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This number is devoted entirely to the proceedings of the annual meeting of the Hawaiian Sugar Planters' Association, held in Honolulu, November 23 and 24, 1903.

The meeting was well attended and the reports presented were of much interest, and with the exception of the report of the committee on machinery, are printed in full.

ANNUAL MEETING OF HAWAIIAN SUGAR PLANTERS' ASSOCIATION.

The meeting was called to order by President H. A. Isenberg on Monday, November 23, 1903, at 10 a. m., in the assembly room over the offices of Castle & Cooke, Ltd.

The roll call of members showed the following present, among others: Andrew Adams, H. A. Baldwin, W. A. Bowen, B. D. Baldwin, J. T. Crawley, H. Deacon, T. C. Davies, B. F. Dillingham, C. F. Eckart, D. Forbes W. W. Goodale, W. M. Giffard, Geo. Gibb, Jas. Gibb, R. Hall, C. Hedemann, J. F. C. Hagens, H. A. Isenberg, C. C. Kennedy, T. S. Kay, D. C. Lindsay, A. Lidgate, J. A. Low, F. B. McStocker, W. Pullar, Geo. H. Robertson, Jas. Renton, Geo. Ross, J. T. Moir, F. M. Swanzy, J. A. Scott, F. A. Schaefer, W. O. Smith, E. D. Tenney, L. A. Thurston, F. Weber, W. G. Walker, J. N. S. Williams, G. M. Rolph.

President Isenberg's address, reviewing the work of the past year, was followed by the secretary's report, after which came the election of trustees for the ensuing year.

The members of retiring Board of Trustees, who were H. A. Isenberg, F. A. Schaefer, H. P. Baldwin, F. M. Swanzy, E. D. Tenney, G. H. Robertson, B. F. Dillingham, W. G. Irwin and W. O. Smith were re-elected, and at the noon recess chose as their officers: E. D. Tenney, President; F. M. Swanzy, Vice-President; W. O. Smith, Secretary and Treasurer, and G. H. Robertson, Auditor.

After the adjournment taken to permit the members to attend the inauguration of Governor Carter, the meeting set-

tled down to the presentation and reading of reports of committees.

The report of the Committee on Cultivation, which committee was composed of the following gentlemen: G. F. Renton, D. Forbes, B. D. Baldwin, H. Deacon, L. Barkhausen and H. P. Faye, was read and presented by Mr. Renton, the chairman of the committee; appended to the report is a letter from Mr. John A. Horner, relative to the advantages of the "disc" plow.

Mr. Renton devoted considerable space to a discussion of the application of the "disc" principle, and suggested that it might be carried out in the steam plowing implements.

The subjects of planting, stripping, ratooning and hilling up, together with the implements used and varieties of cane are discussed. The committee considers that the Lahaina cane for irrigated plantations has maintained its superiority. But on rainfall plantations that Yellow Caledonia is displacing Rose Bamboo. Mr. Eckart, Director of the Experiment Station, is quoted as saying that Demerara No. 117 is, in his opinion, the most promising variety for irrigated plantations.

Next in order came the report of the Committee on Fertilization, consisting of C. F. Eckart, C. B. Wells, C. M. McLennan, F. Meyer, J. T. Crawley and J. F. C. Hagens. The report of the committee, to which is appended letters of Messrs. Crawley and Hagens, was read by Mr. Eckart.

Although little or no comment was made at the meeting upon this report, we venture to prophesy that it will receive most careful attention and study by all thinking plantation men. Mr. Eckart showed quite clearly that the results obtained by the use of large amounts of fertilizers, beyond a certain point, do not justify the cost of the fertilizer.

The report of the Commitee on Handling and Transportation of Cane was presented by Mr. Kennedy. The members of the committee were: C. C. Kennedy, chairman; A. Horner, F. B. McStocker, John Sherman, H. A. Baldwin and F. Weber.

After the reading of this report there was considerable discussion of the different machines in use for loading cane. With the exception of the machines constructed and used by Mr. Kennedy at Waiakea, and the Wilson machine at Waialua, nothing has been introduced which has given satisfaction. Mr. Renton spoke of the Gregg machine at Ewa, and said that the cost of loading by this machine is higher than by hand and the machine had been abandoned. It was the opinion of Mr. Renton, Mr. McStocker and others, that the question of obtaining a satisfactory machine for this purpose is one of time only.

Mr. Low thought the Association should interest inventors and men of mechanical genius in our labor-saving machinery

problems, and should endeavor to obtain machines which would, by doing away with some of the labor employed in the harvesting of the crop, materially lessen the cost thereof.

Mr. Goodale explained the working of the Wilson machine, used with a measure of success at Waialua, and we hope to be able to publish soon a description of this machine.

Mr. Stodart, chairman of the Machinery Committee, had prepared a voluminous report, which, however, because of lack of time, was not read in full.

Later on in the meeting it was decided that in the future all reports of committees for annual meetings are to be printed and distributed to members before the meeting so as to allow the members to read and digest the reports and to encourage a discussion of salient points brought out.

The Committee on the Utilization of By-Products presented a very elaborate and interesting report. The members of the committee were: W. W. Goodale, chairman; James Gibb, James Renton, W. G. Walker, Andrew Adams and G. H. Fairchild.

There was no report from the Committee on Diseases of Sugar Cane, but Mr. Thurston gave an interesting talk on what had been accomplished by the entomology department of the Bureau of Agriculture and Forestry in the matter of finding enemies of the leaf-hopper.

Mr. Thurston said in part: When the ravages of the leaf-hopper became so serious and the matter of finding a parasite of the hopper was first brought up, it was the intention of the Trustees of the Association and the Bureau of Agriculture and Forestry to send Prof. Koebele to Australia to see if he could locate the hoppers' natural enemy. All arrangements to this end were made, when Koebele's health forced him to go to the States; he was very ill there, but the intention was that when he became able he should go to Australia, probably in July. In the meantime, two assistant entomologists were engaged to come here, one to go with Koebele and one to assist Prof. Perkins in Honolulu.

Before Koebele came back he got into communication with a scientist in the East about leaf-hoppers, and it seemed there was, or might be, in Ohio an enemy of our leaf-hopper. Kobele believed it would be well to investigate the matter, and went on to Ohio and found more than he expected in the way of information, and a number of parasites. He commenced collecting, and, for the past three months, has been sending parasites which breed on the leaf-hopper there.

Mr. Terrey, one of the assistant entomologists, has been devoting a great deal of time in receiving and propagating the insects in cages. Up to the present time, however, he has not succeeded in propagating young insects. The insects took greedily to the leaf-hopper, but the eggs which are laid in the leaf-hopper, are not fertile. There has been good,

earnest work at both ends, but we have so far had no tangible results.

Koebele is on his way back now, and unless there is some change in plans will go to Australia at the proper time.

Mr. Adams and others discussed the various enemies of leaf-hopper which had appeared at Kahuku, Kealia and other places, and the methods adopted toward exterminating the hopper.

Mr. McStocker said that the honey dew, or excrement, was very acid, and that the soil beneath the cane was very sour, and that in order to produce a vigorous and healthy growth he had limed the soil, believing it to be advantageous.

The Committee on Forestry—L. A. Thurston, chairman, H. A. Baldwin, G. N. Wilcox, T. S. Kay and G. S. Chalmers,—by Mr. Thurston, presented a very interesting report.

From the list of names of those appointed as forestry agents throughout the Islands, it seems as though a great deal should be accomplished in forestry work. The Governor has certainly made wise selections, and the interest which has been manifested augurs well for the future.

The report of the Committee on Experiment Station,—E M. Swanzy, chairman; F. A. Schaefer, H. A. Isenberg, G. H. Robertson, J. P. Cooke,—was presented by Mr. Swanzy, chairman.

The report deals with the work done at the laboratories and station during the past year. The work at the Station is steadily increasing, and the force of assistants to Mr. Eckart has been enlarged in order to meet the demands for soil and fertilizer analyses, and it was also found necessary to erect a new laboratory building.

At the conclusion of the reading of reports, it was voted that in the future reports of committees be placed in the hands of the Secretary, at least a month before the annual meeting, and that the reports be printed and distributed to the members before the meeting.

Mr. Low wanted a committee appointed to examine into machines for cutting and loading cane, and to recommend appropriations for the purpose of encouraging the invention of such machines. It was decided that a committee on labor saving devices be appointed.

Mr. Eckart stated that the provisional method for sugar house control, adopted by the Chemists' Association last year, was in some respects faulty, and at a recent meeting other methods were brought up to be used during the year, and it is believed that these methods will be a great improvement upon the previous method. The Association does not care to stamp any method as official until it has been found satisfactory in every respect.

There was further discussion upon general subjects, and after a vote of thanks to the officers and Trustees the meeting adjourned.

PRESIDENT'S ADDRESS.

Gentlemen:—It is with much pleasure that I welcome you to the Twenty-third Annual Meeting of our Association.

In looking back upon our past business year we cannot say that the same has been one of extraordinary prosperity, although a marked improvement took place in the price of sugar, as compared with the previous year. Our anticipations in connection with the adoption, by most of the sugar-growing countries of Europe, of the Brussels Convention did not fully materialize; the change thereby created in Europe had no effect on the American market, but proved the latter to be absolutely independent of the former.

It is astonishing how very quickly the Cuban crop recuperated from the set-back caused by the insurrection and war, and the estimates for the coming crop are reported to be far in excess of any crop ever harvested in Cuba. Notwithstanding these facts, the United States Government proposes to grant a tariff concession of 20 per cent. on Cuban sugars, and there seems to be very little doubt of the United States Congress passing the proposed bill. It remains to be seen what effect this action will eventually have on the price of our sugar, the same being sold on the Cuban basis.

Your trustees have held forty-nine meetings, the labor question again being the foremost subject of discussion. Although there has been somewhat of an improvement in the labor conditions of the islands during the past year, there are still times when the supply is inadequate and the subject of obtaining a sufficient number of suitable field laborers remains one of constant anxiety. Among those who have sought for work as field laborers there have been a small number of Koreans, who, so far, have given satisfaction. Two meetings of your trustees, with delegates from the four Islands, have been held for the purpose of discussing all matters surrounding the labor question. These meetings have been quite useful and I would recommend a continuation of the same. Our islands have been favored with a visit from Mr. F. P. Sargent, Commissioner General of Immigration, who made a personal study of our labor conditions and immigration matters. This gentleman expressed himself as highly pleased with the conditions he found upon the plantations, and I record with particular interest his statement in the presence of all of your trustees—that he had fully convinced himself of the fact that the work in the Hawaiian cane fields is not adapted to white people, and that our sugar industry could not get along without Asiatic labor.

The crops of many plantations have been seriously damaged during the past year by the new insect pest, called the leaf-hopper; however, there is reason to believe that this danger will be entirely removed after enemies have been dis-

tributed and increased in sufficient numbers to check the propagation of the leaf-hopper. Reports received from various districts indicate the coming crop to be in splendid condition, and it is to be hoped that the weather will continue to be favorable so as to somewhat offset the many hardships we have to contend with.

An understanding has been reached with the new Department of Agriculture and Forestry, for the joint employment of two additional entomologists, and I would recommend that the planters freely avail themselves of the services of these gentlemen, whenever needed. Professor Koebele, to our regret, returned in very poor health from his successful trip to Mexico in search of lantana destroyers, and it was absolutely necessary for him to take a much-needed vacation. He is, however, at the present time engaged in the search for enemies of the various insect pests, particularly the leaf-hopper.

Mr. Wm. Haywood, the Washington representative of this Association, whose services proved to be quite satisfactory, has been re-engaged for another year.

Mr. H. M. Whitney, for many years editor of "The Planters' Monthly," has retired from active business. Your trustees filled the vacancy by the appointment of Mr. Royal D. Mead, our assistant secretary, who, in the short time of his editorial work, has shown himself to be competent in every respect.

It is with deep regret that I have to record the death of Mr. James B. Atherton, one of your trustees, who, at the time of his death, held the office of vice-president.

In conclusion, I wish to mention that the reports of various committees will be submitted, as usual, for consideration, and I trust much good will result therefrom.

Once more, allow me to remind you of that true proverb: "In Union There Is Strength."

H. A. Isenberg,

President Hawaiian Sugar Planters' Association.

SECRETARY'S ANNUAL REPORT.

Since the Sugar Planters formed an organization in March, 1882, regular annual meetings have been held, besides several special meetings. This is the 23d annual meeting.

At the last annual meeting the following named Trustees were elected to serve for the year: H. A. Isenberg, J. B. Atherton, F. A. Schaefer, H. P. Baldwin, W. G. Irwin, G. H. Robertson, F. M. Swanzy, B. F. Dillingham and W. O. Smith. The Board of Trustees elected the following officers: H. A. Isenberg, president; J. B. Atherton, vice-president; W. O. Smith, secretary and treasurer; G. H. Robertson, auditor.

Owing to the death of Mr. J. B. Atherton, which occurred on April 7th, Mr. E. D. Tenney was appointed to fill the vacancy on the Board and was elected vice-president.

Death of Mr. Atherton.—Mr. J. B. Atherton was one of the oldest of those interested in the promotion of the sugar industry of these Islands. He was one of those who formed the first organization of sugar planters and was ever an earnest and faithful member.

His death was regretted by all, and at a meeting of the Trustees of the Association appropriate resolutions of respect were adopted.

Committees.—The standing committees appointed at the last annual meeting were upon the following subjects: Labor, Cultivation, Fertilization, Irrigation, Handling and Transportation of Cane, Manufacture, Machinery, Utilization of By-Products, Diseases of Cane, Forestry, Experiment Station.

The chairman of each of these committees, with the possible exception of one or more who have been prevented, will present a report upon the subject assigned to the committee.

The value of these committee reports is becoming more and more manifest, and many of them reflect great credit upon those charged with their preparation.

Hawaiian Planters' Monthly.—This periodical, which has been published monthly since April, 1882, has during the past year maintained its high standard. It is being more and more sought for abroad in sugar-growing countries, and many extracts and quotations from it are found in the sugar journals of other countries.

Papers and information on any of the phases of the sugar industry and subjects relating thereto are always welcomed by the editor.

Experiment Station.—The report of the committee on this station will doubtless deal fully with this subject. The importance of the work can hardly be too greatly emphasized. The experiments in cane cultivation and irrigation, and with the various varieties of cane, as also the results of chemical analysis and experiments, are of very great scientific and practical benefit.

The station has been during the past year under the charge of Professor C. F. Eckart, assisted by an able corps of competent men.

FORESTRY.—The organization of a Government Board of Agriculture and Forestry is deserving of more than passing notice.

For many years the subject of forest preservation has been discussed and efforts have been made, both by the Government, this Association and individual land owners, to encourage the protection and planting of forests. A great deal has been accomplished in this direction, but of a desultory character; but under the Act passed at the last session of the Legislature, "To provide for the encouragement and protection of Agriculture, Horticulture and Forestry," provision has been made for the prosecuting of the work in an organized and systematic manner.

Public spirited and qualified citizens have been appointed upon this Board, and with the powers granted by the Act and the help which will be afforded by assistance in the various districts of the Islands, it is to be hoped that great advance will be made in the matter of the conservation of the forests and in tree planting.

The Bureau of Forestry, under the Department of Agriculture at Washington, is taking a lively interest in the subject, and there seems to be good reason to believe that more will be accomplished in these directions than ever before.

CROPS.—A printed, detailed report of the sugar crops produced upon the various plantations for the year is herewith submitted.

WILLIAM O. SMITH,

Honolulu, Nov. 23, 1903. Secretary.

REPORT OF COMMITTEE ON CULTIVATION.

HONOLULU, November 14th, 1903.

To the President and Members of the Hawaiian Sugar Planters' Association, Honolulu, Oahu.

Gentlemen:—As the subject of Cane Cultivation has been so ably presented to your consideration in the previous annual reports of your committees, it has become difficult to submit a paper which will not embrace, more or less, matters formerly reported upon. The subject is further restricted by the assignment, very properly, of the two extremely important items of fertilization and irrigation, to separate committees. Your Committee on Cultivation, therefore, is limited to the discussion of the preparation of the soil, planting of the seed, stripping and the care of cane on plantations whose lands are not irrigated. The subject is also embarrassed in comparative data by the fact that there is no uniformity in the system of accounts kept by our plantations, so that nothing but general conclusions can be drawn; and, finally, we have the greatest complication of all to consider, viz., local conditions.

In this Territory we have localities which suffer periodically from drougths, and plantations which receive rain to spare. We have high temperatures and the reverse. We have lands that are extremely rocky; others without a stone on them. We have flat plains in one place and lands crossed by gulches, varying in depth from twenty to a thousand feet, in another. We have windy districts and districts with no wind. We have rich soils and poor soils, deep soils and shallow soils. In fact. we have every tropical cane growing condition to labor under. Thus Mr. A. Moore of Kilauea in a letter to your committee practically voiced the experience of all the managers of Hawaii, when he said "Each plantation has its own conditions to govern its work, the manner of doing it and its cost."

Your committee forwarded 52 circulars to the plantations of this Territory and received 36 replies; nineteen of these were from irrigated plantations, and seventeen from non-irrigated plantations, classified as follows:

From Irrigated Plantations.	From Non-irrigated Plantations.
6 on Island of Oahu	16 on Island of Hawaii
4 " " " Maui	1 " " " Maui
9 " " " Kauai	
19 Total	19 Total

PREPARATION OF THE SOIL.

This may be briefly summarized by the statement that the general practice is to plow as deep as possible, either loosening the subsoil below or without turning up much of it. Where lands are rocky or difficult to handle otherwise, the 14-inch breaker is generally used; where the lands are not so hilly, the disc plow is in general use; and where fields are broad and fairly flat as in the middle portion of Hamakua, the western end of Kohala, and on irrigated plantations, steam plowing implements of "Fowler" make have been found the most profitable. Briefly summarized the results from 36 replies to circulars received are as follows:

20 Plantations use steam implements.
5 Plantations use breakers principally.
11 Plantations use disc plows with subsoil attachment principally.
36

Your committee refers you to a very valuable communication from Mr. Jno. M. Horner of Hamakua, which is appended to this report, on the advantages of the "disc" plow. From data received from the different managers, the "Secretary" disc plow is used in Hilo and Kohala, and the Benicia disc plow in Hamakua. The main thing to be noticed, is the application of the "disc" in animal plowing, wherever practicable, instead of the old fashioned mould-board. It lightens the draught and breaks up the soil better. Will some one say why the "disc" principle cannot be carried out in our steam plowing implements in place of the old fashioned mould-boards? Ten or twelve years ago there was not a single disc plow in Hawaii; now they are being used wherever circumstances permit, and it would appear that, if the principle is the same, the adoption of the "disc," in steam implements on lands free from rocks, is merely a question of strength of material. At any rate the question is worth looking into. On the plantations of Waialua, Oahu and Ewa there has been introduced a large implement used in second plowing called the "Oliver" plow. This is a 30-inch plow attached to the "Fowler" steam apparatus. Where the soil is deep and free from stones this does excellent work, raching to a depth of from 28 to 30 inches. This sort of second plowing is expensive. A set of 20 horse-power Fowler plows, with this implement, goes over but 5 acres or so per day. At the same time the results obtained fully justify the extra cost. At Ewa, the highest yields ever obtained from certain fields, were those plowed to a depth of 30 inches with the "Oliver" plow.

It is a striking fact that all of the plantations where the nature of the land will allow, use steam plow implements in the preparation of their soils. It undoubtedly costs much

more than animal plowing, but the soil is in so much better condition, and the return per acre so much enhanced that their use is of great financial benefit.

PLANTING.

In the Hilo and Hamakua districts furrows are run, as a rule, from 5 ft. to 6 ft. apart, and in Kohala 4 ft. 6 in. apart. In other parts of the Territory the average is 5½ ft. This last spacing applies also to irrigated plantations. Tops are everywhere preferred for seed, and where these cannot be obtained, either plant or good first rattoons are used, depending in either case upon the appearance of the cane, and the development of the bud. Seed, in general, is cut from 8 to 12 inches in length. The greatest difference to be noted is in the placing of seed canes. In one district this varies from "overlapping" to setting 8 inches apart. In general, it may be said that in the poorer mauka or rocky soils, with heavy rainfalls, seed is overlapped, and that in localities of lesser rainfall or possibly richer soils, seeds are placed either end to end or several inches apart, depending upon quality of seed, soil and season of the year. With an early plant in the warm months of June and July seed is, as a rule, on irrigated plantations spaced a few inches apart. Germination is then at its best, and there are fewer "misses" which can be replanted in good season. But, as a rule, the later seed canes are placed end to end; or, if very late in the season, overlapped so as to insure a good stand, an even start, and to avoid replanting.

STRIPPING.

The pros and cons of this have probably been as much discussed in the Association as any other portion of the industry. On the island of Hawaii, with not as a rule an extra heavy growth of cane so that for two strippings the entire cost runs from ten to fifteen dollars, and because of the rainy weather, especially in Hilo and portions of the Hamakua district, the managers are unanimously in favor of stripping. When, however, we come to consider the question from the view point of the irrigated concerns, where the districts are generally known as "dry," and where the cost of stripping is much greater and frequently double that of Hawaii, there is not the same unanimity of opinion. Seven out of sixteen irrigated plantations, from whom replies were received, do not strip their canes. The remainder advocate stripping for various reasons. It would appear to your committee that where the expenditures for stripping per acre is as large as it is on some of the irrigated concerns, this matter might well be tested at the Experiment Station for the purpose of obtaining data on the subject. This test, of course, would

not settle the question for all plantations on account of differences in local conditions, such as temperature, slow or quick ripening, rainfall, insect pests, etc. But the results certainly would provide food for thought and be a forerunner of tests at each plantation to settle this important question.

RATTOONING.

In the matter of long rattooning, the great preponderance of opinion is, that they are as profitable as plant cane, especially on irrigated lands. From but eight plantations out of thirty-six have we received word that rattoons are not considered as profitable as plant cane. On the other hand, the weight of evidence is against short rattoons as opposed to cutting back. Of course there are conditions and circumstances where short rattoons become profitable. One is cited by Mr. Stodart of the McBryde Sugar Co., where 560 acres yielded 4.44 tons sugar per acre, which was probably exceptional. Of these conditions, each manager can be the one to judge.

HILLING UP.

The matter of hilling up irrigated rattoons is in general favor on Kauai and Maui. At an average given cost of from $4 to $6 per acre, the estimated returns are from three-quarters of a ton to one and one-half tons of sugar per acre. This is a large return for a small expense. This operation is not yet practiced to any extent on Oahu except at one plantation. Experiments are being made at one other. The operation consists in plowing deeply and loosening soil between the furrows with a 10-inch plow pulled by two mules, hitched tandem, and followed by the spreading of the loose, plowed earth against the canes by means of a V-shaped machine; the rattoon canes are thus on the hilled portion and water is applied in the hollow space between the cane rows. It would appear to your committee that where the rattoon furrows are shallow, hilling up is an excellent method to adopt, but that where the furrows are deep, the advantages are not so manifest. In an experiment carried out at Ewa with cane two feet high, a large portion of the stalk was buried, owing to the depth of the furrow. This experiment, however, will not be completed until the cane is ground and results known.

IMPLEMENTS AND CULTIVATION.

The general practice is to use cultivator and horse plow in the Hilo district, and on account of excessive rainfall to fill in furrows and to hill up plant canes as fast as circumstances permit. In those districts of lesser rainfall and occasional

drouth, such as Kohala and the western portion of Hamakua, the general practice is the reverse of that in Hilo. On this subject Mr. Forbes of Kukuihaele writes as follows: "Do not believe in filling in plant furrows, for just as much as we fill in, that much more we have to hill up on rattoons. Then when the evil day of drouth comes those canes which are rooted high are the first to suffer, as the hilled up part dries quicker than if, say, moderately level. Naturally, when hilled up there are surface roots encouraged by the soil being forced around the stem." In rattooning on plantations not irrigated the endeavor is to plow as deeply as possible between the cane rows, using either the Benicia disc rattoon plow or one of the ordinary make, in order to thoroughly loosen up the soil. No special implement or set of implements is used in all cases in rattoon cultivation, owing to differences in local conditions. Where, however, the soil is free from rocks, Horner's cultivator is spoken of highly as a tool for freeing the land of weeds at low cost.

VARIETIES OF CANE.

The old Lahaina cane is still the stand-by on irrigated plantations. Other varieties are being cultivated for experimental purposes; but, so far, your committee has not yet received information that any other variety has as yet established its superiority for general conditions. On estates not irrigated, especially those on the Island of Hawaii, Yellow Caledonia has displaced or is rapidly displacing, Rose Bamboo. In fact, so far as can be learned, Yellow Caledonia is considered in Kohala, Hamakua and Hilo to be the best all-round cane for present cultivation. Within the past twenty years on Hawaii, the general change has been from Lahaina to Rose Bamboo, and from Rose Bamboo to Yellow Caledonia. Some years hence your committee will probably record the passing of Yellow Caledonia, and the general introduction and cultivation of some one or more of the canes now in the experimental stage at the station, or on the plantations.

Rose Bamboo is a deeper rooter than Lahaina on unirrigated plantations; and Yellow Caledonia, in its turn, is a deeper rooter than Rose Bamboo. On this account the Yellow Caledonia suffers less from dry weather than either of the other two varieties. This was amply demonstrated on Paauhau plantation during their last drought. Mr. Eckart, Director of the Experimental Station, suggests that probably irrigated plantations may find it a better cane than Lahaina on old lands or lands that are below the average in general fertility. Kilauea plantation, we understand, has planted a quantity of Yellow Caledonia during the past season, which will give us some data as to its value under the conditions that obtain on irrigated estates. From the very valuable contribution of Mr.

Eckart, in response to our request for information, the following is quoted:

"For irrigated plantations, Demerara No. 117 is in my opinion the most promising variety, as at the Experiment Station field it easily leads all other canes On one of the Oahu plantations, where it has been tried in competition with Striped Singapore, Tiboo Merd, Rose Bamboo, and Fiji Purple, it yielded from a ton to a ton and one-half more sugar to the acre than the other varieties. It is a rather grassy cane that is characterized by thick stooling, giving heavy tonnage per acre, and by juices of rather low purity, except with rattoons, when purity is good. La. Striped has been planted on quite a large scale (about 15 acres, I think), on one irrigated plantation (Haiku) and does very well, that is, fully as well as Lahaina. It flowers earlier and more generally than Lahaina or Rose Bamboo."

As the matters of green soiling, fallowing, etc., belong properly to the question of fertilization of soils, and assigned to special committees, this committee on cultivation does not here take up those matters, but wishes merely to draw your attention to the fact that cultivation of cane on cane land in this Territory is practically continuous, and that, while burning off trash and leaves is general, it is the exception and not the rule to rest lands, either in fallow or otherwise, or to green soil them by the cultivation of leguminous plants.

In conclusion, we thank the various managers of plantations for interest shown by the large number of replies received from them in answer to questions of the committee.

Respectfully submitted,

GEO. F. RENTON,
Chairman.
A. FORBES,
B. D. BALDWIN.

Appendix of Report on Cultivation.

KUKAIAU PLANTATION CO.

PAAUILO, HAWAII, Oct. 7, 1903.

MR. G. F. RENTON, CHAIRMAN, COMMITTEE ON CULTIVATION.

Dear Sir:—Not having room on your circular sheet to reply to your question respecting plows, I herewith beg to answer the same.

The great revolution in the manufacture of improved plows, the past few years, changing from the old style mould board plows to discs, are such great improvements, that all inter-

ested should be informed. The first that came to us was the single disc, with a subsoil attachment. With this tool better plowing could be done, and each furrow subsoiled at the same time, by one man and five animals, than could be done with two men and five animals with the old mould board breaking plow, without subsoiling. With the disc, the man rides, controls the plow and drives the team;—all know how the old plow worked.

The next coming to us was the double disc, one man and five animals could do more second plowing with it than with the single disc, but no first plowing or subsoiling could be done with it, neither could we plow deep with it, and for cane growing in these islands deep plowing is necessary, so this double disc was only good for second or shallow plowing.

"The Benicia Reversible, or Side-Hill Disc Plow."—Of all plows coming to our notice, this leads in quality and amount of work and lightness of draught. In hilly land it will do better and more work with three animals and one man than can be done by two men and five animals with old mould board or breaking plow.

This plow running horizontal throws all its furrows down hill—if there is a hill—whereas all other plows are compelled to throw some of its furrows up hill; not only this, but the team must walk up hill part of the time while plowing. All know when a furrow is being turned up hill, the work is not as well done as when it is turned down, and it requires more power, and it also requires a greater expenditure of power, for a team to pack its own weight up hill than down, or on level ground. The reversible plow avoids most of this useless labor, hence less teams can do more and better work with this reversible disc.

"The Benicia Rattoon Disc Plow."—This marks an advance in the cultivation of rattoon and plant cane; where slight or much hilling is required, more and better work can be done with it in a given time than can be done with any other known plow or tool. This plow being a double disc, turning furrows right and left as it moves along, and having a small shovel plow in front and subsoiler behind, it leaves the soil in a loose, fine and mellow condition, making a perfect mulch, which retains the moisture; it also destroys the weeds and hills the cane at the same time. It will do as much work and do it better, going through once, than can be done by the common plow going three or more times. Six to eight acres can be done with it. They are made in three sizes, for one, two and three animals respectively.

This is a cane plow in earnest, as it will not only cultivate, mulch and hill the cane while growing, but by removing the shovel plow and substituting a rolling coulter, it will cut up large rattoon stools into four or more pieces, thus doing away with the objectionable cane stools that usually lie about the

cane fields, after plowing. After fields have been plowed over with the rattoon plow and harrowed, the land, which was in ridges before, is left comparatively level. Beside the work this plow does in cutting up large cane stools, the plowing of the field it does may be considered as the first plowing, and the fields are in good shape for the second plowing, which can be done most economically to a depth of fourteen inches with the "reversible disc" mentioned above.

Yours very truly,

(Signed) JNO. M. HORNER.

HANDLING AND TRANSPORTATION.

Mr. President, Directors and Fellow Members of the Planters' Association:

Gentlemen:—The subject before us is the Handling and Transportation of Cane to the Mill, after it is cut. The subject is not a new one, for almost every year since attending these meetings, some one has taken it up, and done his best to be helpful to the members. I have often heard it discussed as to its difficulties, but not as to its cost, under the different ways of transportation. I am not in a position to say what the cost per ton of cane has been in the past, but from what I have gathered from the managers of plantations on Hawaii, Oahu, Kauai, and Maui, who were good enough to send me statistics on this point, I shall try to make the subject as interesting as possible and also as useful in our attempt to cut down expense and work connected with the handling and transportation of cane.

It is my object to lay before you the different methods employed to accomplish this end and the expense per ton, on each island, to get the cane picked up after cut and taken to the mill and laid on carrier, by whatever means.

After sending a request to the managers all over the islands, for the same items, about 31 out of 60 replied. I do not purpose to state here just what it costs each place to do it; I consider it would not be fair, but I think it would be fair to give the average cost on the different islands, either fluming, railroading, carting, or wire rope. If I could have had the Maui people do as well as the other islands, we would have had a more useful report. Quite a few, I think, have not charged up all expenses on the transportation, and this will give an opportunity for discussion, not here, but afterwards; as my intention is not to give what each states he can do the work

for, as I fear it might get a little warm, but I can send to those who replied to my request, a copy of all the answers I received. This is only fair, so that men on adjoining places, who flume or railroad, will visit their neighbor to see why it costs them double what it costs the other to do the same work.

I think some have overlooked the charging for repairs, interest, part of managers', bookkeepers', and overseers' time; all these points are required to be charged up.

Two or three years ago, a great desire was shown in this association for machinery to do the heavy work of loading cane. So far little has been accomplished. Nothing has been done to pick up the cane in the fields and place it in sleds or carts. It is done in Louisiana, but to my knowledge none of us have tried to do it, although we are told we can save 5 cents per ton. No doubt our cane picking is different; they have nice straight cane, where ours is crooked and more piled together, twice as much on the ground, perhaps, still I do not see why some enterprising person, who has been in the East and seen machines doing the work, has not adopted them; five cents a ton means a good deal to a place taking off hundreds of tons a day. For instance, we are handling three million tons of cane a year, which means about $150,000 to the Islands.

From all reports, I do not see any new devices for handling and transporting cane, except Waialua and Waiakea. At Waiakea during the last crop, all our cane was put in cars by our loaders, and I can testify they are far more successful in filling cars than men are.

With our new system of handling, we figure the loaders save us 50 men a day, and the unloaders, 10 men a day. I have had all the cane this year, picked up and put on sleds for 9 cents; then it costs 11 to 12 cents to get it hauled on sleds to the cars; this to me is expensive. I am now to try a low car, with 20-inch wheels, the same as the Horners use. With them the mules will take double the load on the sleds; I may be higher in the cost of placing on cars, but lower in the cost of hauling.

At Waialua I saw a loader at work, on a different lay-out from ours, after the same end. I was much pleased with it, and am satisfied it can be made to do lots of work if cars were adopted to suit the machine.

A great many changes require to be made, and managers are a little slow to make changes, especially if labor is plenty; but, gentlemen, the day is coming when we will not be so well off for labor as we are now, and the sooner we get down to machinery to do the heavy work, the better.

Only those who have experienced the difference can rejoice in the loading by machinery; Waiakea had its day of lifting bundles of cane into carts, hauling to railroad and lifting again

into cars; paying extra money for picked men for the work, and trouble to get men to be steady at it; but since we got this new way of loading, we don't have special men in that department, and the overseer knows the lifting will go on all right in the morning.

In Hamakua a great deal of lifting to car is done by hoisting a load of a ton or so at a time, at set stations, carting a few miles.

Waiakea shifts their machines every day if necessary, just as the field is taken off.

I must mention the wire-rope or trolley system, introduced and perfected by Mr. Horner, which is a great benefit to the plantations that use it. I had the pleasure of seeing the rope operating; not only did the bundles come with lively regularity, but in the fields was every appliance for economy of labor and expense. I saw cane taken to the mill over gulches, through woods, fields, etc., which it would never pay to handle any other way. This device is used where there is no water for fluming, where railroads are almost impossible, and carting would not pay. The bundles, once hooked on and started on the right grade, will go miles to their destination.

Some, in Hilo, flume cane, because it is the only way practicable; some railroad, because it is the most practicable; some use portable track, some use stationary, all use portable flume where it can be used. Fluming is done in much the same way as it was years ago, getting it to the flume in the best way possible, either by manual or animal power, sleds or carts, placing it in the flume, or laid down at some convenient point for men to put in the flume at the right time.

I have heard it said that fluming is the cheapest way of getting cane to the mill, all things considered, but I never believed it, notwithstanding some of our friends said so, and I think when you get the statistics from all over the islands you will agree with me.

Some use permanent track for getting cane to the mill, because it is best adapted to the lay of the land. Where the land is rough, hilly and stony, permanent road is the only way, but on land like that of the lee-side of Maui, Oahu, and Kauai, the portable track is the most practicable.

In Kohala district, most of the canes are taken in carts and wagons, either by traction engines, mules or bullocks, to the mills; a little fluming is done when water is available. Instead of dumping wagons as formerly, they lift the load on to the carrier, hosting by machinery or mule power.

In looking about for a helpful, economical method of garnering our crop, have we interested any inventive genius among us? Have we spent a few dollars on such work? We spend yearly for laboratory work, which is of value, no doubt; but what is this Association doing to get at some method of

cutting down the expense of handling and transporting cane, at least a few cents per ton? It is now costing $3.50 per ton of sugar to get cane to the mill, after it is cut, and when it is at the mill all the scientific men are watching carefully to see we do not lose a drop in the manufacture. It only costs $2.50 per ton to manufacture. Suppose for a year or two we spend some money to stimulate invention in this line.

What encouragement, if any, was given to Mr. Horner for all his labor in getting the trolley to such perfection that cane that could not be moved at a profit was by his ingenuity made to yield a reward?

What encouragement did Mr. Crozier get with his machine, after spending thousands of dollars? Just enough to take it to the fields and leave it there. What encouragement has Mr. Wilson's study, work and expense received for trying to make us more independent of labor? Gentlemen, these are questions I cannot answer, but I am more than convinced, that were we to get at something in this line, outside the boiling house, instead of all the watching inside, more money would be saved to the plantations.

If managers would meet the man with a new device, half way and help him work out his theory, practically, there is no doubt a machine would be evolved suitable for different ways. Had it been a mechanic or an inventor on Waiakea, and not myself, who got up our loader, I doubt if it would be working today. Men in the fields are generally averse to machinery, giving very little encouragement to the man trying to make his theory practicable. The only way is to give the man a show, and let it be understood the machine is there to stay.

For the first few weeks, when everything had been working the wrong way, with the loaders on Waiakea, great dissatisfaction prevailed, but now the men think they are the right thing in the right place, and would rebel at once if they were not in use.

The Waiakea loader, with all the other expenses to get cane on the carrier, costs us 36.38 cents per ton for the crop.

Fluming in Hilo costs about 42 cents per ton, as per reports.

Hamakua does carting, railroading (gravity and stationary track) fluming on one place, and gravity wire on another; this district runs about 45½ cents per ton.

In Kohala district, the cost per ton of cane is 54 cents.

If we were to go by districts, Hilo would come out better than by comparing the Islands: for instance, Hilo had 8 or 9 reports, which covered the whole district, with the exception of Kohala Mill. I have a report from all plantations in that district. Kauai also did well, most of them replying one way or another. From Maui I had the least number of answers; however, I thank all for the assistance I have received, and

hope the exchange of figures will be of mutual benefit to all. I will now give you the figures for each Island which is as fair an average as I could make:

Reports.			Cents per ton
9—Hilo District	Fluming & R. Road	about	42
3—Hamakua District	Fluming, gravity & R. R.	about	45 1-2
5—Kohala District	R. R. Wagons & Flumes	about	54
3—Island of Maui	R. R. & Flumes	about	31.37
4—Island of Oahu	Portable R. R.	about	41
5—Island of Kauai	Portable R. R.	about	41.6

Respectfully submitted,

C. C. KENNEDY,
Chairman.

REPORT ON FERTILIZATION.

To the Trustees and Members of the Hawaiian Sugar Planters' Association:

Gentlemen:—The committee appointed by the President to report on Fertilization at this meeting of the Association were C. B. Wells, C. McLennan, F. Meyer, J. T. Crawley, J. F. C. Hagens and C. F. Eckart.

Circular letters containing questions relating to fertilization were sent to the managers of the various plantations, and the answers received furnished some very interesting statistics and information regarding the use of fertilizing material in these islands. As similar data were obtained last year by the fertilization committee, it may be of interest to bring figures into compasion, which represent the value and quantities of fertilizer used for the last two crops.

The average quantity of mixed fertilizer applied per acre for the crop of 1902 was 850 pounds, and for 1903, 910 pounds.

The average formula for the two years was as follows:

Element.	1902.	1903.
Phos. acid	8.0%	7.1%
Potash	9.0%	10.1%
Nitrogen	6.0%	6.1%

The crop of 1903 was harvested from about 90,000 acres, and the total quantity of mixed fertilizer applied was approximately 41,000 tons.

The amounts of nitrogen, phosphoric acid and potash in this quantity of material were as follows:

Nitrogen in mixed fertilizer	2,501 tons
Phos. acid " "	2,911 tons
Potash " "	4,141 tons

About 6,000 tons of nitrate of soda, containing approximately 900 tons of nitrogen, were also used.

These large quantities of the various fertilizing ingredients would have values somewhat as follows:

Nitrogen in mixed fertilizer	$ 750,300
Phos. acid " "	232,880
Potash " "	393,395
	$1,376,575
Nitrogen in nitrate of soda	270,000
	$1,646,575

In addition to nitrate of soda, special fertilizers such as lime, ground coral, fish scrap, muriate of potash, tankage, and a mixture of nitrate of soda and sulphate of ammonia were also applied. The value of these latter materials, together with the cost of bagging, mixing of complete fertilizers, and transportation, would bring the total amount expended for fertilizers to somewhat over $2,000,000.

The large amount of capital annually expended for fertilizers in these islands, together with the fact that other sugar producing countries use very much less fertilizing material, would naturally cause one to consider if the large cost of fertilization in this Territory is justified by the increased returns. The average cost of fertilizer used per ton of sugar produced would approximate $4.65, and per acre $22.20. To pay for the cost of fertilization for the crop of 1903, there must have been at least a gain of 28,571 tons of sugar for the islands, or 635 pounds on an average per acre. An increased production of 635 pounds per acre would represent a gain of about 7 per cent.

There is little data obtainable from plantations as to quantities of sugar produced per acre with and without fertilization, although it would be unreasonable to suppose the increase does not exceed by a good margin 635 pounds of sugar per average acre. Tests made at the Experiment Station with the object of noting the action of the several elements on the cane—i. e., of the influence one element might have as regards the quantity of another appropriated by the plant—afford some interesting figures on the percentage of gain from fertilization. In presenting these figures it should be stated that the fertilization is not rational from a plantation point of view, where the largest increase of sugar is the measure on which practical fertilization is gauged. To study the effect of one element on another, and as to whether a certain element, through its indirect action on the soil or cane, could to a certain extent be substituted for a more expensive one in the applied fertilizer, equal quantities (100 pounds) of the various ingredients were used. The complete fertilizers are, therefore, not properly balanced for maximum increase of sugar, and such gains as are given in the table below would without doubt be exceeded on many plantations where due consideration is given to the relative quantities of the elements required.

Percentage of Gain or Loss of Sugar from Fertilization.
(Unfertilized Plat as Basis.)

Elements.	Gain or Loss in Sugar. Lbs.	Per Cent.
Nitrogen	+ 2,383	+ 13.4
Phos. acid	— 2,430	— 13.6

Potash	— 2,002	— 11.3
Nitrogen and Phos. acid	+ 2,341	+ 13.2
Nitrogen and Potash	+ 3,979	+ 22.4
Phos. and Potash	+ 3,082	+ 17.4
Nitrogen (as Nitrate of Soda), Phos. acid and Potash	+ 4,289	+ 24.1
Nitrogen (as Ammon. sulphate), Phos. acid and Potash	+ 3,072	+ 17.3
Nitrogen (as Blood), Phos. acid and Potash	+ 3,344	+ 18.8

The average gain for the complete fertilizers—i. e., where nitrogen, phosphoric acid and potash were used together—was 20 per cent.

The increased yields from fertilization are not commensurate with the quantity of material applied beyond a certain limit, which limit will naturally vary with the depth and the mechanical nature of the soil. On a soil mechanically good, but deficient in one or more elements, an application of mixed fertilizer will give better results than it would on a compact soil showing the same plant food deficiencies. In the latter case the cane has more to contend with than in the former instance, and what with the soil's poor drainage, resistance to normal root ramification, and insufficient aerification, a crop does little better with fertilization than it would do without. The limit to the amount of fertilizer that could be applied economically to the compact soil would be considerably less than with the one of good texture. A sour soil will likewise respond in less measure to fertilization than a neutral one, a very thin soil less than one of greater depth, and one of abnomally large humus content less than one with a smaller amount of organic matter. In one case a soil calls for lime to flocculate its clay, or a liberal supply of sand to render it more porous; in another, lime or fallowing are necessary to neutralize the excess of acid; with the thin soil it is necessary by the gradual upturning of the subsoil to deepen the staple; and where a preponderance of humus is found (and such cases are not rare on these islands), lime would be of great value in changing the soil to a more fertile condition. Mixed fertilizers will not correct these ills, and they may do nothing more than stir up a prejudice against their value in general, because in a specific instance they have failed through no fault of their own.

The limit to the amount of soluble fertilizers that may be applied with profit to a soil is often far below the quantity of the elements that the cane uses during its growth. The crop of 1903 yielded approximately 4.7 tons of sugar to the acre,

and if we were to consider that the figures obtained from cane ash analysis at the Experiment Station are somewhere near the average for the islands, we would have the following amounts of the elements taken up by the cane per average acre:

Element.	In tops, leaves, etc.	In Cane.	Total.
Lime	133 lbs.	18 lbs.	151 lbs.
Phos. acid	31 lbs.	39 lbs.	70 lbs.
Potash	318 lbs.	169 lbs.	487 lbs.
Nitrogen	97 lbs.	61 lbs.	157 lbs.

The average quantities of these materials (leaving out lime) applied per acre in fertilization for the last crop were:

Phosphoric acid	65 lbs.
Potash	92 lbs.
Nitrogen	56 lbs.

This would mean that the crop removed per acre 5 pounds more of phos. acid, 395 pounds more of potash, and 101 pounds more of nitrogen than was added to the land in the mixed fertilizer. However, at the time of harvesting the preceding crop, there were returned to the soil through the burning off of cane refuse approximately 31 pounds of phos. acid and 318 pounds of potash, the nitrogen having been lost in the burning. The average acre received then, altogether:

Phosphoric acid	96 lbs.
Potash	410 lbs.
Nitrogen	56 lbs.

or 26 pounds more of phosphoric acid, 77 pounds less of potash, and 101 pounds less of nitrogen than the cane appropriated. If we were to disregard loss by drainage and consider cropping as the only source of loss for the above mentioned elements in the soil, it would be necessary for maintaining the same standard of fertility to change the fertilization so that the average formula (based on 910 pounds) would be:

Phosphoric acid	4.3%
Potash	18.5%
Nitrogen	17.2%

It is needless to say that fertilization with such large amounts of nitrogen and potash (together) on land producing on an average less than 5 tons of sugar to the acre would prove more of a loss than a gain where soluble fertilizers are used. In the Experiment Station field, capable of producing

8 1-2 tons of sugar to the acre without fertilization, the results of nitrogen and potash fertilizers were as follows:

Amt. of each element added.	Lbs. of Sugar.	Percentage of gain.
No fertilizer	17,759	....
100 lbs.....	21,738	22.4
150 lbs.....	20,416	15.0

Increasing the quantities of the elements in complete fertilizers (containing nitrogen, phosphoric acid and potash) gave the following results:

Amt. of each element added.	Lbs. of Sugar.	Percentage of gain or loss.
No fertilizer.....	17,759	....
100 lbs.....	21,327	+ 20.0
150 lbs.....	19,524	+ 9.9
200 lbs.....	15,165	— 14.6

The yield of sugar decreased as the quantity of the fertilizing material was increased. Where 200 pounds each of the several elements were applied there was a loss of 14 per cent. of sugar, notwithstanding the fact that the unfertilized cane withdrew from the soil approximately 129 pounds of phosphoric acid, 896 pounds of potash, and 290 pounds of nitrogen (no burning off from the previous crop having taken place.)

The tendency on the plantations during the past year or so has been toward a reduction of phosphoric acid and an increase in potash; in fact, the average formula is 1 per cent. lower in phosphoric acid and 1 per cent. higher in potash for the crop of 1903 than for that of 1902. With few exceptions, where this change has been made, good results have been obtained.

In the report of the committee on fertilization for last year the statement was made that potash could cometimes be used to little advantage in applying large amounts of the element to lands poor in lime. To quote from the last report, "Lime is essential to the most advantageous use of potash, and where the lime of the soil is low it should be augmented previous to the addition of potassic fertilizers." This point with reference to potash is a very important one, as there is not only danger, where the lime in a field is low, of not getting full returns from potash applied, but of also injuring the cane. This fact is one that is often disregarded in fertilization, and it is doubtless capable of explaining many of the differences of opinion held by plantation managers with reference to the value of high potash fertilizers. When a potash salt such as the muriate or sulphate is added to the soil, dissociation takes

place to a large extent, and more of the base—potash—is taken up by the cane roots than of the acid part of the salt. This occasions an accumulation of acid in immediate contact with the tender roots of the plant, and if there is no convenient base (such as lime) present to immediately neutralize this acidity, considerable harm may result. Lands standing well in lime can therefore receive a more liberal supply of potash than lands low in lime, the potash in the two soils showing the same degree of deficiency. This holds true for other fertilizing compounds, and will doubtless help to explain why complete fertilizers, containing 200 pounds of each element in a soluble form, gave a loss of 14 per cent. of sugar, when 100 pounds of each element gave a gain of 20 per cent., as shown in a previous table.

The question might well arise as to why no harm results from the addition of several hundred pounds of potash per acre of land when cane refuse is burned on the soil. This is doubtless owing to the fact that almost an equivalent amount of lime and magnesium compounds are associated with the potash in the ash, and also that the dissociation of the potash salts (carbonate and muriate) do not take place in the land under cane.

In my opinion the increased use of potash and the reduction in phosphoric acid is doing much to raise the average yield per acre in these islands, but a radical increase of potassium salts in any one instance should only occur after a careful consideration of the lime content of the soil in question. With soils of an acid reaction, due to the decomposition of excessive quantities of organic matter, it is plain that lime or other bases of a similar nature are not present in sufficient quantities in a form to neutralize the naturally occurring organic acids, and large amounts of potash should only be applied to such lands with caution, and only after substantial liming. Under other conditions, a radical departure toward the material increase of potassium and other chemical salts in fertilization should only be made after gaining an insight into the composition of the soil through chemical analysis, or the carrying out of tests in the field to learn the efficacy of new formulas. This latter method of gauging the suitability of fertilizers for particular conditions is one that cannot be recommended too strongly, and the time and trouble involved would be more than counterbalanced by the value of the information gained. Changing the formula occasionally and noting the results may often indicate increased yields from improved fertilization, but there is always the element of doubt as to whether such gains were due entirely to fertilization or other conditions. By carrying out field tests and comparing results of one plat with those of another grown under identical conditions except with regard to fertilization, the relative value of different fertilizers may be readily gained.

It is true that chemical analysis of soils will furnish a valuable guide in the matter of fertilization, but there can be no method that will yield more satisfactory and convincing results to a plantation than the actual comparison of weights of cane on the field.

The proper proportions of the several ingredients in mixed fertilizers applied to a given soil is a matter for careful consideration, but it would appear to be of hardly less importance to also place such fertilizers on the land at the time they are capable of doing the most good. This latter point has been touched on in previous reports, and in order to avoid repetition I feel that only a few remarks may be made on this subject. Too early and too late applications of fertilizing material, when the cane is not in a condition to utilize the supply, must oftentimes be a source of loss. Just what may be considered "too early" and "too late" will naturally vary with the locality, and no hard and fast rule can be formulated to meet all conditions. The practice of applying soluble mixed fertilizers in the seed bed is fast falling into disuse, though a few managers still feel that the advantages from this method of fertilization more than compensate for the loss of material that is apt to result. It is true that there are some soils of a clayey nature that would so readily and securely fix soluble fertilizing material that little of it could be lost through drainage following rains between the time of planting and the time of the rooting of the cane. In such land the plant foods are not only securely fixed, but owing to the impervious nature of the soil, the question of loss by drainage is not so serious as in the case of more porous soils. However, it would appear in such instances that the first rootlets of the young cane would show a deeper appreciation of a more yielding medium through which to ramify than of a surfeit of plant food which they are not in a condition to assimilate. On such lands the mechanical improvement of the soil by the addition of sand when readily obtainable, or lime in other cases, would be of material benefit. When fertilizers are applied to the seed bed, it is always safer to use such insoluble material as fish scrap, tankage, etc., than the soluble chemical salts, and in some instances the use of organic substances in such manner have done much to increase the yields. Regarding this subject of fertilizing with the seed cane, one manager writes: "In past years the custom of applying 500 or 600 pounds to plant seed while being set out has been pretty general in this district, and we now find it to have been a wrong method. The past seasons I have given in some instances no fertilizer with seed, although as a rule 250 to 300 pounds, and the heavier application later on when the cane is stronger and can utilize it, thus saving us no end of extra weeds in the plant cane's first stages of growth, when it formerly used to be a severe strife for survival."

In the late fall and early winter the growth of the cane is checked, as a rule, by the comparatively low temperatures and copious rains, and fertilization at such times is usually too late for satisfactory results. There is not only a risk of losing much of the applied plant food, particularly nitrogen, during the wet months of the winter, but the requirements of the cane at such times are small compared with those of the growing seasons of spring, summer and early fall. On the upper lands it is necessary to plant early to insure a good stand of cane before the winter months start in, and for the same reason fertilizers should be applied somewhat earlier than on the lower lands, in order that the cane may be stimulated during the periods when conditions are favorable for rapid growth. On the makai lands the latest fertilization is usually in October or November, when the cane can possibly count on another month before its growth is materially checked, and the fertilizing material added to the soil at such time supplies the cane for the months preceding spring. I believe that if the relative quantities of fertilizer applied at different periods of the year were gauged by the number of good growing months between times for fertilizing, with due consideration for the age of the cane, that more satisfactory results would be obtained than by dividing the total quantity of fertilizer (for the crop) into two or three equal parts and applying them at set intervals in the cane's career.

The whole question of fertilization is certainly a most complicated one, and one that must necessarily be worked out to a large extent by the individual planter for his own conditions. The thought that has been given to this subject, as well as to varieties and cultivation, by the Hawaiian planters, who have carefully considered their separate conditions and requirements, has done much to increase the yield of sugar per acre on these islands, and for the crop of 1903 a gain per acre has been made over the best showing of previous years.

Respectfully submitted,

C. F. Eckart,

Chairman of Committee.

Honolulu, H. T., Nov. 14th.

Mr. C. F. Eckart, Chairman Committee on Fertilization:

Dear Sir: I have no special report on fertilization, but will simply call attention to some work on the fixation of phosphoric acid, potash and ammonia, which experiments were made by me in order to more fully understand the action of fertilizers in Hawaiian soils. This work was published as follows:

"Fixation of Phosphoric Acid in the Soil."—Journal of the American Chemical Society, November, 1902.

"Fixation of Ammonia and Potash by Hawaiian Soils."—Journal of the American Chemical Society, January, 1903.

"Water-Holding Power and Irrigation of Hawaiian Soils."—Hawaiian Planters' Monthly, August, 1902.

The results in brief were as follows:

Phosphoric Acid.

Soluble phosphoric acid is fixed by the soil almost immediately after application, and there is practically no danger of loss of this element either from heavy rainfall or excessive irrigation.

The astonishing fact was ascertained that the red soil with which the experiments were made fixed 35,235 pounds phosphoric acid within one day for the first foot in depth, and 72,545 pounds within 22 days.

Hawaiian soils are very basic, and their bases are probably in a condition to seize at once the phosphoric acid and hold it.

Ammonia.

In making an ordinary application of sulphate of ammonia and irrigation immediately afterwards, one-half of the ammonia is fixed and retained within the first inch of soil, more than four-fifths within the first two inches, and almost all within four inches. While this ammonia is held rather firmly, subsequent irrigations or rains wash it out, but in decreasing quantities. A further loss of ammonia occurs through its conversion into nitrate, in which form it is easily washed away.

Potash.

Seven-tenths of the potash applied and followed by irrigation is held within the first inch of soil, more than four-fifths within two inches, and almost the whole within six inches. But as in the case with ammonia, successive leachings take out potash and in decreasing quantities.

These results have a great bearing on plantation work on these islands. A great deal of the water applied in irrigation passes directly and immediately through the soils. In other cases, as in the Hilo district, the soils are subject to very heavy rains. Were the soluble ingredients of fertilizers not fixed at once, the loss might be, and often would be, very great; but the experiments have shown that even under heavy washings the elements are fixed rapidly. But the solubility of these substances in water after the first irrigation, though slight, emphasizes the importance of keeping irrigation well under control.

Phosphoric acid is quite firmly held, but 19 per cent. of the potash applied was washed below six inches of soil by eight irrigations. Very truly yours,

J. T. CRAWLEY.

MR. C. F. ECKART, CHAIRMAN COMMITTEE ON FERTILIZATION:

Dear Sir: As a manufacturer and dealer of fertilizers, it hardly behooves me to report on the merits of proper fertilization; besides, I think we have in the chairman of our committee the ablest and fittest man for this report. From his own experiments, augmented by the experience of our progressive planters, it will be no hard task to obtain valuable and instructive data on one of the most vital questions connected with our leading industry. I shall therefore limit my words to a few general remarks, and hope that they will to some extent contribute to the understanding of a few points in connection with plant-nutrition.

Agricultural chemistry has advanced with rapid strides in the last decades, and the dissemination of its general principles among those who are chiefly interested has been systematically carried on by our scientists, who have spared no trouble and expense to familiarize the agriculturists with the fundamental laws of plant life and all the important factors bearing on the same.

We all know that by means of its fine rootlets the plant absorbs all mineral plant-food necessary for its growth and maturing, from the soil in a soluble form, and that, owing to specific organic acids secreted by these rootlets, they are enabled to dissolve even plant-food, which is more or less insoluble. The latter property, however, differs somewhat in activity with different plants. One of the chief plant-food elements, the carbon, however, is not-taken out of the soil, but from the atmosphere in the form of carbon dioxid. Just as the roots supply the plant with most of its nourishment, the leaves are the agents in the assimilation of the carbon dioxid. The leaves must be healthy and well developed to be able to properly perform this important function, and if we consider what an important part the carbon dioxid performs in the production of fiber, and especially sugar (sugar being a carbo-hydrate consisting of 42.1 per cent. carbon, 6.4 per cent. hydrogen and 51.5 per cent. oxygen), it will be understood of what value a thorough knowledge and a close study of these circumstances are. For the proper development of the sugar cane and for the normal production of sugar in the cane out of the carbon, dioxid, sunlight—direct sunlight—and solar heat are indispensable; this should never be lost sight of, for in most in-

stances the quantity of sunlight and solar heat determines the amount of sucrose in the cane. The more cloudy days there have been and the more the direct sunlight has been excluded from the cane, the lower will be the sucrose in the juice, although the cane itself may have grown very rank—perhaps too rank. If we realize, therefore, the momentousness of the sunlight in the production of sugar, it will become clear to us why a good soil of high fertility alone does not suffice to produce heavy yields, and that only on such estates where all of the conditions are most favorable can maximum crops be produced.

So much about the importance of the sunlight in connection with the production of sugar. It will explain, I hope, the reason why in some districts, where there are more cloudy days than in others, the average yield falls so low, although all the other conditions may be very favorable. In my opinion, not enough attention has been paid to this circumstance, perhaps for the simple reason that a remedy is beyond human power.

Now a few words about fertilizers:

Too much is often expected from fertilizers, and unless immediate, palpable results are obtained after their use, they are often peremptorily condemned. Fertilizers alone will not make the cane grow unless the other essential conditions are favorable. Fertilizing without proper cultivation is a waste of money. How insignificant is the amount of plant food applied to a soil in the fertilizer when compared with the enormous store of it already present in the soil! If an analysis, for instance, should disclose the presence of 0.1 per cent. of phosphoric acid in the soil, it would mean 3,920 pounds per acre, 1 foot depth (weight of one cubic foot of soil estimated at 90 pounds). Fertilizers generally used contain not over 8 per cent. of phosphoric acid, and when applied at the rate of 1,000 pounds per acre, it would mean the addition of 80 pounds. Yet, how often does the use of a little fertilizer work wonders? And this shows again how thankful the cane is for immediately available plant-food. The fact that the demand for high-grade fertilizers increases from year to year is the best proof of its value and absolute necessity for our plantations.

Respectfully yours,

J. F. C. Hagens.

UTILIZATION OF BY-PRODUCTS.

MR. H. A. ISENBERG, PRESIDENT HAWAIIAN SUGAR PLANTERS' ASSOCIATION, HONOLULU:

Dear Sir: Very few plantations have exact figures showing the value of their waste or by-products, or results from their use.

In nearly all Mill Reports the losses in manufacture, (averaging about fifteen per cent. of the sugar in the cane), are stated as though the valuable constituents of the scum press cake, mill ashes and molasses are lost absolutely, while in fact nearly all the plantations in the Territory use scum press cake and ashes as fertilizer, and molasses to a limited extent for fertilizer, fuel and feed.

In all mills there is a constant endeavor to reduce the losses, and by so doing, the value of the by-products is decreased. These methods adopted may be described by the Committee on Sugar Manufacture. There will always be, however, a certain value to the waste products. The saving to be made in this line belongs to the scientific branch of the industry. There are, no doubt, many ways of utilizing the waste of a sugar mill, as un-thought of to-day as were the useful and highly profitable by-products of slaughter-houses and gas works a few years ago.

After making allowance for the comparatively small value of the waste products obtained by the methods now in use, the losses are still appalling. The subject requires the attention of experts.

For the purposes of this report is seems unnecessary to consider the bagasse as a waste or by-product. The one apparent use for the bagasse is as a fuel for carrying on the boiling processes of the factory. The true waste or by-products are, in the order of their value,—the waste molasses, the scum press cake and the mill ashes.

There is a sentiment among many of the business men of the Territory, resulting perhaps from the training of many of the early settlers, against the distillation of molasses for the manufacture of any kind of liquor, and the influence of such men has been so great that their ideas have been accepted by and made the policy of the existing Governments down to the time of annexation. There can be no valid objection to the distillation of spirits for use in manufactures or as fuel.

Mr. J. N. S. Williams, on his recent trip to the States, gave much time to the study of this subject commercially, and has written a paper which he has kindly given to this committee for this report.

Mr. Williams says:

THE UTILIZATION OF BY-PRODUCTS RESULTING FROM THE MANUFACTURE OF RAW SUGAR FROM SUGAR CANE.

The only by-products resulting from the working up of sugar cane are: First, bagasse or the crushed cane after the bulk of the sugar has been extracted, and second, molasses, or the gummy viscous syrup remaining after as much crystallizable sugar has been recovered from the cane juice as the methods employed will admit of.

Bagasse containing from 3% to 6% of sugar on its weight, and 40% to 45% of water is valuable fuel, and although attempts have been made, notably in the Southern States, to use bagasse or cane fibre for the manufacture of paper stock, no marked success has yet attended the ventures in this direction.

Bagasse as delivered by a good nine roller mill, is worth as fuel delivered into the furnace, one-third of its weight in coal, and since it can be handled automatically, and fed to suitably arranged furnaces in a very regular manner, it would appear that the greatest value of bagasse is obtainable when used to provide steam for the factory which produces it.

Waste molasses presents at the present day an economic problem of no small importance.

For every ton of cane ground in these Islands an average of 50 pounds of molasses is produced, and since the total cane ground during the crop of 1903 reached 3,500,000 tons, it follows that 87,500 tons of molasses containing not less than 30,000 tons of crystallizable sugar were to all intents and purposes wasted.

Molasses contains besides the crystallizable and uncrystallizable sugars, various salts, amongst them potash in some quantity.

The sugars can be utilized in the manufacture of spirits, and the potash can be recovered after the spirits are distilled off.

The question as to whether this can be done at a profit is an open one; certainly under the present market conditions, and Internal Revenue regulations, spirits cannot be made and sold at a profit in the United States, and mainly for the reason that the alcohol resulting from a beet or cane molasses, which has been exhausted of its sugars to the low point now demanded in modern sugar factories, is not adapted to blend with other liquors for direct consumption as it introduces an objectionable flavor, and thus the greatest market for spirits resulting from molasses is closed.

Alcohol is used in the manufacture of explosives, especially smokeless powder, varnishes, perfumery, and in chemical laboratories, also in soap factories to a small extent. Alcohol is also used as a fuel for automobiles and small motors and

has a calorific value about that of coal, with the advantage that it can be used in gas engines and burns completely without leaving any residue as do gasoline or other hydro-carbons.

Alcohol can be used for lighting purposes, and it is reported that alcohol lamps, using a mantle of the Welsbach or Auer type, produce a light equal to electric incandescence at about half the cost, and without odor or other upleasant features.

But for fuel and lighting purposes the United States Internal Revenue Tax of $1.10 per proof gallon is prohibitive, and until the people of the United States demand cheap alcohol for the purposes of lighting and fuel, there is no hope of utilizing our waste molasses in this direction.

A distillery to produce 5,000 gallons of 96% alcohol per day, would cost put up in running order in the Hawaiian Islands about $200,000.00; would require a force of about 35 men, with a monthly pay roll of about $2,500.00; the monthly expenses for fuel and other supplies, etc., not including the raw molasses or containers would be about $5,000.00.

The value of the containers, (if casks) would reach nearly $4,000.00 per month when working at full capacity, and the molasses required to produce 5,000 gallons of 96% alcohol per day (say 14,000 gallons) would cost at 3c. per gallon delivered to the distillery $420.00 per day, or say $11,000.00 per month.

We have then one month's expenses:

Pay roll	$ 2,500.00
Fuel, supplies, etc.	5,000.00
Containers for 130,000 gals. spirits	4,000.00
Molasses (raw material)	11,000.00
Wear and tear and interest at 10% per annum, per month	1,700.00
	$24,200.00

Output 130,000 gallons 96% alcohol.
Cost per gallon 18.6c.

If this 96% alcohol were to be put on the market anywhere outside of the United States, say Japan, it would come into competition with German spirits of the same quality, which are laid down at the present time in Yokohama in bond for 27½c. per gallon, done up in 10 gallon cases, said price including cost, freight, insurance, containers and manufacturers' profit. Deducting freight, insurance and containers, the cost of the alcohol from Germany works out at 19½c. per gallon, which confirms the above estimate of cost of manufacture in this country, and shows that the margin of profit is too small to warrant reaching out for foreign trade in this direction. To recover the potash after the sugars have been removed by distillation, the liquid from the distillery must be evaporated to dryness and the residues calcined in a suitable furnace,

leaving the values available as caustic potash; but as the percentage of potash does not exceed 4½ in Hawaiian molasses, the cost of evaporating the liquid and calcining the residues, will not be met by the cash value of the product, so that this will not be a paying proposition.

Molasses has a value as fuel, and when properly burnt is about equal to bagasse.

There are several ways of burning molasses in use in this country, but it is very questionable if the full thermal value is obtained.

The simplest way is to sprinkle the waste molasses on the bagasse as it leaves the last mill on its way to the furnaces. When molasses is fired in this way at the rate of about 50 lbs. molasses per ton of cane ground, it burns readily, and is of marked assistance to the bagasse as fuel. A greater quantity than this, however, tends to clinker the furnaces, and instead of being a help is a hindrance to the fuel qualities of the bagasse.

Another way is to atomize the molasses by steam as fuel oil is atomized. This is successful in burning the molasses, but as it takes 1¼ lbs. of steam to atomize one lb. of molasses, which when burnt to the best advantage only produces 2½ lbs. steam, it is readily seen that there is no gain in this method over that of sprinkling the molasses on the bagasse, which latter method is by far the simpler.

Another method is that of burning the molasses in a retort-furnace specially adapted for the purpose, means being provided for saving about one-half of the potash, which is recovered in the ashes. This seems to be the best method of utilizing molasses as fuel, but sufficient data is not yet available as to the results.

In all cases where molasses is burnt with the bagasse, a certain portion of the potash is available in the ashes, which when put upon the land, yields results, the cash value of which is difficult to estimate.

The best price which ordinary waste molasses in quantity would fetch in San Francisco is from $5.00 to $6.00 per ton delivered. A ton of molasses contains 166 gallons, and at $5.00 per ton would be worth 3c. per gallon delivered; it would cost at least $3.00 per ton to deliver molasses in San Francisco, or 1.8c. per gallon, leaving 1.2c. per gallon as the net value of a gallon of molasses to the seller here, and since the fuel value of a gallon of molasses is equal to 4 pounds of coal, which is worth at present prices .3c. per lb., it appears that burning the molasses is as good a way of disposing of the waste as selling it, which involves some capital expenditure for containers and arrangements for storing.

But the average waste molasses contains some 35% of sugar, which is equivalent to a little over 4 pounds of pure sugar per gallon; and it is almost certain that by improved methods of

clarification and filtration of the molasses, a large percentage of this loss could be recovered, but a special plant would be required, and it is doubtful if it would pay, excepting in factories of very great capacity, which concerns might purchase the waste molasses from smaller factories at a price based upon the sugar content, and work it in with their own products, in which manner it is quite possible that a substantial saving would result.

Molasses diluted with water, and run upon the land is said to have value as a fertilizer; no figures, however, are available. The only fertilizing value the molasses can have, lies in the potash content, as the nitrogen in molasses is a very small quantity and probably is lost in dilution and exposure to the atmosphere, going off as ammonia.

A brief summary then shows that bagasse as a bye-product of cane is more valuable as fuel than for any other purposed; while waste molasses can be converted into spirits for use as a fuel and for lighting purposes at a small profit, provided that the fiscal regulations permitted, and the American market demanded such. At the present time, however, the best use to put molasses to, exclusive of that small amount which is fed to live stock, is to use it as fuel, or as fertilizer.

There is, however, no doubt but that efforts will be made in the near future to still further exhaust the waste molasses of its sugar contents, since the gross loss amounts to the very large figure of some 30,000 tons of sugar per annum.

J. N. S. Williams.

Puunene Mills, Maui, Nov. 9, 1903.

Mr. E. E. Hartmann, who has looked into this matter from both a practical and a scientific standpoint, says:

UTILIZATION OF BY-PRODUCTS.

The most important among the waste products is the molasses. With the exception of a small quantity fed to the stock, little use has hitherto been made of it. The sugar left in the molasses is no doubt disposed of most economically if used for feed. In practice good results have been obtained from the use of molasses as feed for horses and mules, when used with discretion. Whether it is suited for milch cows is still an open question.

On the plantations only a small portion of the waste molasses can be used up in this manner. An attempt has lately been made to prepare the molasses in such a manner that it can be exported. Geo. Hughes of Barbados introduced, under the name of Molascuit, in England and the United States, a combination of waste molasses and fine bagasse. Eighty

parts of molasses are mixed with twenty parts of shredded bagasse and the mixture dried until it contains about 10% of water. Below are the analyses of two samples of Molascuit, one from Louisiana, the other from St. Kitts. Molascuit made with our molasses would, of course, have a higher percentage of ash and less sugars.

	Louisiana.	St. Kitts.
Albumin	2.1	1.6
Fat	.3	.2
Sugar	61.0	66.3
Digestible Cellulose	10.6	8.7
Indigestible Cellulose	6.5	4.6
Ash	6.9	3.3
Water	12.6	15.3
	100.0	100.0

The utilization of molasses as feed stands undoubtedly first in the line of economy, i. e., if fed to the stock on the plantation only, so that the potash salts are recovered in the stable manure. If Molascuit is exported, the ash is lost, the value of the material being based solely on its contents on carbohydrates and albuminous nitrogen.

Both the sugars and the ash,—and, if required, also the nitrogen,—are saved where spirits is made. But little information is to had in regard to the economical aspect of the manufacture of spirits from cane molasses either here or in Louisiana, though it is hard to understand why a serious attempt was never made in this country to make rum. Great progress has been made in the distilling industry during the last few years, and a distillery might to-day prove a lucrative undertaking, while estimates made ten years ago, were not of a nature to encourage anyone to embark in this industry. The production of spirits for consumption would in all probability prove highly remunerative; the production of commercial spirits, (95%), does not promise to be as profitable, the price of this product being very low.

The remainder from the distillation is of great value as a fertilizer. The lees are generally evaporated to the consistency of a thick syrup, the latter charred and burned in a furnace similar to a molasses furnace, the heat given up by its combustion being utilized for the evaporation; the ashes, consisting mostly of potash salts, may be used directly on the land, or may be sold. A portion of the dunder might be applied to the land with the irrigation water; the portion which cannot be distributed directly in the irrigation water could be evaporated and mixed with carbonate of lime. A fertilizer made in this manner could easily be transported.

A very simple and seemingly economical manner of dispos-

ing of the waste molasses is by running it onto the land with the irrigation water. In this way there is theoretically nothing of the fertilizing value lost. There are so far not many data available as to the advantages of this method. In one or two instances encouraging results have been obtained here, while results of experiments made last year in Java by Prinsen Geerligs were negative. These experiments were, however, as Prinsen Geerligs points out, not conclusive. Moreover, they have no bearing on conditions as they exist here. Almost all our lands require some addition of potash, while in Java, both the lands and the irrigation water are so rich in potash that this latter ingredient need not be, and in fact is not, used in fertilizers. Considering that potash salts form 60 to 70 per cent. of the mineral constituents of the molasses, great things could hardly be expected from their use under such conditions.

There is the danger—particularly with insufficient dilution—that the sugars themselves and the acids resulting from their fermentation in the soil have a damaging effect on the soil—probably owing to the influence they exert on the nitrifying bacteria.

This factor of danger may be eliminated by burning the molasses. Of course by this method all the nitrogen and a more or less considerable proportion of the potash is carried off by the combustion gases. It is evident that the more rapid the combustion, the higher will be this loss. The best heat effect is obtained by feeding the molasses into the furnace by means of an atomizer, in a similar manner as applied to oil. I do not consider this plan economical, as the additional fuel value does not make up for the very much greater loss in potash and the trouble caused by deposits of condensed potash salts in the flues, etc.

The terrace furnace requires more attention and gives a lower heat effect, but this is more than balanced by the far higher yield in ashes.

Molasses has been used in many of the mills of the Islands as a fuel, the method most generally in use being that of sprinkling the molasses upon the trash between the rollers and the furnaces. While there seems to be no doubt as to the value of molasses as a fuel, when properly burned, the result has been in nearly all cases a great accumulation of clinker in the furnaces and boiler tubes.

Mr. George H. Fairchild, of Kealia, Kauai, has given special attention to the use of molasses in this way, and writes as follows:

Kealia, Kauai, November 19, 1903.

W. W. GOODALE, ESQ.,

Chairman Committee on Utilization of Waste Products,
Waialua, Oahu.

Dear Sir:—Some months since while observing the burning of crude oil at the Crockett Refinery, it occurred to me that we might treat our waste molasses in much the same manner and obtain better results from burning it than we had up to the beginning of last season. The burning of the molasses with the trash had been tried by us, but the potash in the molasses united with the silica in the bagasse and in a short while our gratebars were clogged with the glass formed.

The atomization of the molasses and its combustion before it came in contact with the trash seemed feasible. I gave the plans, etc., of the Crockett oil burning plant to our engineer, Mr. Anderson, with instruction to see what he could do in the way of making a practical molasses burner, and as he was mainly responsible for its construction and successful working, I hand you herewith his own report, which should be better than anything second hand from me. I take pleasure in endorsing all that Mr. Anderson has written and can vouch for the successful working of the burners in our mill.

Yours very truly,

GEO. H. FAIRCHILD.

The report of Mr. Anderson, referred to by Mr. Fairchild, is most interesting, and is given in full:

MR. GEO. FAIRCHILD,

Kealia, Kauai.

Dear Sir:—In reply to your request for a description of my molasses burner and a report on its work, I have much pleasure in submitting the following for your consideration, with the hope that it may be sufficiently clear to be understood by all who are interested in the question.

You will remember that it was at your instigation, that I set about seriously to cope with the subject of using waste molasses as fuel, somewhat on the same lines which were being successfully followed in burning oil.

The first few experiments showed that we had a very different article to deal with, although in many respects they were similar. I had become convinced that it would only be by

some system of atomization, that molasses could be successfully burned, as a supplementary fuel in our bagasse furnaces; also that when the molasses was introduced to a furnace in this finely divided state, the hot brickwork which surround our furnaces, offered a splendid medium for instantly converting this waste product into heat. It is needless to enter into all the details of the experiments which I conducted at Kealia last year, as the conclusions arrived at will be sufficient for the present purpose. Those were as follows:

1. That atomization of the molasses was a long step in advance of any other method which had previously come under my notice, in so far as it was rendered more readily combustible, produced less slag and dirt, could be more easily controlled, and a very sensible gain in heat and saving in fuel was apparent.

2. That molasses, owing to its viscous nature and liability to cake or harden with heat, required that in the apparatus for atomizing it, provision must be made for.

(a) Forcing the molasses through the burner in an even steady stream;

(b) For atomizing it with a dry gas;

(c) For opening the nozzle and blowing out any obstruction;

(d) For protecting the working parts from heat;

(e) For blowing out all molasses from pipes which came in contact with furnace and leaving them clean when suspending operations or shutting down;

(f) For returning surplus molasses to tank.

3. That the greater the area of heated brickwork which could be covered by the molasses, in the same proportion was the efficiency and capacity of the burner increased.

I will now describe the apparatus as installed in the Makee Sugar Company's Mill at Kealia, and operated successfully through the crop of 1903.

The burner is detachably fixed in a cast iron water-jacketed case, and this case is built in the front wall of the furnace. Molasses and superheated steam are supplied to the burner through separate pipes, the steam blowing the molasses through a slit-mouthed nozzle, and diffusing it over the whole area of the furnace in a fine spray, the molasses being thoroughly atomized. The upper half of the nozzle is hinged, and provided with a means for opening up the mouth of the nozzle, and blowing out any impediment which may have lodged there. The steam is taken from any convenient part of the boiler, and passed through a coil in the uptake flue, which superheats it and renders a dry and almost perfect gas. The molasses is supplied through a header to the various branches for a battery of boilers, by a duplex pump from a feed tank. The molasses header is extended at each end, the extentions forming return pipes for the surplus molasses.

These extensions join in a relief valve with adjustable weight over the feed tank. This arrangement allows of any desired and uniform pressure being maintained on the molasses, and also of any desired feed to the burners, as all surplus molasses is returned through the relief valve to the tank. The pressure on the relief valve which I used at Kealia, and found to work admirably, was 75 lbs., with about 100 lbs. pressure on the boilers. The whole arrangement can be operated from the furnace front and its work observed through a suitable opening in the front of the water-jacketed case.

In the event of repairs or thorough cleaning of the burners, the whole thing can be detached and removed from the case, without in any way interfering with the regular work of the furnace.

The water-jacketing arrangement prevents injury from heat to all the working parts. The supply of steam and molasses is controlled and regulated by suitable valves, and a steam by-pass is also provided for blowing out and cleaning molasses portion, when shutting down.

While discussing with Mr. George Conan the advisability of decreasing grate surface where the chimney draft was ample, I saw in this idea an opportunity of increasing the molasses burning area at the same time. With your consent, I reduced each furnace from 6 ft. wide to 4 ft. This enabled us to use six boilers instead of five, which, while increasing our heating surface and rendering our boilers more safe, also increased the molasses burning area in each furnace appreciably, and added one more effective molasses burner to the battery.

While cleaning the boilers at the end of a week in which considerable molasses had been burned, we noticed that a large amount of fine ash was taken from under the boilers. When analysed this ash was found to be rich in potash as shown in accompanying report, 24.63%—22.74%.

The amount of ash recovered after burning the molasses from three crystallizers=150,000 lbs. of molasses, was 3,920 lbs., which represents about 950 lbs. of pure potash. As this ash is a valuable by-product obtained by burning molasses in this way, I have suggested the introduction of barriers and pits under the boilers for its more effective recovery. (A sketch of this is in Mr. Catton's possession.)

Anticipating some practical questions from practical men, I append the following questions and answers:

(Q.) What is the value of molasses burned in this way when compared with coal?

(A.) All authorities which I have been able to find on this subject give the value of molasses as ⅓ to ¼ the value of coal. I was unable to get a thoroughly reliable test for a sufficient length of time to satisfactorily answer this question, but from the most lengthened periods, I estimated its value as 1-6 and

this was a very conservative estimate. On this conservative valuation, the saving on a place like Kealia would be 15 tons of good coal per week, which on a 10,000 ton crop would amount to a saving of about $3,000. Then to this must be added the value of the potash recovered from the ash.

(Q.) Has the molasses burned in this way any injurious effect on the furnace?

(A.) None that I was able to see. A little ash or clinker appeared on the brickwork, but I have seen as much and sometimes more where no molasses was burned.

(Q.) Any injurious effect on boiler shell or tubes?

(A.) None that I was able to see; the shells and tubes at the end of last crop were perfectly clean and entirely free from any pitting whatever.

(Q.) What is the effect of heating the molasses?

(A.) If heated by a closed steam coil, the molasses froths up and becomes unworkable, if with steam as in a "blow up," there is so much more water to be evaporated in the furnace. If the molasses is exceptionally heavy and viscous, a little blow up is necessary, but for ordinary waste molasses no heating is required.

(Q.) Would not compressed air be preferable to steam?

(A.) It might have a slight advantage over steam as a combustible, but I think it would scarcely equal the steam as a cleansing agent and it would necessitate the use of an air compressor. If the steam is superheated and the conducting pipes well covered, I think it should be preferable.

(Q.) Is a pump necessary?

(A.) Yes, otherwise the flow is too sluggish and uncertain.

(Q.) Is the water-jacketed case necessary?

(A.) Yes, absolutely necessary, as the burner will become injured by heat, the molasses will cake and it would be impossible to remove burner while furnace was in operation. The water must also be kept circulating, so long as the furnace is in operation, although the burner itself may be inactive.

(Q.) Does the apparatus require much skill to keep in order, or attention while it is in action?

(A.) The working of the apparatus is simple and very easily understood. Any Jap or Chinese boiler attendant of ordinary intelligence can master it in a very short time. I had to watch them closely at Kealia for a few days, as it necessitated a little extra work or rather work of a new kind, which by the average Chinese is never accepted without a fight. These were a number of new valves and a pump to attend to, but so soon as they became acquainted with the details and appreciated its value as a fuel, in that it was easy stoking when compared with coal, and that it meant a big trash reserve pile, they went chasing the sugar boiler for more molasses, when the supply looked like running out.

I instructed a Jap assistant in the machine shop to keep the burners in order. This became part of his weekly duties, to examine them all when the mill shut down and see that they were all clean and in shape for the following week.

(Q.) If I have all the bagasse I can burn, where is the advantage in burning molasses?

(A.) Increase your maceration and take out more sugar. If your evaporating plant limits your maceration increase your evaporating plant or improve it; if, owing to a high percentage of fibre in your cane you have still sufficient bagasse after reaching the economic limit of maceration, don't run your molasses to the sea, burn part of it and recover the potash. Mix the remainder with your surplus bagasse and feed your stock, if you have no pumping plant or other operation in which you can use your surplus bagasse. You are bound to save money in any case. If you have surplus bagasse, because you cannot get over 88% extraction with 25% dilution, it is time your crushing plant was improved or renewed. You have been spending money saving driblets here and there, while a deep rich stream of molasses has been running to the sea or messing up your furnaces. Turn it to the boiler house and atomize it in the furnaces. By so doing you will increase your output of sugar and decrease your expenses.

There is nothing further on the question that I can think of in the meantime, but I shall be glad at any time to give any further information to any one desiring it.

I am, yours most respectfully,

JNO. ANDERSON.

Elm Row, Selkirk, Scotland, 7th September, 1903.

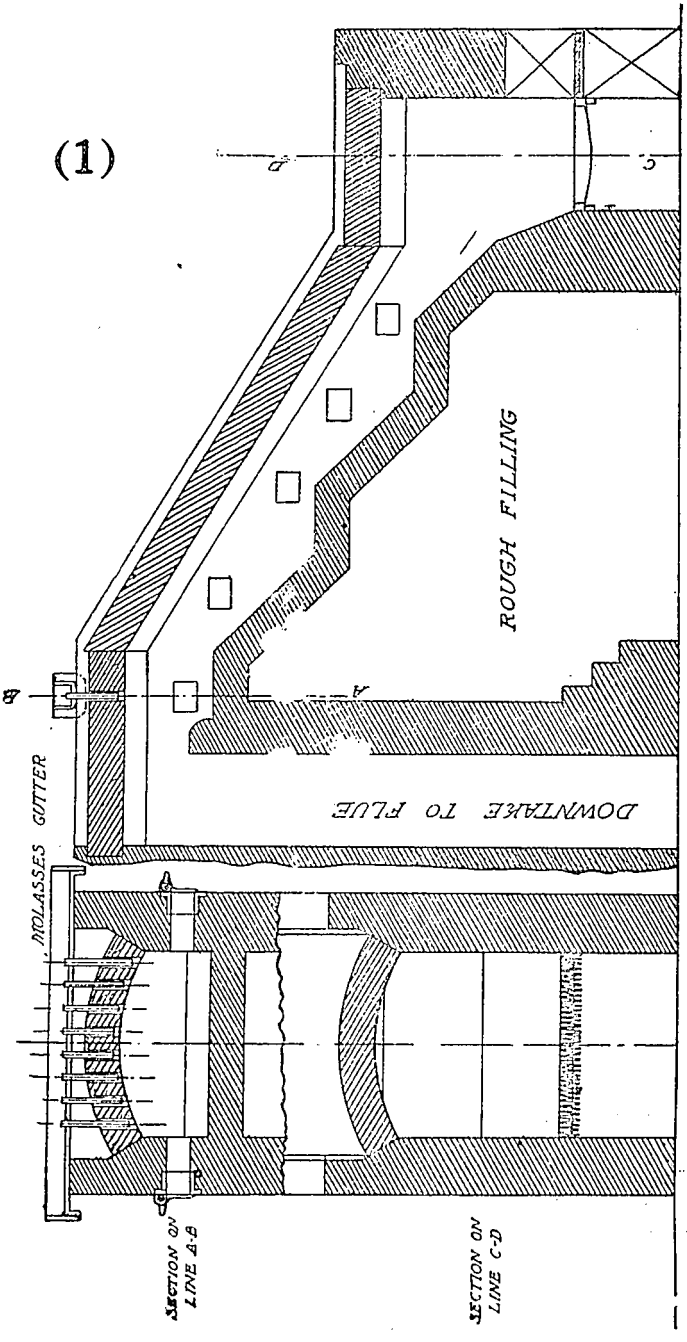
Mr. J. M. Steel, who has been engineer upon sugar estates in Fiji, has had experience in this line, and reports as follows: Sketches of the furnaces in successful use in Fiji also accompany his letter, and are made a part of this report.:

BURNING WASTE MOLASSES.

Waialua, Oahu, November 21, 1903.

W. W. GOODALE, ESQ.

Herewith, I have pleasure in handing you designs for two furnaces for burning waste molasses. The design (1) is for a type of furnace of which one or two have been in use for several years in Fiji and Queensland. In this furnace the molasses is fed in from a cast iron gutter, by means of iron nozzles through the arch in the highest part of the furnace. It falls upon a level brick surface. From thence it flows down a slope of about 45° to another level surface, lower down. From


(1)
ROUGH FILLING
DOWNTAKE TO FLUE
MOLASSES GUTTER
SECTION ON LINE A-B
SECTION ON LINE C-D

this it again flows down another similar incline to a third level surface, from which it is raked down onto the furnace grate, being by this time completely dried and charred.

In starting the furnace, a fire of wood or other fuel is built upon the grate. As soon as it is well under weigh, the molasses is slowly turned on. As it flows over the hot brickwork the water is rapidly evaporated. On the sides of the furnace are small hand doors, through which the attendant from time to time inserts a suitable rake, and sweeps the charred molasses down to the fire grate. As soon as a supply of this reaches the grate, no other fuel is required.

The principal fault of this furnace is, that it requires constant attendance. This would not be regarded as a serious matter in a country where labor is plentiful and cheap, but here it would be a different matter! To obviate this difficulty, I have prepared design (2). In this design the molasses falls into the upper part of an inclined fire-bricklined cylinder, at the lower end of which is the fire grate. The cylinder slowly revolves upon its axis, and as the molasses is carried round it is charred upon the hot surface. As soon as it is charred it falls off, finally falling out at the lower end onto the fire grate. As the delivery from the revolving cylinder is to one side, the centre of the fire grate should be placed to one side of the cylinder centre line, so that the charcoal may fall in the centre of the grate.

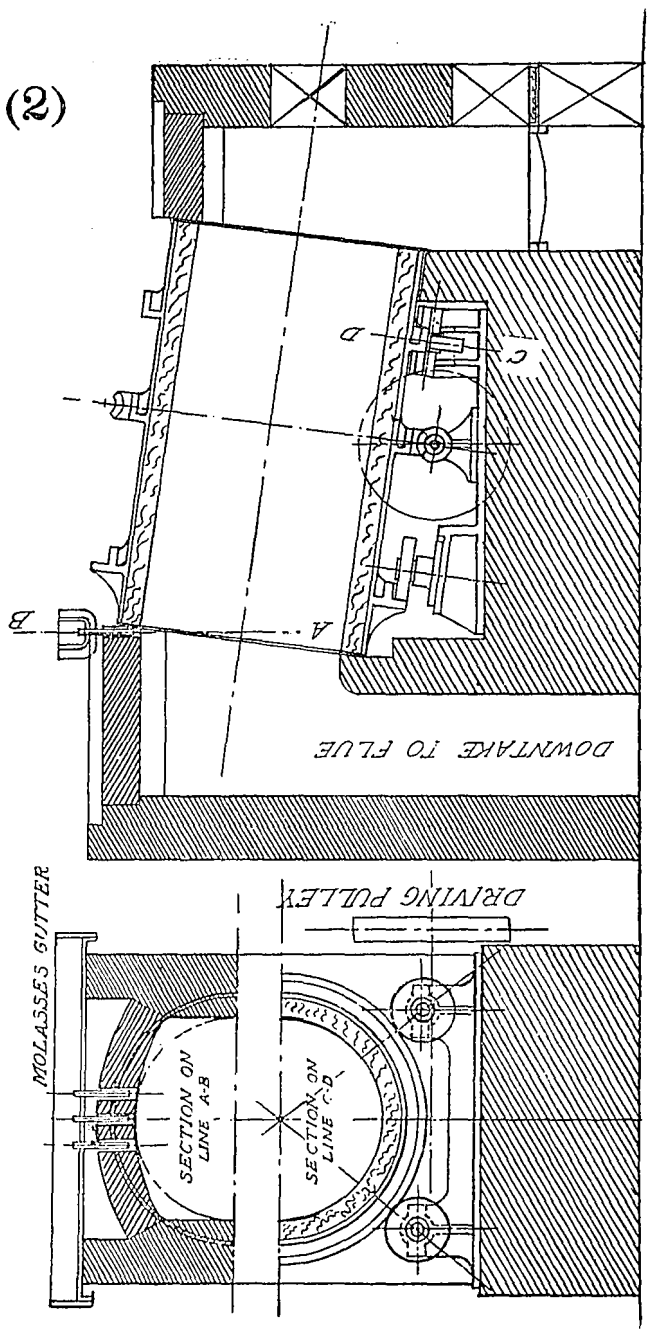
It would probably not be worth while to install a special boiler for the molasses-burning furnace, but in order that the heat generated may be utilized, the flue from the furnace should be led into the combustion chamber, under the boiler of one of the other furnaces.

In working a molasses burning furnace, care should be taken not to allow the fire to become too fierce, as at high temperatures a considerable part of the most valuable constituent—the soluable potash, will be volitalized and carried off with the gases of combustion.

When this happens, either with molasses burned with bagasse or other fuel, or by itself, the fact will be plainly evidenced by the white cloud of potash dust and vapor seen escaping at the chimney top.

To prevent the attainment of too high a temperature, the draft should be no stronger than is absolutely necessary, and only a limited amount of air admitted through the ash pit, the major part of that required being admitted through the furnace door and sides, at or near the surface of the burning fuel.

On the sketches of the furnaces ash pits are shown of the ordinary kind, with a door in front. I think, however, that if it could be arranged, the bottom of the ash pit should be in the form of a hopper, from whence the ash could be drawn off


(2)
D
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DOWNTAKE TO FLUE
DRIVING PULLEY
MOLASSES GUTTER
SECTION ON LINE A-B
SECTION ON LINE C-D

from time to time into suitable receptacles, with the least amount of disturbance.

The great advantage of this system of burning molasses, is that, while its full value as a fuel obtained, that which is still more valuable, the potash, is preserved in a soluable form.

When molasses is burned with bagasse, such of the potash as escapes volatilization combines with the silica of the bagasse ash forming an insoluable siliciate or slag, which is without value as a fertilizer, and which, by clogging the fire grates is apt to give much trouble in the furnaces.

Regarding the consumptive capacity of a furnace of given dimensions, I am without any reliable data. With any furnace the rate of consumption can be varied within very wide limits at pleasure, but in every case ample grate area should be provided, as the smaller the consumption per square foot of grate surface, the lower the temperature will be and the volatilization of potash less.

When the rate of combustion is rapid the loss must be greater proportionately, owing to the necessarily higher temperature, and also to the larger amount carried off as dust, by the stronger draft.

J. M. STEEL.

MR. AUGUST AHRENS of Waipahu, says:

"We burnt for a while our molasses with the bagasse, but found that the molasses ashes encrusted the economizer tubes to such an extent that we had to give it up."

MR. H. P. BALDWIN says:

"No exact tests, but observation as to the value of molasses as fuel."

MR. WM. STODART of McBryde, says:

"Molasses as a fuel now being tested; no exact data yet obtained as to its value."

"Bagasse ashes deposited on walls of furnace as a fine powder in perfect mechanical condition for use as a fertilizer. Potash—8.14%; Phosphoric Acid, 1.68; Lime, 10.98; Soda, 4.21; Inorganic 5.81; Silica 57.52; Iron and Aluminum Oxides 11.21."

MR. ANDREW ADAMS, of Kahuku, says:

"Mill ashes 13% Potash. We formerly burned molasses with bagasse. A mixture of molasses ash and bagasse ash showed 4.13 per cent. soluble salts; .94 per cent. silica; 1.79 per cent. only of potash. Burning of molasses was then discontinued, and waste run into plant cane field of pure sand, crop of 1904; results later. We feed 6 lbs. daily to each mule."

MR. JAS. GIBB of Paauhau, uses waste molasses as mule feed.

MR. D. C. LINDSAY of Paia says that part of the waste molasses is fed to the stock, the rest used as a fertilizer. Scum press cake analysis shows a fertilizing value of $4.50 per ton.

MR. SCOTT of Wainaku. says:

"Scum press cake and ashes are mixed and run through a disintegrator and applied to the land as a fertilizer. We are using waste molasses for feeding our animals, and effecting a saving in hay and grain of 30%. Waste molasses analysis—Brix 86.6; Sucrose 24.1; Purity 27.8."

MR. B. D. BALDWIN of Makaweli, says:

"Waste Molasses—Ash 12.10%
Nitrogen . .... .26%
Potash 4.90%

"Mill ashes are valuable as fertilizer on our lands."

At Waialua molasses was burned on the trash for some weeks, but the slag formed so rapidly in the process, and there was such an incrustation on the tubes of the boilers, that method of using waste molasses was abandoned. A set of samples of the slag and clinker accompany this report.

A small quantity is used as feed for stock, and the remainder runs out with the waste water from the mill into a field of sandy land, without injurious effects.

Scum press cake, with all the water used in washing presses, is put into tank cars and hauled into the field, a gate in the bottom of the tank opened, and a stream of water turned into the car. The cake is thus washed into the main water ditches, carried off by the water, and distributed over a large area.

The dry scum press cake at Waialua contains
85.27% Organic Matter
14.73% Ash

with a fertilizing value of $8.55 per ton, as shown by the following analysis:—

		@ ¢ per lb.	
Nitrogen	1.54%	15	$4.62
Silica	3.60%	..	.....
Phosphoric Acid	2.92%	6	3.50
Potash	.43%	5	.43
			$8.55

The following shows a complete analysis of the Waialua waste molasses, made by Mr. E. E. Hartmann:

ANALYSIS OF MOLASSES.

Water	17.65%
Sucrose	28.00%
Glucose	16.65%
Gums	3.88%
Other Organic Matter	21.25%
Ash	12.57%
	100.00%

Nitrogen	.584
Specific Gravity	1.4934
Brix	91.2°
Acidity	4.0

ASH.

Ca O	9.71
Mg O	2.57
K2 O	42.47
Na2 O	3.20
Fe2 O3	1.70
Al2 O3	....
P2 O5	1.22
S O3	12.00
Si O2	2.16
Cl	25.40
CO2 & diff	5.29
	105.72
O equiv. to Cl	5.72
	100.00

Fertilizing Value of Molasses per Ton:

107 lbs. Potash @ 4 1-2 ¢ per lb	$ 4.81
12 lbs. Nitrogen @ 15 ¢ per lb	1.80
	$ 6.61

Fertilizing Value of Molasses Ash per Ton:

850 lbs. Potash @ 4 1-2¢ per lb	$38.25

MR. ROBERT HALL, of Niulii, says:

"We have used molasses with cut cane tops for years. Also use mixed scum press cake and ashes for fertilizer."

MR. GEO. ROSS, of Hakalau, says:

"We feed about six pounds of waste molasses to our work

horses and mules per day all the year round and find it a valuable adjunct to the other food rations and a considerable saving in expense.

MR. E. E. OLDING sends the following analysis of waste molasses used for fertilizing purposes:

	Sample No. 1.	Sample No. 2.
Total Solids	79.75	80.
Insoluble Ash	.25	.90
Lime	1.	1.44
Magnesia	.42	.32
Potash	2.24	3.88
Sulphuric Acid	.42	.61
Phosphoric Acid	.17	Trace
Chlorine		1.95
Nitrogen		.31

MR. FORBES, of Kukuihaele, says:

"For the past four years we have not allowed a gallon of molasses to go to waste—that is, to the sea or beyond recovery, as was done in former years. I have used up molasses in the following ways: As feed to our mules and horses, mixed up in cane tops, or the fine megass dust which can be collected on carriers through a wire screen; also to our milch cows and feed cattle, of which we keep about 20 head, and hard feed once a day. Of the molasses not used up in feed we prepare a soil dressing in various ways, mix up with mill ashes and press cake, applying to the soil after the pile has once been turned over and heated to assist disintegration; then at times, if there is any spare trash, we have mixed up molasses and carted out on fallow land, but this is a dangerous quantity to handle, being readily combustible. One of the best composts I have got is secured by mixing up a certain per cent. of sulphuric acid with molasses, which reduces the molasses to a powder; this to be again mixed with the press cake, makes a dressing from which we never fail to note results."

When the horses and mules on a plantation are doing hard work and at the same time keeping in good condition on the regular diet of barley, cane tops and hay, a careful manager is unwilling to make any change, believing in letting well enough alone.

The use of molasses for feed has become so general, however, that there would seem to be no risk in adopting the use of a small quantity per day with other feed. Of the many managers who have tried it but one reports any injurious action. He states that the practice was followed for some years, but was abandoned on account of the mules losing their teeth.

An article referring to the use of molasses as feed for horses, published in the "Saturday Evening Post," has been widely copied, as follows:

"Scientific tests in substituting molasses for oats and other cereals in feeding horses have yielded surprising results. It is now definitely established that as a horse diet there is magic in molasses. The horse rapidly takes on solid weight, develops prodigiously in muscular energy, grows a glossy coat and enjoys uninterrupted health. For these animals, therefore, molasses is declared to be both a tonic and a health food. A molasses diet reduces the cost of horse maintenance over 25 per cent.

"For scientific experimentation two abject and unthrifty animals were selected. One weighed 900 pounds, the other 940. No preparation was made for the sudden change of diet, but in place of the usual allowance of hay and oats the horses were given, three times a day, one quart of molasses diluted with three quarts of water and mixed with five pounds of cut hay. A marvelous improvement in the animals resulted. In two weeks one gained forty pounds in weight and the other forty-five. In four weeks from the beginning of the molasses diet horse No. 1 gained ninety-five pounds and horse No. 2 one hundred and two pounds.

"After six weeks horse No. 1 weighed 1,075 pounds and No. 2 1,086 pounds. All symptoms of decrepitude disappeared. At the termination of the six weeks' experiment the animals could not be recognized as the forlorn creatures with which the tests had been begun. The animals are now employed profitably by commercial firms.

"These and other tests are extending the use of molasses as a food for horses. Firms employing many horses in the hardest kind of contract and truck work are discovering that the animals will perform more service and remain in better condition on a diet of molasses than when fed the choicest and most liberal allowance of cereals. In the United States Artillery Corps there are enthusiastic champions of molasses as a horse diet, and horses in the armies of France, Russia, Germany and Austria are being fed on molasses with very satisfactory results.

"The conclusion that eminent specialists have arrived at is that good molasses is not only a fattening and energy-producing diet for horses, but that in many cases it will restore ailing animals to health. The cost is an important consideration. One quart of molasses at 3 cents takes the place of from three to four quarts of the best quality of oats at from 4 1-2 to 6 cents."

The "Agricultural Gazette" of New South Wales publishes a pamphlet on the "Economic Feeding of Working Horses," written by T. U. Walton, as follows:

*THE ECONOMIC FEEDING OF WORKING HORSES.**

By T. U. Walton, B. Sc., F.C.S., F.I.C.

It is a generally accepted principle that in order to keep a working horse in good condition a food rich in nitrogenous material must be used, or, as it is sometimes expressed, the "albumenoid ratio" must be high. This ratio is defined as the numerical relation of the digestible nitrogenous matter in the food to the digestible carbo-hydrates (including any small quantity of fat, calculated into its equivalent of carbo-hydrate, but not including any digestible fibre, which has been found to be useless for the production of work[1]). Thus a ratio such as 1 to 5 is said to be high, while a ratio of 1 to 12 is regarded as low.

For farm horses Wolff, the recognized German authority, recommends[2] a daily diet containing the following quantities of nutriment per 1,000 lb. live weight:

1.56 lb. digestible albumeniods.
11.19 lb. digestible carbo-hydrates (including 0.5 lb. fat).
Albumenoid ratio 1:7.

When horses are very hard worked he recommends an increased diet still richer in nitrogen:

2.5 lb. digestible albumenoids.
13.8 lb. digestible carbo-hydrates.
Albumenoid ratio 1:5½.

The object of the present paper is to give a short account of some feeding trials conducted on a very large scale, which prove that at least under certain conditions a high diet is not essential to the performance of hard work or the maintenance of good condition, provided sufficient nutritive food be given.

In Fiji the Colonial Sugar Refining Company have about 1,000 head of farm horses and mules, which, until a few years ago, were fed chiefly on oats and maize, with some green cane tops in addition. But this did not prove satisfactory in the trying tropical climate; sickness was frequent, and the death rate high, while the charge for fodder was very heavy. As large quantities of waste molasses were available, it was thought well to investigate whether the sugar in this material might not be advantageously used as a substitute for some of the starch in the ordinary food.

The use of beet molasses for feeding dairy cattle and for fattening stock has in certain parts of Europe proved highly satisfactory, but I have seen no record of its use in the regular

*Read before the Congress of the Australasian Association for the Advancement of Science, 1898. Since this pamphlet was compiled the system has been continued in Fiji, also extended to other places, with equally satisfactory results.

[1] Farm Foods, by Wolff, transl. by Cousins, p. 111.

[2] *Ibid*, p. 242.

diet of working horses. Cane molasses contains much less nitrogen than beet molasses, the Fiji article having only one-fifth of what is usually present in the beet product, and being, therefore, according to the generally accepted theory, less valuable for feeding purposes.

When these trials were commenced care was taken to begin with only small quantities of the new fodder lest the high proportion of salts should prove too laxative. Horses unaccustomed to sugar do not like it at first, but the sweet taste is soon acquired, after which they will eat it in preference to any other food. With the growing appetite for it the proportion of molasses was gradually increased till as much as 30 pounds per day were regularly given to many of the animals. This large proportion was after a time, however, reduced to 15 pounds; not by reason of any ill effect beyond a tendency to fatten, but because it was considered too risky an experiment with so much valuable stock. Contrary to expectation, the molasses diet produced constipation, instead of being laxative, and a few pounds of bran had to be given daily to keep the bowels in order. The ration finally adopted was 15 pounds molasses, 3 pounds of bran, and 4 pounds of maize per day, with as much green cane tops as the animals can eat, the molasses being mixed with the bran and chopped cane tops. It may be mentioned that on one occasion when the supply of maize ran out, and had to be replaced by some additional molasses and cane tops, the absence of it for a month or two did not seem to affect in the least the health or working power of the horses. It has not yet, however, been decided to discontinue altogether the use of maize, and the ration referred to (15 pounds molasss, 3 bran, and 4 maize) has now been given daily to the whole stock of over 400 horses at Rarawai Plantation for nearly two years. The result is entirely satisfactory. There has been no undue fattening nor injury to the wind, and no tendency to excessive perspiration or softness. In the early stages of the trials, a dozen of the animals were weighed once a month, the average weight at the start being 1,273 pounds. After the first month there was an average loss of weight of 15 pounds per head; after the second month 4½ pounds of the loss had been recovered, and after the third month there was a further gain of 16½ pounds, making a gain over the whole period of 6 pounds per head.

Sickness, which formerly was frequent, is now uncommon, and the horses are capable of perfoming harder and more continuous work. The improvement in this respect is so great that while the area of cultivation has been largely increased, it has not been necessary to make any addition to the working stock.

Another important consideration is the financial result. In 1893, with oats as the staple food, it cost £13 3s per head per annum to feed the stock; in 1897 this has been reduced to £4 2s 2d* being a saving of over £9 per head per annum. Such

*Now (in 1900) about 40s per head for mules.

a saving, however, has only been possible by reason of large quantities of waste molasses and valueless cane tops being available on the spot. Cane tops cannot in ordinary circumstances be produced for horse feed by the farmer, though lucerne or any fresh grass is even more suitable. Then, for molasses, which at a sugar mill has little or no value, a price has elsewhere to be paid to cover the cost of carriage and handling. But this is not all, for the Custom tariff makes the use of molasses for feeding purposes almost prohibitive in all the Australasian Colonies in which it is not produced. In Queensland and New South Wales, with production of molasses beyond the demand for it, the tariff is inoperative, the selling price being actually lower than the duty itself. Yet, even in the Colonies where duty is charged, it is a question whether it would not pay to use a certain proportion of molasses, containing as it does, more digestible matter than oats,[2] though much less nitrogen, especially as it will often render palatable some dry food that it not otherwise readily eaten.

It is worthy of mention that at a second plantation in Fiji to which the molasses system of feeding has been extended, the same satisfactory results were not at first obtained, and it was only after a considerable time that the cause of failure was discovered. The molasses had to be pumped into a storage tank, but proving too thick to be taken readily by the pump it was thinned out with water by the engineer. Fermentation soon commenced, and the stock began to suffer from purging, which was for a time wrongly attributed to the molasses.

According to Wolff[3] the whole of the albumenoids and carbo-hydrates in molasses are digestible. Taking Wolff's analyses[4] of bran and maize in the diet that has been described above, but neglecting the cane tops, would give the following digestible constituents 1.02 lbs. albumenoids, 12.53 lbs. carbo-hydrates and 0.19 lb. fat. Taking 1 of fat=2½ carbo-hydrates, and reckoning the average weight of the stock at 1,270 lbs., the constituents per 1,000 lbs. live weight are:

0.80 lbs. digestible albumeniods.
10.24 lbs. digestible carbo-hydrates (including 0.15 lb. fat).
Albumenoid ratio, 1:12.8.

The weight of green cane tops is not exactly determined, but this is about 30 lbs. per 1,000 lbs. live weight, or 38 lbs. per horse. At the same time the nutriment in this fodder is low, and its albumenoid ratio is only 1:9, so that any variation in the quantity used has but a trifling influence on the whole diet. Taking the quantity as 30 lbs. per 1,000 lbs. live weight, this

[2] According to Wolff (*Farm Foods*, transl. by Cousins, p. 306) there is 57 per cent. digestible matter in oats, while molasses contains 64 per cent.

[3] Farm Foods by Wolff, translated by Cousins, p. 310.

[4] *Ibid*, pp. 306, 309.

would add to the diet 0.33 lb. digestible albumenoids and 3.07 lbs. digestible carbo-hydrates (including 0.22 lb. fat).

The whole daily ration per 1,000 lbs. live weight is then:

1.13 lbs. digestible albumenoids.

13.31 lbs. digestible carbo-hydrates (including 0.24 lb. fat).

Albumenoid ratio, 1:11.8; also 1.80 lbs. salts.

It is thus seen that the full proportion of carbo-hydrates considered necessary by Wolff for a hard-working horse has been experimentally arrived at in these trials, but that only half the orthodox proportion of albumenoids has been found necessary, and only half the fat. Probably the warmth of the tropical climate renders the small proportion of fat sufficient, but the satisfactory results obtained with the reduced proportion of albumenoids prove that the current theory on the matter is erroneous.

The conclusions that can fairly be drawn from the trials that have been made are:

1. That for working horses the sugar in cane molasses is a satisfactory substitute for starchy food, being readily digested and transformed into work.

2. That 15 lbs. of the molasses can be given to a 1,270 lb. working horse, with advantage to the health of the animal and to the efficiency of its work.

3. That it produces no undue fattening, softness, nor injury to the wind.

4. That the high proportion of salts in it has no injurious effect.

5. That an albumenoid ratio as low as 1 to 11.8 has proved highly suitable for heavy continuous work when a sufficient quantity of digestible matter is given.

TABLE OF ANALYSIS.

	Cane Molasses. (Fiji.)		Wheat Bran.		Maize. (Grain.)		Green Canetops.		Oats.	
Digestible albumenoids	2.5		10.8		8.0		1.1		8.0	
Do carbo-hydrates	61.5		42.3		67.5		9.5		42.5	
Do fibre	0		2.1		1.1		4.4		2.2	
Do fat	0		2.4		4.0		0.3		4.3	
		64.0		57.6		80.6		15.3		57.0
Indigestible albumenoids	0		2.8		2.1		0.6		2.4	
Do carbo-hydrates	0		6.8		1.1		4.1		15.3	
Do fibre	0		12.6		1.2		3.0		9.0	
Do fat	0		1.0		0.7		0.3		0.9	
		0		23.2		5.1		8.0		27.6
Water		26.0		13.6		12.7		75.2		12.4
Ash		10.0		5.6		1.6		1.5		3.0
		100.0		100.0		100.0		100.0		100.0

The analyses of bran and maize, as already stated, are from Wolff, those of molasses and cane tops have been made in the Sugar Company's laboratory, the separation into digestible and indigestible constituents in the cane tops being based on Wolff's analysis of sorghum.

Several years ago molasses was shipped to San Francisco in barrels to vinegar makers. The price paid for molasses delivered at plantation landings in barrels furnished by the buyer was $1.00 per barrel.

There was great difficulty in keeping the molasses in the barrels, as it would froth and overflow. The business proved unprofitable to the buyer, troublesome to the shippers, and was abandoned.

About one year ago a manufacturer in San Francisco offered $2.00 per ton of 2,240 pounds of molasses, to contain 40 to 50 per cent. of sugar, and the contract to be for ten years. The offer was declined, and a sample of the waste molasses forwarded with a complete analysis. The would-be purchaser expressed great surprise at the low purity and the high percentage of invert sugar and potash. The analysis of the sample sent was as follows:

Brix	92.6
Sucrose	27.2
Purity	29.6
Glucose	22.9
Glucose Ratio	83.6
Potash	4.85%

Conclusion: Although the bagasse carries with it a large quantity of sugar, it is not altogether a waste product. The loss of sugar can be controlled to a great extent in a well designed mill with sufficient evaporating capacity. It is not probable that any use can be made of the bagasse in the manufacture of paper or any other material that will be as valuable to the producer as it is for fuel. Its use for that purpose is confined almost entirely to the sugar mill where it is made. Scum press cake is a by-product the loss in which can be reduced to a minimum by proper methods of treatment. As a fertilizer it should be applied fresh, so that the soil will receive the lime, nitrogen and potash—its most valuable constituents.

Ashes, a by-product containing potash in a soluble form, should be so taken care of that they are not wet and the potash leached out.

Molasses, a waste and by-product, presents a more difficult problem. Improved methods of manufacture tending to reduce the sugar content to the smallest possible quantity also reduce the value of the molasses as a by-product for other purposes.

When the sugar-making processes cease, the problem becomes one for the chemist and the inventor.

To run the molasses into the sea or waste ditches is criminally wasteful.

To apply the molasses to the land in large quantities may injure the soil and throw it out of use for a long period until it regains its fertility.

To apply it to the land in such small quantities as not to injure the soil or growing crops then on the land is wasteful, as the quantity of potash or nitrogen is so minute that the plants receive no immediate benefit, and the rains or irrigation water will carry the useful constituents through into the subsoil, where they are lost.

There seem to be three methods only by which the valuable by-product may be made fully profitable:

1st. By distillation, by which means spirits can be made, and also a by-product of distillation, potash for fertilizer.

2nd. By burning in properly constructed furnaces, so that the full heat value may be obtained for producing steam, and all the ashes saved for potash making.

3rd. By its use for feeding working horses and mules, and for fattening cattle and hogs.

The subject is so important that it deserves the attention of specialists in their different lines.

Yours respectfully,

COMMITTEE ON UTILIZATION OF WASTE PRODUCTS:

Wm. W. Goodale, Chairman.
Jas. Gibb,
Jas. Renton,
W. G. Walker,
Andrew Adams.
Geo. H. Fairchild.

REPORT OF COMMITTEE ON EXPERIMENT STATION, NOVEMBER 23, 1903.

Appended hereto will be found the report of the Director of the Experiment Station, which very fully sets forth the nature and extent of the experiments and work done at the station for the past year.

It is gratifying to note the great increase in the number of soil analyses indicating, as it does, the growing confidence in the value of our laboratories and in the importance of thorough familiarity with the chemical make-up of our soils. The average yields of our plantations both irrigated and unirrigated have increased for the past year, the former by 696 lbs. sugar per acre and the latter by 912 lbs., and although much of this may be due to more favorable seasons or other conditions, it is reasonable to suppose that it is largely the result of careful and well-advised fertilization. This being admitted, the necessity naturally follows of having our soils analyzed, and our fertilizers based on the analyses, and it is hoped that the demand for soil analyses will show even a greater increase during the coming year than it has shown in the past.

It will be observed with satisfaction that the fertilizers now being supplied by manufacturers conform much more closely to the guarantees than ever before, and if this result was the only one achieved through the laboratories, we would feel amply repaid.

The addition to the laboratory buildings and the engagement of another chemist have been necessitated, as the director states, by the increased amount of work, and the trustees have approved of the expense which these changes involve. The staff, on the arrival of the chemist recently engaged, will consist of the director, Mr. Eckart, and four chemists, Messrs. Peck, Werthmueller, Jordan and Thompson. The field work is still attended to by Mr. Clark, who employs two laborers regularly, and such additional help as may at certain busy seasons be required.

It is unfortunate that the area of the station grounds is so small, as the field experiments have to be restricted much more than is desirable, especially at such times when the necessity arises for fallowing portions of the land. It is, however, impossible to undertake the cultivation for experimental purposes of other lands, even if such could be found at no very great distance from our station, owing to the heavy expense which would be incurred thereby and which we do not think it wise to recommend at this time.

The expenses of the station have been higher than those of the previous twelve months by reason of the improvements and the increased amount of work, and the estimate is that

the expenses of the coming year will aggregate about $15,000. This is the sum usually appropriated for State experimental stations where the amount of work done rarely comes up to that accomplished at our station, and it is the opinion of this committee that the sugar planting community of these Islands get most excellent value for what it expends on the Experimental Station and Laboratory of its Association.

Your committee hopes that the practical members of the Association will make it a custom to pay visits to the Station whenever they happen to be in Honolulu, but especially at this time when our annual assembly has brought so many planters together.

The unfortunate illness of the director, extending over a period of seven weeks, has delayed the publication of his report on the experiments of the past year, but it will be brought out just as soon as possible, and a copy will be mailed to each planter.

F. M. SWANZY,
F. A. SCHAEFER,
GEO. H. ROBERTSON,
H. A. ISENBERG.

MR. F. M. SWANZY,

Chairman, Committee on Experiment Station.

Dear Sir:—I herewith submit a report on the work of the Experiment Station and Laboratories of the Hawaiian Sugar Planters' Association for the year 1903.

FIELD WORK.

Cane was harvested in May of this year from the following plats of experiments:

Stripping experiments, four in number, planted in July, 1901.

Irrigation experiments, five in number, planted in June, 1901.

Fertilization tests, twenty-six in all, started in June, 1901.

Salt experiments, four plats, planted in June, 1901.

An exhaustive report, regarding these experiments, is now in course of preparation, and will be issued at an early date. I regret that through force of circumstances it was impossible to have the same completed prior to this meeting of the Association.

Experiments to be harvested in 1904 comprise six plats receiving saline irrigation water, containing 200 grains of salt

per U. S. gallon. In these plats the relative value of ground coral and gypsum, as well as various forms of the several fertilizer ingredients, will be tested for such conditions, and it is believed that data of considerable value will be obtained.

Seventeen varieties of cane, enumerated in the report of last year will also be harvested. The ash of the leaves and cane in this series of tests will be subjected to analysis to learn the relative demands of the varieties for the principal soil elements. Their sugar producing value will also be compared with that of varieties tested during previous years.

Thirty-three new varieties are being grown for seed to be used in future experiments. Twenty-six of these were enumerated in last year's report to the Experiment Station Committee, and chiefly comprise Demerara and Queensland seedlings, the additional varieties being six native canes received from Mr. H. A. Baldwin, and Altamati cane received from Mr. Robt. Hall.

Twenty plats of cane, in fertilizer tests started by Dr. Maxwell, were rattooned in June of this year and will be harvested in 1905. The object of these tests is to learn the influence exerted by the various fertilizing ingredients on the demands of the cane for the principal soil elements. At the harvesting of the rattoons in question, this series of experiments will have covered a period of eight years and will be discontinued.

Fertilizer experiments to be started in May, 1904, will deal with fertilizers balanced according to the needs of the soil, and applied at varying intervals and in different quantities during the growth of the cane. The primary object of these tests is to study the influence of times of application of fertilizers on the yields of cane and sugar.

It was deemed necessary, owing to the heavy cropping to which the Experiment Station field has been subjected, to allow one-third of it to lie fallow during the present year, after turning in a crop of Mauritius beans. Through the necessity of removing strippings, etc., for weight and analysis, burning off of cane refuse is not practiced after harvesting and consequently the plant foods are removed from the soil in more than double the quantities removed on plantations.

Experiments to determine the relative value of hydrocyanic acid gas, corrosive sublimate, and carbolic acid, in the treatment of seed cane infested with leaf-hopper eggs, were carried out during the past year. The results of this work are contained in a report of Mr. R. C. L. Perkins on "Leaf-hopper of the Sugar Cane" submitted to the Board of Agriculture in August of this year.

LABORATORY WORK.

The work in the laboratory for the past year was character-

ized by a large increase in the number of analyses over that for 1902. This was largely due to the large number of soil and fertilizer samples received from plantations. A comparison of the numbers of samples analyzed for the last two years may be made from the following summary:

SAMPLES ANALYZED.

Samples.	1902.	1903.
Soils	91	225
Fertilizers	239	368
Waters	179	111
Cane Juices	31	96
Cane Ash	56	40
Molasses	3	13
Miscellaneous	15	35
Total	614	888

The fertilizers analyzed during the past year showed a much closer conformity to guarantees than was found in previous years. This may be seen by the following figures covering a period of four years:

Year	1900.	1901.	1902.	1903.
Fertilizer samples received	75	189	229	368
Difference between valuation of Expt. Stn. and Manufacturer	$12,000	$11,000	$9,000	$4,900

Owing to the large increase in the numbers of soil and fertilizer samples received during the past year, it was found necessary to increase the laboratory facilities of the Experiment Station. For this purpose a new laboratory building has been erected close to the main building and will be fully equipped for analytical work about the 1st of December. An additional chemist has been engaged and will arrive during the latter part of the present month. These improved facilities will allow of more prompt execution of analytical work and will entirely meet the demands on the laboratory caused by the increased patronage of the plantations.

During the current year three chemists and two sugar boilers have been afforded instruction in analytical work.

A financial statement is appended, showing the expenditures of the Experiment Station for the year ending October 31st, 1903.

Respectfully submitted,

C. F. Eckart,
Director.

EXPENDITURES FOR THE YEAR ENDING OCT. 31st, 1903.

November, 1902	$ 1,123.92
December, 1902	816.88
January, 1903	892.33
February, 1903	1,533.23
March, 1903	1,153.92
April, 1903	1,107.97
May, 1903	1,011.35
June, 1903	1,150.99
July, 1903	1,076.24
August, 1903	1,200.83
September, 1903	914.43
October, 1903	2,872.96
	$14,855.05

EXPENDITURES WERE DIVIDED AS FOLLOWS.

Salaries	$ 9,684.41
Field Expenses	1,018,31
Laboratory Expenses	1,488.71
Director's Travelling Expenses	106.25
Freight and Expressage	119.94
Stationery	72.32
Typewriting and Printing	367.70
Postage	20.50
Books and Journals	79.15
Electric Lighting	38.55
Telephone	48.00
New Laboratory (building and plumbing)	1,627.00
Miscellaneous	184.21
	$14,855.05

REPORT OF COMMITTEE ON FORESTRY.

To President Hawaiian Sugar Planters' Association:

Sir:—The past year has been an important one for the cause of forestry in Hawaii.

The importance consists, not so much in actual results accomplished in the field, as upon:

First—The securing of necessary legislation for carrying on the work effectively.

Second—Concentration of the public mind upon the subject; and

Third—The bringing to the front of a large number of prominent men, willing to voluntarily give their time and efforts for the furthering of the cause.

WORK ACCOMPLISHED.

A brief resume of what has been accomplished in this respect is as follows:

At the last annual meeting of this Association a special committee was appointed to devise some practical method of establishing forestry reservation. The committee consisted of L. A. Thurston, Geo. Ross, D. Forbes and E. E. Olding. The committee met with the Governor on November 25th, and made to him the following suggestions:

(1) That the Governor designate some person in each district who should take upon himself the responsibility of making a map and description of a proposed forest reservation in such district, to be submitted to the Governor for approval.

(2) If the forest reservation so suggested met with the approval of the Governor, he, so far as lay within his power, to set apart the localities so designated as forest reservations, government lands within such reservations to be reserved from sale or lease, the Government to use its influence with lessees of lands and private land owners owning lands within such reservations, to secure their adhesion to the several reservation propositions.

(3) Upon such reservations being set apart, the persons designated in each district, by the Governor, to undertake to secure subscriptions to secure the fencing out of the reservations so made.

The committee recommended to the Governor the names of E. E. Olding as forestry agent for the district of Kohala, D. Forbes for the district of Hamakua, and George Ross for the district of North Hilo, assuring him that they would take upon themselves the responsibility in those several districts of carrying out the suggestions of the committee.

The committee also offered to ascertain the names of re-

sponsible residents of other districts who would be willing to serve on the lines suggested by the committee and recommend them to the Governor for appointment.

The committee further recommended to the Governor that he commend to the next Legislature the passage of a law setting apart forest reservations and authorizing the condemnation and purchase of private property for the same purposes.

The Governor responded to the suggestions of the committee, cordially approving of the suggestions made. In the Governor's reply he made the following additional recommendation:

"I would suggest to your committee that it use its influence toward a conservative plan of selection of forest reservation limits, as lines seriously prejudicial to private interests would probably raise opposition from such interests and thus delay progress of the enterprise."

As a matter of general interest and for future reference there is appended to this report the full letter of the committee to the Governor, dated November 25, 1902, and the Governor's reply, dated December 4, 1902.

GOVERNOR'S FORESTRY AGENTS.

Later the committee recommended to the Governor, and the Governor appointed the following named persons as Forestry Agents in the several districts, for the purpose of recommending forestry reservations and assisting in the carrying out of such recommendation:

On the Island of Hawaii—

North Kohala—E. E. Olding.
South Kohala—A. W. Carter.
Hamakua—Daniel Forbes.
North Hilo—George Ross.
Kau, from and including Punaluu to Puna—Julian Monsarrat.
Kau, from the boundary of North Kona to Punaluu—George Hewitt.
Kona from Kau to the South Kona Agricultural Co.—Franz Bucholz.
South Kona, from and including the South Kona Agricultural Co. to North Kona—Wm. R. Castle.
North Kona to land of Kahaluu—John D. Paris, Jr.
Land of Kahaluu to South Kohala—Eben Low.

Island of Maui—

District of Lahaina—L. Barkhausen.
Kaanapali—H. P. Baldwin.
Wailuku—C. B. Wells.
Hamakua—H. P. Baldwin.

Makawao, to and including Kaupo—L. von Tempsky and Dr. J. H. Raymond.

District of Hana—K. S. Gjerdrum.

Island of Oahu—

District of Ewa—Walter Dillingham.

District of Waialua—W. W. Goodale.

District of Koolauloa—Andrew Adams.

District of Koolaupoko, from Koolauloa to Heeia—L. L. McCandless.

Heeia and Kaneohe—C. Bolte.

Honolulu, from and including Manoa Valley to Makapuu Point—Frank E. Dodge.

Honolulu, from and including Kalihi Valley to the Ewa District—D. McIntyre.

Island of Molokai—

Albert Judd.

Island of Kauai—

District of Hanalei to Kalihiwai—A. S. Wilcox.

Kalihiwai to Anahola—Andrew Moore.

Anahola to District of Lihue—Z. S. Spalding.

District of Koloa, between Koloa Plantation and District of Waimea—J. M. Lidgate.

District of Waimea—Francis Gay.

Of these twenty-nine agents, nearly all made written reports to the Governor, in most cases accompanied with maps and descriptions of proposed forest reservations.

NEW LEGISLATION.

Upon the meeting of the Legislature in February last, a recommendation was made by the Governor to the Legislature to enact necessary forestry laws.

A law was drafted by the select committee appointed by this body and submitted to the Senate. A joint meeting of committees from the Senate and the House was held to consider the said forestry bill, together with certain other bills relating to agriculmture and entomology, at which joint meeting the public were invited to attend.

The said bills were discussed, and as a result, a committee consisting of W. M. Giffard, F. M. Swanzy, A. F. Judd and L. A. Thurston was appointed to prepare a single bill to provide a Board of Agriculture, Forestry and Entomology, which should have control of the three subjects.

This bill, when drafted, was submitted to Professor Perkins of the Bureau of Entomology; Mr. C. F. Eckart, of the Planters' Experiment Station; Governor Dole, Superintendent of Public Works H. E. Cooper, A. W. Carter and several others who were interested in the subject.

With the amendments and additions suggested by these gentlemen, a bill was finally submitted to the Legislature, passed by both houses and approved by the Governor, with but slight amendment.

The bill provides for a Board of Forestry and Agriculture of five members, the Superintendent of Public Works being ex-officio also a member.

FORESTRY COMMISSIONERS.

Upon the passage of the bill, Governor Dole appointed as members thereof: W. M. Giffard, A. W. Carter, James D. Dole, J. F. Brown and L. A. Thurston.

The Board duly organized and immediately entered into communication with the Bureau of Forestry at Washington, with a view to co-operating with that body and securing the services of an expert forester to examine and advise upon a course of action, and to secure, if possible, an expert forester, familiar with American methods of dealing with the forestry question.

VISIT OF W. L. HALL.

As a result of the correspondence with Mr. Giffard Pinchot, the head of the United States Forestry Department, William L. Hall, Chief of the Forestry Extension Division of the United States Forestry Bureau, visited Hawaii during August and September of this year. He visited all the main islands and made minute inspection of the main districts where forestry is a problem, more particularly the Ewa basin, and the Waialua and Kahuku slopes of Oahu; the western and northern slopes of East and West Maui, and the Kohala, Hamakua and Hilo districts, on the Island of Hawaii.

Mr. Hall has reported back to the Department at Washington, and the Board is in expectation of early results from his visit.

VOLUNTEER FORESTERS.

Meanwhile, nearly all of the gentlemen who served as volunteer forestry agents under the appointment of the Governor, have accepted appointment under the Board of Forestry as unpaid forestry agents in their respective districts.

In addition, several others have been appointed, viz.:

Mr. F. Weber for the District of Lihue, Kauai.

Mr. A. M. Nowell, District of Waialua.

Mr. H. A. Baldwin, for the District of Hamakua, Maui.

Mr. J. A. Maguire, for the northern half of North Kona.

Mr. F. B. McStocker, for the District of Puna, North Kona, Hawaii.

Mr. F. W. Carter, for the District of South Kohala, Hawaii.

No stronger body of men can be selected in the Territory for carrying out any proposition.

FACTORS OF SUCCESS.

The accomplishment of effective work during the coming year depends upon two factors:

First—The securing of an effective executive head to the Bureau.

Second—The hearty co-operation of the local land owners and lessees in the several districts.

The cause is already assured of the hearty co-operation of the Government and of the largest private land owner in the Territory, viz.: the Bishop Estate. In fact, the trustees of the Bishop Estate have already set apart and reserved for forestry purposes a larger area of land than the Government and all private land owners together.

If the other owners and lessees of land in the several districts will co-operate with the Board with equal heartiness, a substantial area should be set apart for forest purposes, and a good beginning made toward fencing the same out from stock and reforesting it.

FORESTRY PRINCIPLES.

The principle which I think should govern the Board in carrying out the forestry law is as follows:

The creation of a forestry reserve and the re-foresting of barren areas, are not an end, but means to an end.

There is nothing sacred about a forest, nor should de-foresting be allowed to take place only above or below a certain fixed level.

While it is right and proper that the aesthetic and the beautiful should be considered in the creation and preservation of forests, the prime reason therefor is commercial and practical.

BENEFITS OF FORESTRY.

The practical benefits of forest reservations are:

(1) Increase of railfall.

(2) Conservation of water, so that it will supply springs and streams when there is no rain.

(3) Holding back the water during heavy rains, so that it will not rush off in floods.

(4) Prevention of drying up the soil by heavy winds.

(5) Regulation and modification of heavy winds by breaking up and scattering the wind currents, which acquire velocity where they have an uninterrupted sweep.

(6) Creation of timber and lumber sources.

(7) Creation of a fuel supply.

Some of these benefits apply to one section of the Territory and some to another. One or more benefits apply to every portion of the country.

For example:—Hilo does not need forestry to increase the rainfall; but it is vital to the interests of Hilo to conserve the water and prevent disastrous floods which accompany heavy rains, and which, but for the forest, would increase greatly in violence.

Puna does not need forest, either, to increase the rainfall, for it now has too much already; nor to conserve moisture, for it has neither streams nor floods; but it does need regulation of wind—the wind has perceptibly increased since clearing began—and will later need firewood.

In Hamakua and Kohala forests are needed for almost every purpose.

FOREST CONDENSATION OF MOISTURE.

There are, even in the drouth districts, those who do not believe that forests affect the rainfall. Without attempting to argue the question at length, I will state an instance which recently came to my attention in Upper Hamakua, while on a trip of forest observation with Mr. W. L. Hall.

The district was dry and the roads and paths dusty. We noticed, however, that wherever there were clumps of trees, the grass was green and the soil moist under them.

At the Parker Ranch dairy, above Mana, and some ten miles up the slope of Mauna Kea from Waimea, there are several large eucalyptus trees standing beside the cattle pen, the trees being 60 to 80 feet high.

The dust in the pen and on the roads and trails leading thereto was several inches deep. We found that there was a pond of water standing under the trees some 30 feet long and 12 or 15 feet wide by two or three inches deep, the overflow of an iron tank which caught the drainage from an iron roof some 15 feet square, standing directly under the largest eucalyptus tree.

The only water available to fill the tank was rain water and mist which condensed on the eucalyptus leaves and fell. We were assured by the ranch manager, Mr. F. W. Carter, that there had been no rain for some time, and that all the water in the tank and on the ground was from the condensed mist. The claim that there had been no recent rain was corroborated by the dusty ground. The elevation of the station —some 5,000 feet—accounted for the mist. That mist did condense in sufficient quantities to accomplish the results witnessed, was proven to our satisfaction by observation of other trees in the vicinity. On the previous evening at Kalaieha, at an elevation of between 6,000 and 7,000 feet, we also saw ordinary mist condensing on the windward side of a hedge of

Monterey cypress, some 25 feet high, and falling to the ground in a heavy shower. In the open there was no rain, and no precipitation of moisture would have been recorded in a rain-gauge. Whatever the effect of forests in condensing moisture at low levels, the foregoing is a demonstration that at elevations where there is mist in the air, the precipitation directly caused by the cool forest coming in contact with the moisture-laden air is very great.

The manager of the Parker ranch has undertaken to keep a record of the exact amount of condensation at the dairy spoken of.

GREATEST GOOD TO GREATEST NUMBER.

Whether a given area should be reserved for forest, should depend on whether or not such use of such area will accomplish the greatest good to the greatest number.

The raising of sheep, cattle, and agricultural products, both for local consumption and export, are all to be considered in arriving at a conclusion of whether given areas are to be devoted to forest or otherwise. Each object is a necessary and proper one, and no one of them should be hampered or obliterated in the interests of the other or others.

The climate, conditions and necessities of the several Islands, and even of small districts on the Islands, are so diverse, that no general principle governing forest reserves can be laid down. Each section will have to be considered separately, although, as a matter of course, certain general principles and precedents applicable to one locality may also be applied to others.

CO-OPERATION NECESSARY.

Whether or not the efforts of the Board will be a success or a failure, depends very largely upon the disposition to co-operate therewith shown on the part of the planters. In most districts the planters, either directly or indirectly, control the areas which are desirable for forest reservation. Their hearty co-operation will remove most of the obstacles in the way of the Board.

A point concerning which earnest consideration should be given by land owners or lessees who control land required for forest reservation, is, that there is no appropriation available with which to purchase forestry reservations.

EXCHANGE WITH GOVERNMENT.

The best that can be done in this respect is to secure an exchange by the Government, giving to such owners and lessees other government land, or leases of lands, in exchange

for lands owned or controlled by them which may be surrendered for forestry reservations.

The late administration was heartily in sympathy with carrying out this policy, and it is earnestly to be hoped that the incoming administration will do likewise.

Strong efforts are now being made by the Board to bring the Government and proposed forest reservation land owners together so that such exchanges may be promptly negotiated.

FENCING.

After such exchanges are consummated, there will still remain the question of securing the fencing out of such reservations so that stock can not injure them.

There is no appropriation for this purpose and if it is achieved, it must be at the direct expense of the principal local interests.

It is submitted for the consideration of this Association that in a large number of instances, it is directly and vitally in the interests of the local plantations to fence out the forest reservations determined upon. For example, it will be a most direct and positive benefit to the plantations in the Ewa basin to fence out the forest reserves in the Waianae and Koolau range of mountains, which it is hoped may be reserved.

The same statement will apply equally to Kohala, Hamakua and some other localities.

APPOINTMENT OF SUPERINTENDENT.

Since writing the foregoing, the Board of Forestry have received a cablegram from Mr. Giffard Pinchot, head of the Forestry Bureau at Washington, recommending a Mr. Hosmer for appointment as Superintendent of Forestry in Hawaii. Mr. Hosmer has for some years been connected with the Federal Forestry Bureau in connection with the establishment of forestry reserves and forestry extension. He was the first choice of Mr. W. L. Hall, who stated that he considered Mr. Hosmer the best man connected with the department for the duties involved.

Mr. Hosmer's appointment by the Board will doubtless take place at its next meeting, and he is expected to be able to assume the duties of his office during December. The array of forces now brought to bear should enable next year's forestry committee not only to report progress, but substantial results accomplished.

Rspectfully submitted,

L. A. Thurston,
For the Committee on Forestry.

Appendix.

CORRESPONDENCE BETWEEN PLANTERS' ASSOCIATION COMMITTEE AND GOVERNOR DOLE.

Honolulu, H. T., November 25, 1902.

S. B. DOLE, GOVERNOR OF THE TERRITORY OF HAWAII:

Sir:—At the recent annual meeting of the Hawaiian Sugar Planters' Association, a special committee, consisting of the writer, George Ross, D. Forbes, and E. E. Olding, were appointed to consult with you to see if some practical method could not be arrived at for establishing forest reservations and protecting them from the ravages of cattle and other disturbing influences.

In accordance with the understanding arrived at between you and the committee, at the meeting held at your office, the committee now suggests to you the following method of accomplishing the results desired, viz.:

(1) That you designate some one or more persons in each district who shall take upon themselves the responsibility of procuring a map and description of a proposed forest reservation in such district, which map and description shall then be submitted to you for your approval.

(2) If the several suggested forest reservations meet with your approval, you thereupon to, so far as lies within the present power of the Territorial Government, set apart the localities so designated as forest reservations for such purpose, all Government lands within such several reservations, to be thereupon reserved for forest purposes, from sale or lease, in so far as the same are not now under lease; and if the same are under lease, the land therein described shall, upon the expiration of existing leases, become subject to the reservation, from any future sale or lease. If the lands so reserved are now under lease, the Government to use its influence with the several lessees and with private land owners owning lands within the reservations, to secure their adhesion to the proposition to make a forest reservation of the lands so described.

(3) Upon such approval being given, you to notify the persons who have been designated to secure descriptions of forest reservations, they to thereupon take charge of securing voluntary subscriptions to fence in the reservations so that live stock cannot trespass thereon.

So far as the districts of Kohala, Hamakua and North Hilo are concerned, the committee hereby suggest to you the name of E. E. Olding as your agent to designate forest reservation lines in the district of Kohala; D. Forbes, for the district of Hamakua; and George Ross for the district of North Hilo.

The gentlemen named will undertake to furnish proper maps and descriptions of proposed forest reservations in those respective districts, the outlines of same to be determined after consultation with the residents of the several districts.

They also hereby assure you that if reservations are made by you on the lines above suggested, they will undertake to procure, by private subscription, the necessary funds for fencing in such reservations.

The committee will take pleasure in recommending other names to you for other districts, to assume the same duties, as soon as they are in position so to do.

In further conformity with the verbal understanding arrived at between the committee and yourself, the committee suggest that you make a recommendation to the next Legislature, that the Governor be empowered to set apart forest reservations consisting of both public and private lands; and also to pass a statute authorizing the condemnation and purchase of private property which may come within such forest reservations.

The committee are prepared to act along the lines above indicated as soon as they receive a favorable response from you.

I remain, your obedient servant,

(Signed) L. A. THURSTON,
For the Committee.

Honolulu, December 4th, 1902.

Messrs. L. A. Thurston, George Ross, D. Forbes and E. E. Olding, forming a Special Committee of the Sugar Planters' Association, Honolulu, T. H.

Sirs:—Your letter of November 25th, addressed to me by Mr. Thurston, embodying suggestions for a plan of action for "establishing forest reservations and protecting them from the ravages of cattle and other destroying influences," has been received.

I heartily approve of the proposed plan and will do all that I may be able within my powers, to promote the same. I sincerely appreciate the public spirit shown by the members of the committee as to their willingness to take hold of the enterprise and give their personal services towards its management. With such a disposition on the part of men with the influence and resources of managers of plantations in the different districts of the Islands, much can be done in the important work of protecting and restoring our forests.

I have selected Mr. George Ross as my agent to suggest forest reservation limits in the district of North Hilo, Mr. D. Forbes to perform the same service in the district of Hamakua, and Mr. E. E. Olding for the district of North Kohala, all of the Island of Hawaii.

I would suggest to your committee that it use its influence toward a conservative plan of selection of forest reservation limits, as lines seriously prejudicial to private interests would probably raise opposition from such interests and thus delay the progress of the enterprise.

I would also suggest that your committee include tree planting where necessary in the plan of operations, for three reasons: although there are many localities where the restoration of forests will take place by natural causes alone when there is protection from cattle, yet there are lands which have been denuded of trees for a considerable time and have become covered with a heavy growth of grass which is so much of an obstacle to the germination of seeds, and to their making a fair start if germinated, that artificial assistance is essential to the reforesting of the same.

I enclose a copy of my letter on the subject to Mr. George Ross. Similar letters were sent to Mr. Forbes and Mr. Olding.

Very respectfully,

(Signed) SANFORD B. DOLE.

SYNOPSIS OF THE REPORT ON MACHINERY SUBMITTED BY MR. W. STODART, CHAIRMAN, MACHINERY COMMITTEE.

COST OF MANUFACTURE: Mr. Stodart recommends that the Secretary of the Planters' Association present at the annual meetings a report, in tabulated form, on the cost of operations (manufacture), including supplies, from the Hawaiian factories, for the purpose of determining the relative value of the various machine installations in relation to their efficiency.

BUILDINGS: He also advocates reducing the cost of new factories by eliminating useless ornamentations, and excessive height, and prefers to place the crystallizers on the ground floor and empty their contents into the mixers above by means of compressed air, thereby saving that floor in height.

CANE UNLOADERS: He states that the total cost of unloading cane at McBryde Mill, from moving the loaded cars from the storage tracks to delivering the empty cars on the return tracks, including weighing, was 2.69c. per ton of cane, a saving of 35% over hand labor, using the Mallon-Bodley cane unloader and handling on an average 735¼ tons of cane per 24 hours. Mr. J. N. S. Williams states that the cost of this work at Puunene Mill was 2.5c. per ton of cane, using Gregg's machine, with about 1,100 tons cane per day.

EVAPORATORS: Mr. Stodart states the important factors in the proper construction of evaporators, and claims that the triple-effects at McBryde Mill supply most of these conditions. "Efficiency" of heating surface does not necessarily mean economy, except in the first cost. The film evaporator comes nearest perfection as regards the small amount of juice under operation, the large liquid surface, and good circulation, but Mr. Stodart thinks it has drawbacks which partly counteract these advantages. The main advantage of the McBryde evaporators consists in the construction, which creates a large liquid surface by ejecting the juice from the vertical tubes to a height of from 12 inches to 18 inches, and the streams only combine when the evaporation is completed in that cell. A table shows the effect of scaling on the efficiency during a week's run, when the work was practically uniform for the entire week, and the lbs. of water evaporated per sq. ft. H. S. per hour was proportionate to the quantity of juice treated—an average of 8.3 lbs. in this case. A table of the average work for the season shows: Steam pressure, 6 lbs.; reduction, 69.8% by weight; 7.93 lbs. water evaporated per sq. ft. H. S. per hour. Mr. Stodart also presents a table showing evaporator work in a number of other factories, furnished by the managers, but as this table is very incomplete, and the re-

ports at variance with one another, no reference is made to it in this resume. Mr. Stodart suggests that accurate data on evaporation be regularly furnished by the various factories during the season and presented at the annual meetings.

SUGAR DRYERS: The Hersey Hot Air Dryer and Granulator has been in operation during the last season on two of the Oahu factories, and considered good investments. Similar dryers will be in use in other factories during the coming season. The arrangement and construction of these machines is as commonly used in other sugar factories, but with the double capacity of heater.

AUTOMATIC BAG-FILLING AND WEIGHING MACHINE: Mr. Stodart believes these will only work satisfactorily on dried sugars, and should embrace an automatic sewing attachment. A machine is on the market which will fill, weigh, count and sew 75 bags per hour, with the attention of one man and a boy, and should be arranged in connection with a bag conveyor direct to the cars.

PUMPS AND PUMPING: Mr. Stodart regrets not having reliable data on the comparative cost of pumping with the various styles of irrigating pumps, and the saving affected by using oil instead of coal, and suggests that such accurate data be presented at the annual meeting. He states that the average cost of pumping at the McBryde Plantation, using coal, and including labor, repairs, and superintendence, was:

Risdon Iron Works 10 million gallon flywheel pump and Heine boiler, with economizer, 4.48c. per million foot gallons.

Riedler 10 million gallon flywheel pump, with B. & W. boilers, and no economizer, 4.65c. per million foot gallons.

Worthington 6 million gallon vertical pump, with Stirling boilers and no economizer, 7.05c. per million foot gallons.

All these pumps have triple-expansion and surface condensing engines.

SPECIAL PAPERS.

Mr. Geo. W. Connon: This paper treats the subject of water-driven centrifugals in an instructive and interesting manner, stating the calculations to be used in order to determine the proper speed, water pressure and power required on the motor. After a lengthy, detailed description of the difficulties experienced with the 40-inch machines installed in the McBryde factory, and the changes made to piping and pumps, the final results were that with 200 lbs. per sq. in. pressure on the water for the centrifugals drying first sugars, and 160 lbs. on the water for the centrifugals drying second sugars, with a pump piston speed of 50 ft. per min., there was no difficulty in drying the sugars satisfactorily. Mr. Connon reasons out mathematically that as nearly all 40-inch centrifugals used here have 20-inch motor wheels, and use about one

gallon of water per second, the proper pressure to insure the maximum efficiency should be 205 lbs. per sq. in. He recommends as the most suitable pump a duplex, outside-packed plunger, flywheel pump, with automatic "cut-off" engine and hydraulic governor. Such a pump will use 30 lbs. steam per indicated H. P. per hour, while a direct-acting pump would use 100 to 150 lbs. steam per indicated H. P. per hour.

Messrs. W. G. Hall and W. A. Ramsay: These gentlemen have invented an automatic, continuous centrifugal, which was fully described in "The Scientific American," May 23, 1903. The advantage claimed by the inventors is to continuously charge and discharge the machine while it is rotating at the proper speed, thus obviating the waste time and energy in stopping and starting for each charge. It is to be hoped that this ideal aim of so many inventors is here realized. So far only an experimental machine has been tried at the works of Messrs. Catton, Neill & Co., Ltd., with very promising results. A more perfect machine is now being built.

Mr. James Steel: This paper gives a comparison between the mill work as practiced in Fiji and Australia and in the Islands here. The most striking difference lies in the application of maceration water. In those countries, the three three-roller mills are placed with a long distance between them and, therefore, driven by three engines, and the bagasse is conveyed through a bath of hot water or diluted juice from the last mill. The bagasse is immersed for 10 to 12 minutes, instead of 1¾ minute as here. Mr. Steel makes the general statement that with a shredder and a six-roller mill as high extraction is obtained by this method as with our nine-roller mills and crusher, and supports this statement with some simple calculations, but does not, however, mention the fuel question. He prefers the separate engines, as thereby the mill speeds can be regulated, and believes the mill hydraulics will compensate for variations in feed. In these countries the second and third mills run more slowly than the first mill, and are fitted with force feeder, and engines often "pull up" with too heavy feed. The quadruple effects are worked with a pressure of 31 lbs., to 4 lbs. on the first cell, which also supplies steam for other boiling house purposes. The juice is filtered through bagasse instead of sand, and this bagasse is passed through the mills after being used.

Mr. James W. Donald: This interesting paper on "Clarification" describes a somewhat different method used in the McBryde factory to what is generally used in other factories here, and should have been referred to the Committee on Manufacture for the proper presentation it deserves. The machinery used consists of lime slacking vats, lime mixer with stirrer, pump, sulphurizer, juice heater, circular defecating tank with steam coils, and storage tanks for settlings, etc.

The modus operandi differs from that followed in other Hawaiian factories, principally in the liming of juices, which is done by pumping very dilute milk of lime as maceration water after first mill, whereas water is used after the second mill. The greatly over-limed juice from the second and third mills mixes with the normal, unlimed juice from first mill and the mixed juice is pumped to the upper end of a sulphurizing tower, from where it flows zig-zag to the lower end while being charged with sulphur fumes. It is then heated from 190° to 200° and enters the circular defeating tanks (clarifiers) where the juice is brought to the proper temperature and left to settle. Sulphurating is only used when needed. The settlings are heated, limed and pumped to the filter presses without being perceptibly diluted. The cake is washed in the press in the usual manner and contains when discharged: Max. 3.5%; min. 1% and average, 2.75% sugar.

Mr. J. Anderson: Mr. Anderson contributes two interesting papers. The first treats the subject of centrifugals and describes in detail the construction of the machines built by Messrs. Watson, Laidlaw & Co., Glasgow, Scotland. Mr. Anderson compares these machines with those of American make, and states that while his experience with the latter is confined to the Makaweli and Kealia factories, he has had good opportunities to study the make of the Scotch machines in the Glasgow works of the above firm. After a detailed description of both styles, he comes to the conclusion that he prefers the Scotch machines, especially on account of the greater ease with which they can be oiled and examined, the inside bushing being bronze instead of white metal, and the lesser weight of the basket, which is 833 lbs. in the Scotch and 1070 lbs. in the American machines. Then the spindle washers are, in his opinion, more carefully made in the Scotch machine, and carry only 271 lbs. per sq. in. when loaded, whereas the American machine washers carry 438 lbs. Mr. Anderson next describes the recent improvement of substituting steel ball bearings for washers. He apparently gives preference to the water-driven machines with the automatic "cut-off" attachment, which he describes. He also states that electrically-driven machines are now being made, and mentions two different types, but does not attempt to discuss the relative merits of this to any other form of motive power which largely depends upon local conditions. The "floating spindle" machine is interesting in that neither washers nor balls are used. Oil is pumped under a specially constructed spindle bearing at such pressure as will lift the whole machine, which then revolves on an oil column. This form is used for very large machines. Mr. Anderson describes a self-discharging centrifugal with 48-inch diameter and 30-inch deep basket, with sloping bottom and distributing movable

cone on the spindle. The machine is charged while in motion, but stopped for discharging, while the sugar is not touched.

Mr. Anderson's second paper deals with various machine installations at the Kealia factory. He is not in favor of the Kilby vacuum pans there, on account of the difficulty he experienced in draining the coils, the heighth of belt, and inaccessibility for making repairs to coils. He objects to the sand filters in that factory (they are large tanks with a double perforated bottom on which the sand lies, and are not of the "Standard" vertical type) and prefers the settling of the juice in tanks. The Wellner-Jelinck evaporator worked well, but Mr. Anderson thinks this was due to its large heating surface—12,000 sq. ft. The considerable entrainment was checked by the application of extra baffle plates and save-alls.

Mr. Anderson believes that is no hard and fast rule for setting mill rollers, except that they should be adjusted so that the mill is *just able* to take the bagasse from the preceding mill without choking. He prefers hard material in the rollers, as they become loose if soft, and the application of bands shrunk on the shafts at the ends. He also recommends water-jacketted bearings for the purpose of cooling the journals. The temperature of maceration water should be from 100° to 120° and applied by a force pump with 50 to 60 lbs. pressure through a small pipe under the bagasse as well as on the top. Of cane unloaders, Mr. Anderson likes the "Froelich" machine, which easily unloads 1000 tons of cane in 24 hours, but he does not state with how many men and at what cost per ton of cane.

Mr. E. Kopke: Mr. Kopke contributes to the general subject on evaporators a carefully prepared report, with diagrams on some tests he has conducted with a "Lillie" quadruple-effect. These tests were made under adverse circumstances and do not indicate normal work, and should, therefore, be withdrawn, together with the evaporator table mentioned before, and, after new tests have been made, incorporated with a general report on this subject, to be presented at the next annual meeting.

Mr. L. L. Mann: Mr. Mann describes a water measuring machine he has invented, and which has been in successful operation in one of the main water-ways at the McBryde Plantation since January 1st, 1903. It is designed for automatically recording every five minutes the true depth of the water flowing over a weir, so by reference to a weir table, the quantity of water flowing for any given time may be ascertained. The apparatus is very simple and inexpensive. Mr. Mann states its cost to be about $30.00, including the housing for it. It consists of a combination of clock-work, an electro-magnet and a pencil, which automatically traces a curved line on a suitably ruled record paper, while a float on the water indicates the variations in depth.

Mr. Geo. Ross: This paper treats of automatic bagasse feeding as practiced at Hakalau, but Mr. Ross says he knows of but little new which has been introduced in this line during the last year. The principal feature of newly-built furnaces is that they project in front of the boilers so as to insure the maximum temperature of the flame when reaching the entire boiler bottom; also the increased space under the boilers. All the Hakalau boilers settings have been gradually changed to this plan, resulting in increased efficiency. Mr. Ross describes the arrangement of the automatic bagasse conveying and firing at Hakalau factory, which, however, differs but little in the central points from what is in use in other modern factories here. The saving over hand firing, he claims, is eight men per 24 hours (four men in each shift) for four furnaces. He also mentions the "Simon" automatic sack-filling and weighing machine imported by the Honolulu Iron Works as a sample, and believes this likely to come into general use, insuring more accurate weighing and saving labor.

Mr. E. W. Cant: Mr. Cant submits a description of a battery of eight crystallizers installed in the Onomea factory. These were made from eight old boiler shells on the plantation and with plantation help. The dimensions are 6 ft. by 12 ft. These machines differ from other such installations in these islands in that the entire shell revolves one revolution in three and three-quarters minutes by means of a worm and worm wheel, and are driven either by an electric motor or an engine. In the interior is bolted to the shell, diametrically located, two curved plate supports extending the entire length of drum, and to these are fastened a 150 ft. long 1½ inch galvanized pipe coil, with its ends projecting through the center of the drum heads with trunnion boxes, as shown in sketch. By passing hot or cold water, or steam through this pipe, the proper temperature is adjusted, a very important point in obtaining the best results.

Mr. Cant describes a screw conveyor for the removal of press cake, a contrivance used in several factories, and also how he pulverizes 98% of the total press cakes for fertilizing purposes. Three thousand tons such material was procured by a crop of 13,500 tons sugar. Mr. Cant also describes and exhibits two models of improved link-belt chains and sprocket wheels to be used for intermediate apron conveyor in mills. The object is to prevent fine bagasse packing into the pockets of the links, causing the breakage of the same. (This trouble is, however, obviated in all later built mills by having no teeth on the lower sprocket wheels, but only on the upper driving one.

Our readers will regret to learn of the death of Mr. George W. Fisher, the Vice-President of the Fulton Iron Works of St. Louis, Mo., who passed away at his home in St. Louis on November 10th last, at the age of 76. Mr. Fisher was well known by many of our local sugar men. He visited the Islands some years ago and became acquainted with the methods employed in the manufacture of sugar in Hawaii.

Mr. M. D. Hall, representing the California Fertilizer Works of San Francisco, is in the city looking up the interests of the company, and will do the plantations thoroughly before returning home.

It will be of interest to our readers to learn that Ernest E. Hartmann has decided to establish himself in this city as consulting sugar chemist. Mr. Hartmann is well known in these Islands, having been connected with its sugar industry for many years, formerly on the Island of Hawaii and lately as superintendent of Waialua mill. His practical knowledge of modern processes of sugar manufacture, acquired both here and on his extensive travels in other sugar producing countries, should prove of great value to our manufacturers. Mr. Hartmann is staying at the Alexander Young Hotel.