest or value to anyone, if unaccompanied by the content of sucrose in the cane, as the cane will vary greatly in this respect, in different islands, different districts, and even on the same plantation, as is shown by the figures above.

Following is the analysis of the waste molasses from C sugar, the average quantity of molasses per ton of sugar made is 27⅓ gallons (imperial), which is excessive, and will be largely reduced in the coming season,

Water	20.80 per cent	Sp. gr.	1.4
		Composition of the Ash.	
Sucrose	42.40 "		
Glucose	12.50 "	Carb. of Lime	1.14 per cent
Org. non-sugar	13.35 "	Alkaline salts	9.01 "
Ash	10.95 "	Undefined	80 "
	100.00		10.95

Total amount of molasses made ....2,131,738 lbs.
" " glucose therein .... 266,467 "
" " " contained in cane .... 535,639 "

One-half of glucose in cane left in exhausted chips.

SPECIMEN WEEKS' WORK—LABORATORY REPORT FOR WEEK ENDING MAY 11TH, 1889.

Cane juice, Brix	21.08 per cent
" " Sucrose	18.84 "
" " Quotient	89.4 "
Diffusion juice, Brix	15.40 "
" " Sucrose	13.66 "
" " Quotient	88.7 "
Cane worked up	3,412,305 lbs.
Masse cuite	666,418 lbs.
" " Per cent sucrose 80.7	537,799 lbs.

A sugar 349,659 lbs. 97.25 per cent pol. 52.5 per cent from masse cuite.
B " 133,017 " 88.7 " "
C " 41,510 " 87.6 " "
A " 174.82 tons.........66.7 per cent.
B " 66:5 " ....25.3 "
C " 20.75 " .... 8.0 "

Total sugar obtained per ton of 2,000 *lbs. of cane*=307.2 *lbs.*

To manufacture this sugar during the past crop, the exhausted chips, having been passed through the mills, were burnt with the addition of 1,564 tons of coal, wood of the value of 107 tons of coal, and oil of the value of 125 tons of coal, making the total fuel consumption, reduced to tons of coal, 1,796 : or .324 ton coal per ton of sugar made ; and it must be borne in mind that the two double effects were not connected into the present quadruple effect for at least two months after the crop had been started upon ; that the clarifiers, cleaners and filter-presses, [all of them steam users], were in use for some time, and worst of all, the boilers gave out, and for four months some of the boilers had to be forced while the disabled boilers were being repaired. These facts coupled with the experiments that were being carried out at the commencement of the crop, account for the excessive use of fuel ; as the quantity used per ton of sugar made during the last two months of the run did not exceed a half of the average amount used.

A well known gentleman, who went abroad for the purpose of getting information concerning diffusion from "reliable sources," made a statement which appeared in the public prints of Honolulu, that "the great drawback to diffusion appeared to be the inversion that takes place in the cells." This calls for an answer. *Inversion does not occur in the cells of a diffusion battery properly run.* The analyses of the molasses from third sugar given, show that only about one-half of the glucose contained in the cane is present in the waste molasses. thus making good the point always maintained by the writer, that the process of diffusion, while getting nearly the whole of the sucrose contained in cane, abstracts the glucose from the ruptured cells only, and this feature shows itself very plainly when by any chance a lot of poor cane is sent to the mill.

In conclusion the writer has only to say that the foregoing figures and results are fairly good, it is known and appreciated by the management of Kealia Mill that better work can be done, and there is no doubt but that the energy and ability displayed in the past to bring the mill to its present standing, will be continued, and in the future, instead of having to confess to a loss (in manufacture) of nearly 11 per cent, it is quite possible that a return of sucrose in bags to the value of 95 per cent of the sucrose in the cane may be attained.

J. N. S. Williams.

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FROM SACCHARINE TO SUCROSE.

From prehistoric ages man has probably been more or less familiar with the process of squeezing saccharine juices from plants, first fermenting them, then learning how to convert them into crude syrup and caramel, and lastly into the two products, sugar and molasses. As a drug it was used to cure the ills that flesh is heir to ; then it became a luxury, used only by the rich in limited quantity, and now, in many civilized countries, it has become a household necessity and also used in manufacture and the arts.

Until the latter part of the last century the tropical cane supplied the commercial demand for sugar, but since then the marketable product from beets has assumed gigantic proportions. Asia is the supposed home of the sugar producing cane, yet it is found growing wild on the isles of the Pacific. The plant from which the sugar beet has been developed has its home on the European shores of the Mediterranean.

Pursuant to the law of supply and demand, not only has volume of production kept pace with requirements, but the quality has of late years vastly improved, until the climax was reached in the exhibition of electric sugar by the fraudulent Friends. Whatever the process the crystals are beautiful. The progressive steps from the production of the almost tar-like mass to the white sugars of 99 7-10 test directly from the cane juice has taxed the ingenuity of man for centuries. Even to-day the refiner will scarce believe that such an article can be produced without bag filters and bone-black.

Concentrating vessels, defecating agents, and a means of thoroughly removing the scum during the early stages of manufacture are necessary to produce clean syrup, from which alone sugars of fine quality can be had with bright colored molasses. In many parts of the world can be seen the primitive pots or kettles in which the crudest sugars known to the trade are produced; then again, the magnificent usines of Europe, furnished with the costly and elaborate machinery necessary to scientifically fabricate sugar from beets. It is rapidly becoming an admitted fact, that to produce maximum results in quantity and quality, cane juice should be converted into sugar as rapidly as possible after the canes are cut in the field. Inversion, at one time almost unthought of, has now become a dreaded enemy in the manufacture of sugar; the possibility of its taking place must be eliminated as far as possible in the process. Although the difficulties of fabrication are less with tropical cane than with sorghum or beets, yet negligence is attended with poor results, both as to yield and price.

Defecating agents of various kinds have been tested in the sugar-house and laboratory, but so far lime seems to be the most efficacious. There is no prescribed rule for its use, circumstances alone must guide; as for instance, in the tropics, where they manufacture for this country, high liming is resorted to, to evade duty. A large grained sugar of 96 test will range from ten to twelve Dutch standard. Powder such in a mortar and you will have a sugar of about twenty Dutch standard, due to the coloring matter adhering to the outer surface of the crystals alone, the interior being pure sugar. When there is deficiency in lime there is defective clarification, which results in soft gray sugars.

The use of sulphurous acid, owing to its bleaching properties, has gained a strong foothold in Louisiana, and perhaps for another reason little thought of by many who apply the fumes to the juice as it comes from the mill, and that is, it arrests fermentation in the house, teeming with bacteria and has the odor of a vinegar factory, owing to the *wasted* juice and fine particles of bagasse which accumulate sometimes for days between the mill walls. The loss from fermentation in many places is simply immense, and it should be remembered that cleanliness is next to godliness in a sugar-house.

Should the acid be used, and, if so, should the saccharine solution be thoroughly impregnated with it and the juice limed to neutrality thereafter, or partially limed as it leaves the mill, are questions to be solved by actual experiments. Science must decide as to whether the juice should be slightly alkaline or acid, as good sugar can be made under either condition. Can we dispense with the vegetable albumen of the canes and produce bright crystals of sugar, devoid of grayness, or even brilliant yellows? Mr. Paul Horsin Deon, whose views are certainly worthy of great consideration, tenaciously advocates the retention and utilization of the albumen of the cane in the perfect defecation of juice. The object of defecating ingredients is to aid in the elimination of all injurious particles, as the presence of foreign substances seriously retard crystallization and renders the process absolutely impossible to a marked degree. Therefore, how imperative to have thoroughly defecated and cleaned juice prior to rapid concentration in double and triple effects.

As soon after diffusion or milling as circumstances will permit, the juice should be heated to 210 deg. or 212 deg. F., and the capot or blanket removed, after which the remaining impurities should be skimmed off as the process of concentration progresses, whether in vacuo or open vessel. The superior quality of the Louisiana molasses is due to the lower density of the juice than in more tropical climates, and, therefore, a longer time allowed to remove the same which arises on the boiling mass. As it often resembles honey and is produced without settling tanks, why cannot such be dispensed with when vaccum pan sugars are made?

Let us not combat, but utilize nature's laws, as does the intelligent housewife when cleaning and concentrating syrup. Observation has taught her that the scum, as it rises in the slow boiling pot or kettle, recedes from the hottest to the least heated portion of the vessel (there to be removed), and the operation continues until the liquor becomes clear or too thick to allow any more scum to arise. Where a fine quality of syrup 's desired, then the albumen of the white of an egg is incorporated with the cold solution which, in coagulating, seizes the impurities, which can be removed in the form of scum.

Take a rank of kettles when in full operation, charge each from batteries to grande, until the scum begins to flow, and it will be found, if kept in that condition, no skimming will be required, as the entire scum will be boiled off to the grande. Why? Because the heat, being greatest at the bottom, in the act of boiling, the foreign particles caught and held by the albumen are forced to a cooler medium.

Twenty years ago I was informed by a visitor from Java that they used an evaporating apparatus somewhat similar to the half of a six-foot boiler, about forty feet long, under which a furnace was placed at one end (situated like that under the batteries) where the fire was applied. As boiling progressed the scum gradually moved from the syrup over the furnace to the other extremity, where the heat was less and the liquor more diluted, and where it was removed by one operation. A somewhat similar vessel can be constructed where steam can be used as the clearing and concentrating medium instead of the direct fire, either in long three or four-inch copper pipes or a steam jacket (copper above), placed along the bottom nearly the entire length. If necessary, small steam jets can be inserted at irregular intervals in the lower side of the jacket, sloping backwards.

Instead of the steam escaping, as with the open kettles and the Java apparatus, the entire vessel can be converted into a species of vacuum pan, and the vapor utilized to heat the cold juice or water. The skimming can be performed thoroughly in vacuo (the scum falling into a receptacle at the far end), the partially cleaned juice entering at the one end, and the cleaned liquor, which has been concentrated to any desired density at the other, in a continuous stream on its way direct to the double or triple effect.

The present rectangular clarifiers can be cleaned without skimmers by placing a steam pipe along the side *opposite* the trough. Boil slowly with heat from bottom coil, then turn on the steam in horizontal pipe immersed in the liquor, and the scum will be forced off in a diagonal direction. When boiling becomes too rapid the possibility of skimming ceases.

The refiner has recourse to bag filters, because the fuel economy demands that he melt to about thirty degree Beaume.

Whereas, with the Louisiana planter ten degrees Beaume is rarely met in cold juice as it comes from the mill; therefore he has ample time to thoroughly clean prior to marked concentration, a fact of which every advantage should be taken. So long as a sugar solution remains weak the effect even of the direct fire under the vessel is not injurious, does not invert, does not color. It is only when the great volume of water has been evaporated that the syrup must be boiled at a low temperature and converted as rapidly as possible to masse cuite; therefore apply the greatest heat when the liquor is of comparatively low density. Regardless of form of vessel or method of concentration the process of cleaning the juice should be prolonged until well done. From the mill to the mixer the concentration should be as nearly continuous as circumstances will permit.

It is very doubtful if the use of bone-black will ever become general on plantations, as it is attended with much difficulty and expense. Effectively remove coloring matter and other impurities from the juice when at a low density and its necessity will be almost entirely removed if the syrup is cooked rapidly and with less than ten pounds pressure on the coils. Boil somewhat free in the pan and make only medium grain, as planters do not get paid for the extra polarization in the large-grained sugars. Should the material for second sugars have become slightly acid, neutralize with lime water. Dilute in the blow-up with *hot* water, grain in the pan, and do not keep the mass stiff when boiling, and wagon as when boiled in the ordinary way. By the above method from five to six pounds of sugar per gallon of Cuban molasses is had in some northern houses. Thereby the necessity of boiling thirds is in a great measure obviated. Even in the best equipped sugar-houses strict attention to every detail from scales to shipment is required to arrive at a high point of excellence in quantity and quality of products manufactured. From information and observation it can safely be stated that a high grade and as fine quality of sugar can be made from the juice of the cane in Louisiana as in any part of the world. The aim should be to obtain in fabrication the greatest money value for *products* from a ton of cane.—T. Mann Cage in *Louisiana Planter*.

Terrebonne, June 1st, 1889.

THE CAUSE OF DROUGHTS

In a clever little *brochure* lately given to the world by Mr. Velschow, of Copenhagen, the author, in treating of *The Natural Law of Relation between Rainfall and Vegetable Life*, aims high, for, in his short concise treatise, he endeavors "to set forth a theory of the formation of deserts, notably those in Australia. and to give an explanation of the real cause of deserts and droughts; thereby indicating how far it may become possible to work against, and in many instances eventually overcome, the evil of drought." If his theory and remedy are correct, South Africa, which is a land of droughts, as well as Australia. ought to profit by Mr. Velschow's observations.

But he is not by any means the first writer who has propounded the "general principle" "that absence of vegetable life is the real cause of absence of rain," though he seems to think that in so saying he will "hardly find many followers." Indeed, one might almost say the idea is as old as the hills. One very ancient writer, Cretias (about 600 B.C.), speaks of the "sickness of a country in consequence of deforestation;" and more than three hundred years ago, Fernando Colon declared that "the rains in Madeira and the Canaries had become rarer since the trees had been cut down." Humboldt and many others have given forth their notes of warning—alas! too often unheeded—with the consequence that, on account of the destruction of timber, vast countries are subject to drought.

This has not always been the work of the European settler only. In Southern Africa, we know that the natives have a regular season for setting fire to the long rank grass which grows in Kaffraria and in different parts of the various colonies and states, thereby frequently injuring large tracts of forest land; and this custom was kept up by the early Dutch Boers; also that of chopping down all the mimosas, the thorny branches which they use to make their sheep and cattle kraals. Dr. J. Crombie Brown, when Government botanist at the Cape of Good Hope, sudied the subject deeply, and in his work upon the *Hydrology of South Africa*, says, speaking of bush-fires: "In this way does the destruction of forests by fire tend to promote the desiccation of a country so far by combustion, and further by exposure of the humus to decomposition by the sun's rays destroying one of the constituents of the soil which exercises great retentive power on its moisture." And again, in his book on *Forests and Moisture, or Effects of Forests on Humidity of Climate*, he says: "There are cases in which an extensive destruction of forest has been followed by a marked desiccation of soil and aridity of climate, and some cases in which the replanting of trees has been followed by a more or less complete restoration of humidity; or the planting of trees where there were none has been followed by a degree of humidity greatly in excess of what had previously been observed."

But South African writers upon this subject are too many to be enumerated. In a little book, written several years ago, *The Farm in the Karoo*, the chapter upon Karoo Deserts takes up the subject, also quoting a paper that Mr. C. Brown had read before the British Association at Clifton. Mr. Velschow's chapters on what he calls the "air-cushion" are very interesting, and give a reason for that most distressing phenomenon we so often used to observe in Southern Africa in times of drought, namely, the coming up of clouds evidently well charged with moisture, and their gradual dispersion without apparently bursting or leaving a single drop of rain.

We have lived in the Karoo during a severe drought, when not only every blade of grass had long disappeared, and every leaf and twig of the Karoo bushes had followed, but the very stems and stalks of the plants were barked by the hungry, starving sheep and goats; and well do we remember our all rushing out of the house in answer to the cry, "There is a small cloud coming up from the sea." How we watched that cloud! It came on steadily till it was nearly over our heads. Surely it would descend in a copious shower, for its aerial voyage was at an end, and it seemed stationary. Alas, although the cloud did not move on farther, all the same it was soon gone, and not a drop of rain had fallen on any portion of that thirsty land. It only rained *in* the clouds, and went towards helping to saturate what Mr. Velschow calls the "air-cushion." He says: "The sky over the inner plains of Australia is generally for weeks covered with clouds before rain ultimately sets in after a drought; and during this time, the clouds are constantly engaged in discharging moisture, until the air-cushion at last becomes saturated. Then the clouds no longer discharge moisture into the air, but on the earth's surface itself." Thus showing that if the clear transparent air just above the earth were moistened by the evaporation from vegetation or forest trees, the rain-clouds would pass through the air-cushion by amalgamating with the moisture already therein.

This is the reason of our having such great floods of rain after a drought in South Africa, when rivers are frequently rendered impassable for several days at a time. The water is there, although we do not see it; and when at last the air-cushion is broken into by some powerful electric disturbance, it falls to the earth in torrents so abundant that rivers rise to a height of forty and even seventy feet above their usual level; the greater part of the water rushing away at once to the sea, a comparatively small quantity being saved by dams and reservoirs.

The application of the theory in a practical form is, that when the land becomes cultivated and clothed with cornfields, vineyards, hop-grounds and orchards, as well as having the forest lands continually renewed, the rain-clouds, attracted by the evaporation which will inevitably ascend from all such growth will be constantly distilling as rains the moisture taken up from the ocean, thus preventing the great air-cushion from ever becoming so dry and waterless that in satisfying its own great thirst, the dire disaster of drought is felt all through the land.—*Chambers's Journal, June, 1889.*

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THE PEANUT—HOW IT IS CULTIVATED, GATHERED AND USED.

In Virginia, the first twenty days in May is regarded as, in the main, the most suitable time for planting. Some plant as early as the last week in April, and the seasons frequently favor this early start and the crop does well. More, however, plant in June than in April, and sometimes planting is delayed until the middle or last of June. On warm and dry land there is no great risk in planting the first week in May, but on colder land the planter should wait until the ground has been warmed by the sun, say the latter part of the month.

The above dates apply to the latitude of Virginia. In the far south peanut planting begins early in April, while north of Virginia the first half of June would, in most seasons, be quite early enough to commit the seed to the earth. It should not be done anywhere until all danger from frost is passed for the season. A very slight frost will destroy the peanut.

If the ground has been once plowed in the early spring, let it be plowed again only a few days before planting time, and if at all rough or cloddy, have it harrowed until in fine tilth. When ready to plant, draw furrows the same as for corn, two and a-half or three feet apart. If the land is fresh and strong and never before in peanuts, make the rows at least three feet apart. A small ridge is then formed by lapping two furrows over the drill with the turn plow, after which the knocker and dotter follow, one leveling the ridge and the other dotting the row by making little depressions in the soil the proper distance apart for the seeds.

The knocker and dotter are combined in one, and it is withal a unique implement. Always home-made, it partakes of all the native roughness and varied ingenuity of the Southern planter. The two pieces of timber are sawed from a log to serve as wheels, such wood is selected as does not split easy. The diameter of the wheel is made the desired distance between the hills, and three wooden pins are inserted equi-distant in the circumference, so thas the wheels will make three dots or signs, for planting, at each revolution. These wheels are connected by an axle, and the same distance apart the rows are to be asunder. Two shafts are pinned to the axle and braced in front of the wheels, to keep them steady. A piece of heavy scantling, or a log of wood six inches in diameter, is secured to the under side of the shafts just in front of the wheels. This is the knocker, and serves to level the ridge before the wheels. Properly adjusted it does beautiful work and leaves a flat, smooth ridge, in fine condition for seed.

Hands—women, children or men—follow the dotter, dropping a seed in each mark or depression and carefully covering it with the foot by pressing enough soil into the hole to just fill it. The holes are made one and a-half to two inches deep, and the hands are cautioned not to get the seed covered deeper than that. One inch is deep enough to plant, if the soil is moist, but if quite dry the seed may be put deeper. Proceeding in this way, covering first with one foot and then with the other, the planters get on quite rapidly, although the hills are so near together. The planting is not at all tedious after one gets the knack of it, and is light and pleasant work.

In about two weeks from planting, if the weather has been mild, the young plants should be large enough to show where re-planting is necessary. The planter goes along the row, making slight depressions with his heel at all the missing hills, drops a pea therein and covers it with the foot, the same way as at the first.