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Sugar Plantations, Cane Growers and Sugar Mills.

ISLAND AND NAME.		MANAGER.	POST OFFICE.
OAHU.			
Apokaa Sugar Co.	*	G. F. Renton	Ewa
Ewa Plantation Co.	*	G. F. Renton	Ewa
Waianae Co.	***	Fred Meyer	Waianae
Waialua Agricultural Co.	*	W. W. Goodale	Waialua
Kahuku Plantation Co.	x*	Andrew Adams	Kahuku
Waimanalo Sugar Co.	**	G. Chalmers.	Waimanalo
Oahu Sugar Co.	x	E. K. Bull	Waipahu
Honolulu Plantation Co.	**	J. A. Low	Aiea
Laie Plantation	x*	S. E. Wooley	Laie
MAUI.			
Olowalu Co.	**	Geo. Gibb	Lahaina
Pioneer Mill Co.	x	L. Barkhausen	Lahaina
Wailuku Sugar Co.	**x	C. B. Wells	Wailuku
Hawaiian Commercial & Sug. Co.	x*	H. P. Baldwin	Puunene
Maui Agricultural Co		H. A. Baldwin	Paia
Kipahulu Sugar Co.	x	A. Gross	Kipahulu
Kihei Plantation Co.	x*	James Scott	Kihei
HAWAII.			
Paauhau Sugar Plantation Co.	**	Jas. Gibb	Hamakua
Hamakua Mill Co.	*x	A. Lidgate	Paauilo
Kukaiau Plantation	x	J. M. Horner	Kukaiau
Kukaiau Mill Co.	*x	E. Madden	Paauilo
Ookala Sugar Co.	**x	W. G. Walker	Ookala
Laupahoehoe Sugar Co.	[illegible]	C. McLennan	Papaaloa
Hakalau Plantation	[illegible]	J. M. Ross	Hakalau
Honomu Sugar Co.	**x	Wm. Pullar	Honomu
Pepeekeo Sugar Co.	**x	Jas. Webster	Pepeekeo
Onomea Sugar Co.	**x	J. T. Moir	Hilo
Hilo Sugar Co.	**	J. A. Scott	Hilo
Hawaii Mill Co.	x	W. H. Campbell	Hilo
Waiakea Mill Co.	*x	C. C. Kennedy	Hilo
Hawaiian Agricultural Co.	**x	Wm. G Ogg	Pahala
Hutchinson Sugar Plantation Co.	**	Carl Wolters	Naalehu
Union Mill Co.	*x	H H. Renton	Kohala
Kohala Sugar Co.	*	E. E. Olding	Kohala
Pacific Sugar Mill	x**	D. Forbes	Kukuihaele
Honokaa Sugar Co.	x**	K. S Gjerdrum	Honokaa
Olaa Sugar Co.	xx	J. Watt	Olaa
Puna Sugar Co.			Kapoho
Halawa Plantation	x*x	T. S. Kay	Kohala
Hawi Mill & Plantation	††	John Hind	Kohala
Puako Plantation	††	Jno. C. Searle	S. Kohala
Niulii Sugar Mill and Plantation	*x	Robt Hall,	Kohala
Puakea Plantation	*x	H. R. Bryant	Kohala
KAUAI.			
Kilauea Sugar Plantation Co.	**	Frank Scott	Kilauea
Gay & Robinson	x*x	Gay & Robinson	Makaweli
Makee Sugar Co.		G. H. Fairchild	Kealia
Grove Farm Plantation	x	Ed. Broadbent	Lihue
Lihue Plantation Co.	x	F. Weber	Lihue
Koloa Sugar Co.	x	F. McLane	Koloa
McBryde Sugar Co.	*x	W. Stodart	Eleele
Hawaiian Sugar Co.	x*	B. D. Baldwin	Makaweli
Waimea Sugar Mill Co.	*	J. Fassoth	Waimea
Kekaha Sugar Co.	x	H. P. Faye	Kekaha

KEY.	HONOLULU AGENTS.	
	Castle & Cooke	( )
**	W. G. Irwin & Co.	(8)
***	J. M. Dowsett	(1)
x	H. Hackfeld & Co.	(9)
*x	T. H. Davies & Co.	(8)
**x	C. Brewer & Co.	(6)
x*	Alexander & Baldwin	(6)
x**	F. A. Schaefer & Co.	(2)
x*x	H. Waterhouse Trust Co.	(2)
††	Hind, Rolph & Co.	(2)
xx	Bishop & Co.	(1)

THE HAWAIIAN PLANTERS' MONTHLY

PUBLISHED FOR THE

HAWAIIAN SUGAR PLANTERS' ASSOCIATION

[Entered at the Post Office at Honolulu, T. H., as Second-class matter.]

VOL. XXVI.] HONOLULU, MAY 15, 1907. No. 5.

SUGAR PRICES FOR MONTH ENDING MAY 17, 1907.

	Centrifugals.	Beets.
April 12	3.722c.	9s. 3¾d.
April 19	3.765c.	9s. 4¼d.
April 26	3.73c.	9s. 5¼d.
May 3	3.765c.	9s. 6d.
May 10	3.875c.	10s. 1½d.
May 17	3.86c.	9s. 10½d.

Messrs. Willett & Gray, under date of May 9, report as follows:

RAWS.—During the week under review Europe has led the advance, which has been more notable than any rise of recent months. Beet sugar rose from 9s. 6d. to 10s. 0¾d. (parity of 4.12c. for Centrifugals), and cane sugar rose 6d. also, with a very strong market at the close.

Prominent sugar experts in London have recently said that the action of the beet sugar market at the time of lowest quotations, 8s. 7½d., remaining firm and refusing to decline further although Cuba quotations were forced 40c. per 100 lbs. lower than the beet parity, is a good evidence that the trend of values of sugar have completely changed.

When beet sugar was at its lowest it stayed there without support or manipulation to put it on the lower basis of Cuba sugar. These experts maintain that the market evidence given is the strongest sort of evidence that such low prices will not be seen again for several years to come. We are inclined to agree with this opinion and to look for extremely prosperous conditions for the whole sugar trade from steadily increasing values from the present basis. Europe takes the lead and is now on a parity of 4.12c. for Centrifugal sugar 96 test against present spot value of 3.83 per lb.

The highest level reached last year for Centrifugal sugar in our market was $4\frac{1}{8}$c. nett. (Sept. 30, 1906) or the present parity of beet sugar, but this season promises to exceed this level with Centrifugals. The Cuba weather crop situation does not improve at all and the closing of the present crop season before the appearance of the rainy season is quite suggestive of poorer crop conditions for the next campaign.

Such remarkable weather conditions as have recently prevailed in Cuba and the United States and Europe are detrimental to all crop interests.

Under date of May 10, Czarnikow, Macdougall & Co. say:

Our last report was dated 3rd May.

Local conditions have been against the spot market, which has been handicapped by heavy receipts and by a general strike of the longshoremen, which has proved a serious impediment to the movement of sugar and all other commodities in the port of New York. Naturally, refiners with unusual quantities of their own sugar to care for, decline to add to their difficulties by relieving importers of sugars arriving unsold. This may compel the storing of some sugars in port, which, otherwise, would have found a ready market, as the prices asked are below what can be obtained for sugars due a week hence.

To these local and temporary adverse conditions has to be added the prevalence of weather unfavorable to the expansion of the demand for refined.

But the influences operating against the market have been overborne by those operating in its favor, the chief among the latter being a prolongation of the drought in Cuba and the cessation of grinding on 37 additional Centrals, thereby reducing the number at work to 45, as against 174 at this time a year ago.

It has all along been recognized that the determining factor in deciding the course of international markets would be the Cuban crop. So long as the December estimate of a crop possibility of 1,500,000 tons was entertained, the hopes of higher prices as a result of United States drafts upon the crops of Java and Europe were kept in check, but the reports of the last few weeks have proved the correctness of the later forecasts which point to a crop whose total will fall short of the early estimate by something like 200,000 tons. That the sugar world has now accepted the reduced estimate is seen from the course of the market for Beets and Javas, which since the opening of the month have advanced 9d. and 6d. per cwt., respectively. The advance in our spot market during the same period has been about $\frac{1}{8}$c., and in Cubas for second half May shipment 3-32c. per lb.

The total Cuban production up to 30th April was 1,231,787 tons.

The Cuban news has not been the sole influence at work in advancing European Beets, for that market has been helped by a good demand from consumers and the Trade, by the sowing being less than expected, and by the weather being somewhat less favorable for the crop.

The business done this week has been much larger than is reported, and it is believed to include several cargoes of Javas for June-August shipment. Today's quotations for Javas are: 10s. 6d. to 10s. 9d. c. f., according to time of shipment; for Cubas, 2 11-16c. c. f., basis 96 deg. for June shipment.

THE OUTLOOK FOR THE COMING CAMPAIGN.

Seldom has a sugar campaign begun under such favorable auspices as the present one. Economically and politically the conditions are more favorable today for a sound development of a domestic sugar factory industry in the United States than they ever were before. Nothing will prevent the domestic sugar industry from developing, so long as the increase of population and the increase in general sugar consumption keep up so well with any increase in sugar production as they have done up to the present.

There is not the slightest indication anywhere that the sugar markets will be overstocked during the next campaign. On the contrary, there is more than one indication that the demand will be far ahead of the coming supply, not only in this country, but all over the world.

The principal source of supply for raw sugar for the American sugar trust, Cuba, has not come up to expectations during the last campaign. Already the expert statisticians have had to reduce their preliminary estimates considerably, and it is certain that the Cuban sugar output will be at least 250,000 tons below the annual average. Java sugars have been taken very freely by Japan of late, and there is no sign of any startling increase in the sugar output of either Java or Japan in the near future. While the raw sugar factories in Formosa have done well, considering the short time they have been under Japanese management, and while the domestic sugar refineries in Japan are making good progress, the Eastern sugar markets will for many years have to draw upon Europe for a large part of their sugar supply. The possibility of increase of sugar production in the Philippines is so remote it would not materialy alter the market quotations of sugar in the United States. Of course, this does not mucan that this journal would look indulgently upon any attempts to reduce the tariff on Philippine sugars and thereby favor Philippine sugar more than domestic sugar. On the contrary, if favors are to be granted and exceptional privileges bestowed, it is the domestic sugar industry, which ought to be the first to receive privileges, and of all sugars in the world's markets today Philippine sugar ought to be the last to be treated indulgently by American legislators. For the present, at any rate, the Philippine sugars, whatever proportion of the present output reaches the American markets, are unable to affect market quotations of beet sugar to any appreciable degree.

Hawaii has not made such rapid progress as its prophets foretold, and the next sugar crop of Hawaii will be well within the average limits. If there should be any increase in these islands, it will not be so considerable as to alter the market constellation.

The minor sugar countries of the tropics have their own troubles and will not be able to increase their sugar production materially.

So far as the coming Cuban crop is concerned, there is every reason to believe that the long drouth will throw its shadows far into the coming year and keep next year's Cuban crop well within the limits of this year's. The European beet sowings show but a very small increase over last year's. The visible stocks in all principal countries are not out of the ordinary and are certainly not large enough to prevent the markets from holding up firmly. The increase of the domestic sugar production in the United States, while assured, will not be above the average.

On the other hand, there has been a steady increase in the sugar consumption of all countries, with the exception of England. The next year will not bring any falling off in the general consumption, but rather a further increase. With sugar production almost at the same level, and with sugar consumption steadily increasing, and at all events increasing faster than the sugar production, the market quotations of sugar are certain to hold up during the coming campaign.

THE SUGAR CANE INDUSTRY IN CUBA.

FIGURES AND PRESENT CONDITIONS OF AN INVESTMENT FROM THE INSIDE AS INVESTIGATED BY A BUSINESS ECONOMIST.

By George Harvey Seward.

These great sugar estates, or "centrales," of Cuba are practically isolated, in many instances, from the rest of the world. One on which I spent seven months is fifteen miles from the nearest town, telegraph office and railroad. It is on the coast, however, and is touched twice a month during the grinding season by steamers calling for loads of sugar.

Communication with the nearest town was possible by telephone and mail courier.

The plantation had many of the elements of a community; means of earning a livelihood in the fields, on the railroad, in the sugar mill or in one of the many stores of the private town forming a part of the estate. There was also a public school and good opportunities for social intercourse and recreation.

The sugar cane estates are much more picturesque than the competing industry; sugar beet raising of Europe and the United States. The long rows of low plants cannot compare in effect with a tropical field of waving cane, dotted here and there with stately palms, and having the black, wooded hills as a background.

A sugar estate, in its practical aspect, makes large and constant demands upon several branches of natural science. It assembles men of various technical training, often from all over the globe. Several languages are often in use on one estate. At one business meeting I attended there were seven nationalities represented. In Cuba there are more commercial travelers from Germany, England and France than from the United States.

When I mounted my horse and rode out from the administration buildings to visit the field hands in their settlements or "camps," it was in the capacity of instructor in modern business methods that I went. My surprise at finding them skilled in agriculture, successful cattle raisers, economic users of mechanical, physical and chemical agencies, in their grinding mills, changed the role I had come to play to that of a student.

Upon this great industry two million inhabitants of the island are more or less dependent. Nearly a hundred million dollars of capital, chiefly invested by United States interests, changes hands annually in the work. Each enterprise divides itself into three departments of activity: 1. Agricultural. 2. Transportation. 3. Industrial.

Cuba is splendidly planned for cane culture because of the tropical heat, copious rain and freedom from frost.

Sugar cane itself is a grass-like saccharine plant which flourishes luxuriantly with practically no care. Each crop furnishes the seed for the succeeding crop. Stalks are cut up into pieces, each of which includes an "eye," from which the new plant springs.

One planting arrangement of simplicity consists of a series of long furrows into which the seed-cane is placed just before the rainy season. In a remarkably short time green stalks burst through the earth's surface. In a few months the stalk has grown to the height of the planter.

Crops are harvested by hand, no successful machinery having been devised for this. The cane cutters sever the stalk from the root just below the ground so as to leave the root protected. It is not necessary to plant new cane for a number of years. As each crop is cut off another appears. This is kept up in good ground for ten, fifteen or more years. Field hands transfer the cut cane to ox-carts, driven right into the fields, then it is taken to a scale, weighed and transferred to cars on a switch of the railroad.

Railroad tracks form a network over these immense farms (ranging up to 100,000 acres) to bring the cane to the central grinding mill. These private railroads of Cuba have a mileage of over a thousand miles; individual equipments include as much as thirty miles. Besides transporting cane, they haul the manufactured products to the coast or trunk lines for export and bring in the supplies.

At the mill, or "ingenio," to which it is taken by railroad or ox-cart, the cane is dumped on upward-traveling conveyors, which feed it between crushers; part of the brownish liquid contents is extracted in this process. Other crushing machinery is then used and juice extracted until the woody fiber becomes as dry as kindling wood and is used as such in the big furnaces.

The juice is caught in drip-pans and pumped up into the sugar house where it is subjected to chemical processes. This precipitates the non-sugar elements, and throws off the water, mixes and crystalizes the sugar. Then centrifugal apparatus separates the raw, brown product from what surprised me very much,—molasses—a sub-product which is a source of profit both in its natural state and when fermented and distilled on the plantation into alcohols and rums.

Grinding is continuous seven days in the week, day and night, except when the plant is being cleaned. This is kept up month after month while the supply of cut cane lasts, or until rains interfere. In the eastern end of the island the grinding season commences about the first of the year and continues until stopped by rainy season of late summer or early fall. During this "dead season," the mill machinery is dismantled, cleaned and repaired.

Modern sugar mills are usually gauged by the number of bags of sugar produced per annum. Fifty thousand is the average. Today there are two or three plantations having a capacity of over 200,000 bags; twenty-five over 100,000, and about 150 smaller ones.

On a plantation producing 100,000 bags per annum the larger items in its inventory of the investment would approximate these figures:

Mill and machinery	$ 500,000
Land	300,000
Railroad and equipment	300,000
Houses	150,000
Cattle, carts and horses	30,000
Tools	10,000
Supplies in warehouse	50,000
Total	$1,340,000

As may be expected the plantations are increasing in size; one now under way, backed by American capital, will have a daily capacity of 3,000 bags (1,000,000 pounds); will cost two million dollars to establish and occupy 100,000 acres.

The cost of cultivation of the cane and extraction of sugar in the mill, including delivery to New York, is a little less than two cents per pound, made up approximately as follows:

	cts. per lb.
Plantation cost	.0150
Commission and insurance	.0014
Freight	.0011
Miscellaneous expenses	.0005
Total	.0180

The difference between these figures and the current market price is the owner's profit. As the market fluctuates so considerably it is almost impossible to show this profit, but taking four cents—the price of September, 1906—it would be two cents or 100%. This is lower than the average for the year 1904 and 1905, when prices ranged from 3 3/16 to 5 1/4 cents.

A profit of two cents per pound is six dollars per bag; a shipment of 5,000 bags means $30,000 per annum to owners having the average 50,000-bag plant.

The celebration attending the grinding of the last car of the season is unique, joyous and noisy.

EUROPEAN IMMIGRATION TO HAWAII.

In the early part of May the second shipment of European immigrants obtained by the Territorial Board of Immigration, arrived at Honolulu on the steamer "Heliopolis," and consisted of a total of two thousand two hundred and forty-six men, women and children, exclusive of those who, on examination, were found to be suffering from trachoma.

These people were recruited in the District of Malaga, Southern Spain, and their appearance was better than that of any immigrants from Europe who have thus far come to these

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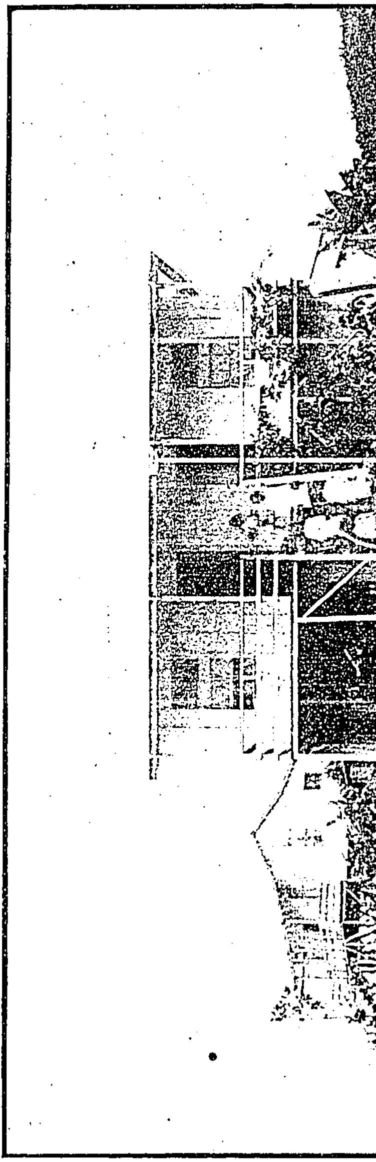

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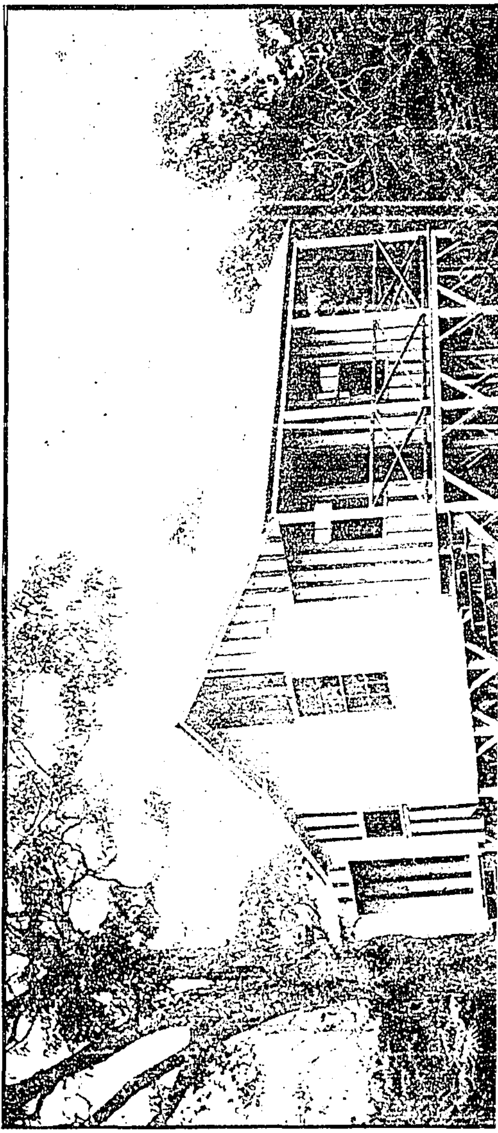

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TYPES OF HOUSE OCCUPIED BY HOMESTEADERS—ISLAND OF HAWAII.

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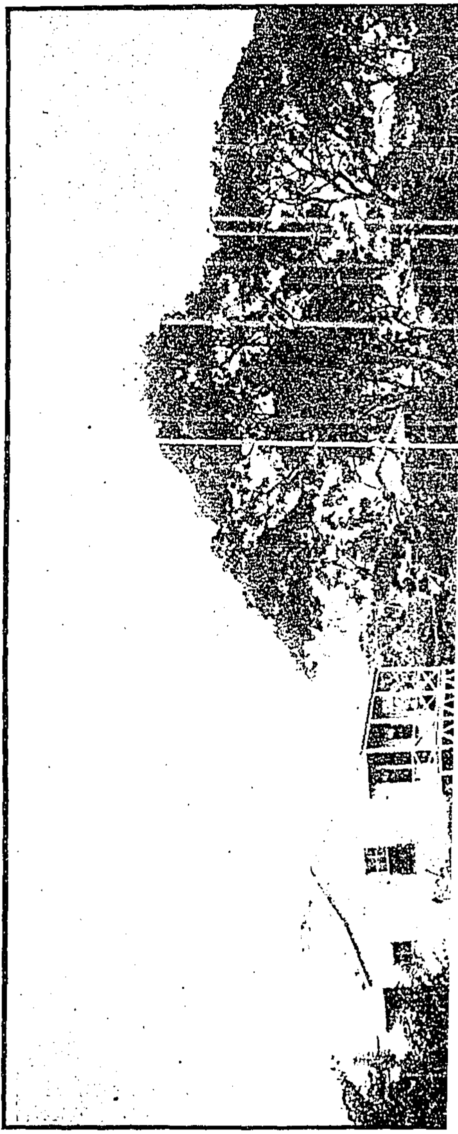

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HOUSE OFFERED SPANISH IMMIGRANTS—ISLAND OF HAWAII.

perty of value. The advantages resulting to the plantation from a settled laboring population are manifold.

There is one additional shipment of immigrants from the Azores now on the way and is due to arrive here toward the end of June. This lot consists of approximately eleven hundred people.

The total number of European immigrants, inclusive of the shipment on the way, which the Board of Immigration will have assisted to Hawaii, will be in the neighborhood of four thousand, six hundred and fifty men, women and children, which number, considering that the Act of the Legislature of the Territory of Hawaii, creating the Board, and under which it was organized, was not approved until April 29, 1905, makes a very respectable showing indeed.

Whether with the third shipment the Board of Immigration will cease its present efforts to obtain European labor for the Islands, depends upon a variety of circumstances, but principally upon the construction that is to be placed upon the Immigration Law as amended at the last session of Congress. The various opinions of the Attorney General on the new law have been unfavorable to a continuation of the immigration upon present lines, and the whole matter is at present being held in abeyance. That the kind of immigrant that has been obtained cannot come to Hawaii without financial assistance is without doubt, and that the financial condition of the Territory does not permit the appropriation of sufficient money to carry on the immigration is also beyond question. And therefore, if there is to be a continuation of the work of the Board of Immigration, it would seem that either the law will have to be amended by Congress, or a more liberal construction given thereof.

FORMOSA SUGAR.

Consul Julean H. Arnold writes from Tamsui that the production of sugar in Formosa is increasing year after year.

The season for 1906 showed a production of 159,000,000 pounds of brown sugar and a total of 178,500 pounds of of all grades. This is 50 per cent. greaer than the production of 1905, while in eight years the production of sugar in Formosa has shown a growth of 90 per cent. Formosa sugar is admitted to Japan free of duty, although an export duty is imposed upon this sugar when exported from Formosa to foreign countries. The 1906 exports from Formosa to Japan exceeded those of 1905 by over $1,160,000 gold, being equivalent to about 15 per cent. of Japan's total consumption. As Japan proper produces no sugar, it is plainly evident that the recent increase in import duties is intended to assist the Formosa industry.

A Sugar Bureau has been created under the charge of Dr.

Nitobe, a well known economist, who has been making a special study to improve and extend sugar cane culture in Formosa. Shoots for planting have been distributed free of charge to growers. That the growers have taken to the introduction of improved canes is attested to by the fact that in 1903 there were 2,520,000 shoots distributed among them, which increased in 1906 to 15,410,000 shoots, so completely exhausting the supply of the Bureau that purchases had to be made from private nurseries.

Improved fertilizers have been introduced. Among the new fertilizzers in use are goose bone dust, Australian bone dust, and Manchurian bean cake. The importations of bean cake in 1903 were 154,835 pounds and during 1905, 477,756 pounds. Peanut-oil refuse was also imported for fertilizing and used to the extent of 149,040 pounds in 1904, but has not been popular because of its higher cost. It is expected that the use of artificial fertilizers will continue to increase as the development of the sugar cane industry advances.

BONUSES AND SUBVENTIONS.

To assist and encourage the growing and the manufacture of sugar, the Sugar Bureau grants bonuses and subventions to growers and manufacturers. In the southern part of the island there is considerable land belonging to the Government which is adapted to the cultivation of sugar. In order to bring this land under cultivation, the Sugar Bureau is empowered to grant to prospective growers the following bonuses: For plants, a sum not to exceed $1.80 gold for each one-tenth ko (1 ko=2.43 acres); for fertilizers, a sum not to exceed $2.50 gold for each one-tenth ko; for cultivation expenses, a sum not to exceed $1 gold for each one-tenth ko. After ten years of successful cultivation the grower is entitled to a title deed conveying to him the land cultivated by him. For irrigation and drainage works, before any such may be undertaken, application must be made to the government, upon the granting of which the government empowers the Sugar Bureau to defray an amount not greater than 5 per cent. of the total cost of the undertaking. Up to 1904 the Sugar Bureau was empowered to dig artesian wells and undertake drainage systems, and it spent $7,117 gold in so doing. The total area under cultivation now as compared with the area under cultivation in 1902 is about double the area at present cultivated, being estimated as 88,000 acres.

METHODS OF MANUFACTURE.

In 1900, the agricultural section of the Formosan government, with the aim of introducing modern methods of manufacture of sugar in the island, installed two American crushing mills. It was soon shown to the Chinese producers that they might secure 20 per cent. more juice by the use of these rolls instead of the antiquated Chinese stone crushers. After the creation of the Sugar Bureau, a number of these rolls were introduced to displace the stones. The efficiency of modern machine methods over primitive native methods has been amply demonstrated. For several years the Sugar Bureau was empowered to grant subventions to companies erecting sugar factories, basing these grants on the amount of capital invested. Since 1904 bonuses have been granted upon a basis of 20 per cent. of the purchase price of the machinery. Since the establishment of the Bureau $380,348 gold has been distributed in bonuses to factories.

When a new company wishes to engage in the manufacture of the crude sugar, it must file an application with the Sugar Bureau, through the prefect in the district in which it desires to operate, stating in this petition full particulars as to its working capital, proposed capacity, etc. In case the Sugar Bureau grants the application, it designates certain areas from which this mill may secure its cane. No company is permitted to purchase cane in any other than the district assigned to it unless by special grant from the Sugar Bureau.

The growers, in turn, are obliged to sell their cane to the mill operating in their respective districts, unless granted special permission from the bureau to do otherwise. Thus, competition in the buying and selling of the sugar cane is barred. The price paid for the cane is determined by the company making the purchase. In case the growers are dissatisfied with the price offered they may lay the matter before the district prefect, whose duty it is to effect an arbitration between the company and the growers.

It is the duty of the prefect of each district to keep in touch with the conditions obtaining in their respective perfectures as regards any tendencies on the part of the mills to take undue advantage of the growers, and report such to the chief of the Sugar Bureau. The mills are obliged to send to the Sugar Bureau regular reports setting forth complete statements of their operations, prices paid for materials, sales of sugars, prices realized, etc.

OFFICIAL REGULATION.

In this manner the Sugar Bureau regulates the industry, and is able to render to it such assistance as it finds practical. A large number of these mills control the land upon which much of their cane is raised, renting it to growers and advancing to these money and materials sufficient to carry on the growing of the cane at a small profit to them. In other cases the manufacturers arrange at the beginning of each season with the growers, fixing a certain price to be paid for the cane, and advancing money against the crop upon the fixed price basis. Most of the mills have agents in Japan who contract to take their products for the

Japanese refineries. Practically all of the refining is done in Japan.

The prospects for the erection of a number of new mills of large crushing capacity are quite bright. In fact, several large companies have already organized and are preparing for the erection of their plants as soon as they are able to secure the necessary machinery and equipment. One crushing company has a capital of $2,500,000 gold, another has increased its capital from one-half million dollars to five times that sum; another half million dollar one is organizing, and there are many smaller concerns making up an aggregate of $10,000,000 capital either invested or about to be.

LAYING OUT OF CANE FIELDS FOR IRRIGATION.

By George R. Ewart.

(Read before the Hawaiian Engineering Association at its May, 1907, Meeting.)

In talking of a subject by the Topics Committee of our Society, Mr. Gartley suggested the above subject. My first thought was that it was so well known among us and there was so little to tell, that it would prove of no interest. On my expressing myself as above Mr. Gartley said, perhaps that was true as far as I personally was concerned, it being so familiar to myself, but it could not be to others who were not so familiar with the subject, and on thinking it over I have thought that perhaps he was right, hence this short paper.

It is hard to give a good title to this paper without making it a long one. If my memory serves me right, Mr. Gartley spoke of the subject of laying out fields for irrigation, but it is difficult to explain the laying out of fields without touching on irrigation and drainage, so as to give a reason for what little there is to say about the laying out of fields for irrigation. Let the title go as it is and please accept anything else there is in the paper as an aside, as the subject of irrigation and drainage in all its phases is too large a one for a paper before any society—it is a subject for a book.

There are two kinds of irrigation practiced on Hawaii, flooding and by furrows. The former is the practice in rice and taro growing, the latter in cane growing. But as this paper is on the laying out of cane fields we merely mention the flooding system.

The axiom in all kinds of irrigation is that you must "water from the highest point and drain from the lowest." The amount of draining to be done depends upon the nature of the soil, for instance, a soil that will hold 86.9% of its weight of water may not want so much drainage as a soil that only holds

31.8% of its weight. Soils on the islands vary as much as the above comparison.

Most of the irrigated plantations are on the leaside of the islands and give very little trouble so far as drainage is concerned. The soil is deep and the roots of the cane go lower than on plantations on the weatherside of the islands, so the plant has the benefit of the water as it wants it without the water becoming stale or sour. On the weatherside the soil is shallow, with a hard non-porous subsoil, and in confined places the water will come to the surface and turn sour. Even if the subsoil is broken it is a small help to the plant as its water holding properties are bad; and, as the roots will not enter the subsoil, it is really a greater loss than if you leave the hard pan entact, for the reason that the water may drain away at a lower level than it can be picked up again. By careful draining you can, in a great many cases, use any surplus water that may drain away over again. I had one field where we could do that three times in a distance of about 3/4 of a mile. We took all the water there was at the upper end of the field and were able to collect all surplus water three times out of the gulch. It would take a few days at each place before the water would get there, but in constant irrigation, in time we could get all there was of the water the soil could not hold. I suppose if it were possible to give the soil no more water than it would hold there would be no need of draining, but that is impossible in our system, it cannot be gauged to such a nicety, let alone considering the class of men who do the watering.

So, a field being plowed and ready for furrowing, with the main ditches at the upper end of the field, you start from your main ditches, and with a level—either a Dumpy or Y—and a rod, whose target is painted with four squares, two red or black and two white, the colors at opposite corners, so that the center line will show clearly. You send a boy out, say, thirty paces, depending, of course, on the grade of the field. A field with a grade of 1%, you can readily see would easily come many times within the field of the level without moving, whereas, one of 8% would not. Thirty paces gives the furrow team about five furrows to plow before coming to another contour line, so every thirty paces, where possible, the contour lines are run. At, say, fifteen paces a pin is put in along the line (where puhala roots can be got easily they are split and used as pins) standing about eighteen inches above the ground. At the end of the furrows or any change that is to be made two pins are put together and crossed. As soon as the leveler is out of the way sufficiently, the furrowing gangs are ready. Some put a small plow to follow the pins of the contour lines and a furrowing plow to follow. When you have good plowmen the small plow is not needed. The same is sometimes done with the furrows, between the contour lines. A small plow is run parallel with the contour line at whatever distance you propose to have your furrows apart, five feet, five feet six inches, or any other distance. Good plowmen can run such furrows with the furrowing plows without having the furrows marked with a small plow, the same as they can do the laid out contour lines. The plowmen have rods given them the distance the furrows are apart to measure their distances from each furrow. Awais or latterals are then marked off running from the main or parallel ditches, every, say, thirty feet, or whatever space you think the water will carry without giving all the water at one end of the furrow and very little at the other. Some soils you can easily have your awais sixty feet apart. The object is to have your furrows level or as near level as possible so that there will be no wash when the water is run in, to have a good steady stream of water so that the furrows will fill quickly and be evenly distributed over the whole furrow.

On the weatherside of the islands where the soil is shallow and coarse grained the awais are nearer together than where the soil is deep and fine grained, for the reason that the water drops down through the coarse grained soil easily. I've known it to take, at the first watering, seven minutes for the water to reach the end of a thirty foot furrow, volume of water the man was handling, about 1/8 cubic foot per second. First watering is done usually with a small stream of water as the soil being in a loose state it washes easily, as it becomes packed you can use much more, up to 1/2 cubic foot per second, and, of course, good work is then done. In gulches where teams cannot turn easily they usually run to a point and the furrow is worked out with hoes by hand. Every, say, one hundred yards, or where most convenient, parallel ditches—parallel with the main ditches—are run. The reason for that is to keep the men together and to reduce the waste of water that takes place when run in long small awais. On side hills awais are run at right angles to the furrow. The reason for that is to save the furrows from being washed out by overflowing. The greatest danger is in big rain storms.

In level, or fairly level, lands you run the awais at any angle to the furrow that is the most convenient for the lay of the land or your ditches. The hardest fields to lay out are those that are dead level, or nearly so, where they run to hollows and hills and no grades to carry the water on. Such fields have mounds that you must get water to to be able to carry out the axiom of watering from the highest point. These fields have many such places. When high enough you carry water by flumes and when not so high, you make a raised ditch with earth. The latter method is very wasteful of water and only done where the ditch is short, or you have an abundance of water or where you have a soil that will hold water easily and not let it away. Level fields are usually wasteful of water anyhow and are a source of great anxiety when drainage is bad as the water is liable to stand in puddles and sour, drainage being just as hard to manage as it is to get the water on the field. In blind gulches—gulches where there is soil in them and no water courses—the furrow plow is run down the lowest point as many times as is necessary to reach the hard pan, following the plows with men who clear away the soil and dig down into the hard pan or subsoil deep enough to carry away whatever water you think will run when irrigating or that might gather in a rain storm. You will readily see that the larger the gulch the larger the drain must be. The reason for carrying the drain down into the hard pan is that it won't wash out as it does if only made in the soil. On fields of steep grades the greatest care must be taken both with your ditches and awais to prevent them from being washed out.

Gentlemen, you will see from what I have read that there is really little to say regarding the "Laying out of cane fields for irrigation," that a great deal depends on the lay of the fields and the soils composing them.

SEEDLING CANES AND MANURIAL EXPERIMENTS AT BARBADOS.

(From Bulletin of Imperial Dept. of Agriculture, West Indies.)

The results of the manurial experiments indicate, generally, that larger yields are obtained by supplementing an ordinary application of farmyard manure with artificial manues than by giving a large application of farmyard manure without artificials. Also, that the application of nitrogen, both to plant canes and ratoons, is followed by a profitable increase in the yield. It will be observed that the results of manuring with potassic and phosphatic manures are not, this year, in accordance with previous results; slightly increased yields have followed the application of superphosphate, while the use of potassic manures has not been profitable.

The production of seedling canes by artificial cross-fertilization has been continued by Mr. F. A. Stockdale. Reference is made to the proposals for future work along these lines, by which it is anticipated that the raising of seedling canes under control will lead to the production of much improved varieties of the sugar cane.

SEEDLING AND OTHER CANES, SEASON 1904-6.

The following is a summary of the more important and interesting results of the season in connection with the sugar cane experiments carried out under the direction of the Imperial Department of Agriculture for the West Indies.

One of the most important of the branches of this work is the endeavor to obtain such varieties of canes as will best suit the varying conditions of soil and climate existing on each plantation.

To this end, during the last nine years—the period during which the Imperial Department of Agriculture has been in existence—some 30,000 canes have been raised from seed, and these 30,000 varieties have been studied in the pot, in the field, and many of them in the chemical laboratory in order to select and afterwards propagate varieties that possess the most desirable agricultural and chemical characters. The means by which this object is attained are briefly as follows:

The majority of seedlings are raised from seed planted early in the year in boxes and afterwards potted: the better specimens (generally some thousands in number) are planted in May in a field arranged for irrigation, so that during their more tender period they can be protected from drought if necessary. They are kept under careful observation during their growth, and when they come to maturity in the March or May of the following year, those varieties whose agricultural qualities are good enough are reaped and analysed. The whole stool is cut, weighed, and crushed, and if the chemical analysis shows that the juice is rich and pure, the stools are irrigated to induce a spring of ratoon canes to provide plants for multiplying the variety the following December. From that time the variety is annually propagated and multiplied in the usual manner, and, if the results warrant, it is grown in an increasing number of plots in different districts both as plants and ratoons. Each year these plots are reaped and weighed, samples of the canes are crushed in a small estate mill at the laboratory, and the juice is analysed, and this goes on until the cane is either ultimately rejected, or plants are supplied to the planters with the recommendation to try them on a small estate scale.

In this process of agricultural selection, we have, of course, to pay attention to certain main points. In this pamphlet we give a list of the more important characters of the sugar cane to which attention should be directed in making a selection, and you are invited to refer to this list; but of them we regard germinating power, tonnage, resistance to disease and drought, richness and purity of juice, as those that should be first attended to.

The seed of the cane plant is, as you are aware, produced by a sexual process in which generally two parent plants participate. We may speak of the mother plant or plant that ultimately bears the seed, and the pollen-bearing plant that bears the dust-like pollen that fertilizes the flower of the mother plant. Until a few years ago only one half of the parentage, namely, the mother plant, of the young seedling was known, so that an uncertain element came in in the unknown characters of the pollen-bearing plant. One of us, in 1901, drew attention to this and suggested methods of raising seed in which both parents might be selected, but pointed out that unless the difficult operation of taking pollen from one known variety were carried out, complete certainty would not be attained. In 1903, this difficult task was accomplished by Mr. L. Lewton-Brain, then Mycologist of the Imperial Department of Agriculture. Certain very promising varieties were selected for the purpose of thus artificially crossing, and ultimately, five seedling varieties of completely known parentage were obtained. Mr. F. A. Stockdale, the present Mycologist, has since attacked the problem and has made some very valuable propositions as to the future methods of carrying this work out, in which is incorporated the latest knowledge of plant breeding, and we hope that, working with seedlings thus raised, it may be possible to reach our goal with greater certainty and in a much shorter time than we would if we confined our attention to varieties of which the parentage was not completely controlled.

The selected varieties were cultivated at thirteen estates typical of the localities in which they are situated, eleven being black soil estates no two red soil estates. * * * *

SEEDLING CHARACTERS.

The following are the most important field and factory characters, a consideration of which goes to determine the value of any variety of cane:

Field Characters—

1. Germinative power.
2. Behavior under extremes of dryness and moisture.
3. Habit, that is, whether upright or recumbent.
4. Power of resisting the attacks of insects and fungi.
5. Period of growth.
6. Productive power in tons of cane.
7. Tonnage of tops.
8. Ratooning power.

Factory Characters.—

9. Milling quality, that is, whether the canes are tough or brittle.
10. Fuel-producing property, depending upon the percentage of fiber.
11. The relative percentage of expressible juice (determining the "dryness" or "juiciness" of the canes).
12. The richness of the juice.
13. The purity of the juice.

NITRATE OF LIME, A NEW FERTILIZER.

METHODS OF MANUFACTURE IN NORWAY.

Consul John C. Covert, of Lyon, France, supplies the following information concerning nitrate of lime:

The agricultural papers of France are manifesting considerable interest in nitrate de chaux (nitrate of lime), the new fertilizer which was not long since given to the public by a Norwegian chemist. It is believed that it is destined to fill an important place in agriculture. A member of the French Institute recently read a paper on this new fertilizer before the French National Society of Agriculture, from a report of which I make a brief resume:

The only azoted fertilizer of quick assimilation which has been in use up to the present time is nitrate of soda, imported from Chile. The air contains immense quantities of nitrate, offering an inexhaustible source to draw upon. The progress of electrical science has afforded us a means of capturing this useful element. Azote is captured from the air by means of an electrical furnace heated to a very high temperature. The azote in the air is oxidized and converted into azotic or nitric acid. Various ingenious applications take place in a number of granite chimneys, accomplishing a gradual concentration of this acid, which is finally received into a wooden chimney filled with quick lime. This lime absorbs the nitric acid and is converted into nitrate of lime. This is in turn concentrated in basins heated to about 145 deg. The matter in fusion is afterwards poured into cylinders, then pulverized, when it is ready for use. The nitrate of lime thus produced contains an average of 13 per cent of assimilable azote. This powder is very hydroscopic—that is to say, it readily takes up the dampness in the atmosphere and gradually assumes a doughy consistency. The factory puts the article on the market in closely made barrels containing 220 pounds each. The nitrate is thus delivered to the consumer in good condition and is kept close in the barrels until used.

Many experiments have proved that nitrate of lime is as good a fertilizer as nitrate of soda. Its action is the same in all kinds of ground, even in calcareous land. In some kinds of farming, especially in the cultivation of the beet, it is superior to nitrate of soda, which is sometimes detrimental to a perfect development of the plant.

Although the raw material for the manufacture of nitrate of lime is in the air and is cheap and inexhaustible in quantity, its conversion into an article for use is costly. An expensive element in its manufacture is the motor power which is necessary to obtain the high temperature of the electrical furnace Waterfalls, carefully controlled, are indispensable, and Norway is exceedingly rich in this form of power. In France the cost of production will be much greater than in Norway.

SHARE SYSTEM IN CANE CULTIVATION IN FIJI, HAWAII, AND MAURITIUS.

(From West Indian Bulletin.)

The following is a further contribution from his Excellency Sir Henry M. Jackson, K.C.M.G., on the subject of the Share System in Cane Cultivation adopted in Fiji, Hawaii and Mauritius.

In the recent exhaustive inquiry held into the condition of the labor supply in Trinidad, it was made abundantly clear that the scarcity of labor pressed most heavily on the sugar industry, and that it was largely due to the fact that the overwhelming majority of indentured immigrants left the estates immediately on expiration of their terms of service, and their labor was no longer available.

It was pointed out that the East Indians have been described as "the most conservative peasantry on the earth" and that if some means could be devised of offering them comfort and independence in the district, where for five years past they had been forming many ties, it would probably afford a cheap and permanent remedy, by inducing them to remain on the estate. It is not to be expected of any free laborer, whatever his origin, that he will be content to continue working on the same terms as when under indenture, when there are so many openings for a more independent life and more prosperous occupation; but if he can find on the estates the means of making as much as he can elsewhere, and of leading his own life, it would be natural to him to remain among his friends. It is with the object of showing how these means have been devised and successfully worked elsewhere, that the writer submits the following notes on the share system, worked by means of cane companies in Hawaii, Mauritius, and Fiji.

In Hawaii, the Commissioners of Labor reported that in 1902 there was only one plantation on which the system had not been adopted, but that that estate was close to a large town and enjoyed special advantages in the way of local labor. It is true that the imported labor in Hawaii is Japanese, and that these men form the cane companies, but in Mauritius the conditions closely resemble those of Trinidad, and in Fiji the labor on the sugar plantations is almost exclusively Indian coolie immigration.

In Mauritius, at the commencement, considerable outcry was made by some planters when the land owned by others was first offered in small blocks to the coolies; but later many who had at first opposed the system, similarly offered their land, having recognized the great benefit to them of the change. The system was found on experience to lessen the annually recurrent heavy outlay for the introduction of new labor, besides cheapening the cost of the cane supplies, and ensuring the settlement in the vicinity of the mills of considerable numbers of free coolies, from whose ranks could be obtained contracting gangs for some of the harvesting and other work to be done during the crushing season, which work if performed wholly by indentured labor, as formerly, necessitated the maintenance during the whole year of the maximum requirements of labor during any portion of the year, with the result that the cost of the crops was unduly burdened.

In Fiji, there was also considerable opposition at first among the managers of estates, and as the success of such innovations is largely dependent on the active sympathy of those entrusted with the administration of the details, the earlier results were somewhat disappointing. The proprietors were, however, convinced that the distrust could only be based on the absence of knowledge as to the actual effects, and insisted on the system being given a fair trial, with the result that it was found that the trouble was more apparent than real, and that the greater supervision as compared with the ordinary plantation duties of the overseers, which the work under the "share system" required at the outset, rapidly became counterbalanced by the spontaneity of the work done, and by there being no need to measure up the individual tasks in each instance daily. The preliminaries, no doubt, necessitate a good deal of additional trouble, but the extra work is fully repaid by the sensible reduction in the cultivation expenses.

The "share system" consists of the division of the land to be cultivated into blocks, a convenient size for which was found to be 60 acres. The land is prepared and planted by the estate, and the blocks are then handed over to cane companies, which may be composed of either free or indentured laborers, or both, and which carry on the cultivation under the supervision of the estate management. Until the cane is harvested the members of the cane company receive an advance of 1s. a day for each day of nine hours worked by such members, such payments being afterwards deducted from the price paid for the canes. When the canes are cut and taken to the mill, the cane company is credited with the amount per ton agreed upon beforehand, and from this is deducted the advances made during cultivation, and the cost of any work done by the estate after handing over.

Attached are copies of the actual accounts of a cane company working a block of 60 acres on an estate in Fiji:

The block yielded 1,843 tons of cane, which, at 4s. a ton, gave the cane company a return of....		£368 12s. 0d.
From which was deducted advances made for days worked....	£141 19s. 11d.	
Cost of stripping and loading (by estate)	8 18 11	
Hired labor for cutting (advanced cane company)	66 0 0	£216 18 10
		£151 13 2

There thus remained a balance of £151 13s. 2d. to be paid to the cane company, the members of which had worked approximately 2,595 days. This is equivalent to a bonus of 1s. 2d. a day, in addition to the 1s. a day already advanced, making their total earning 2s. 2d. a day. The block was not a specially good one, as on the same estate some cane companies earned as much as 3s. a head per diem, and in no case did they earn less than 2s.

Appendix B gives the actual cost to the estate of the canes of that block delivered at the mill, which is shown as 7s. per ton, including the cost of preparing and planting before the cane company took over the block, and of the laying of the portable tram line and of all the transport. It also includes a charge of 30s. per acre for supervision and maintenance, and a charge of 5d. per head per day worked for introduction and hospital expenses, though the actual cost of these was only 4d. per unit. It will be noticed that this is charged on the members of the cane company as well as on the estate coolies, and this is due to the fact that the whole of the members of No. 8 company, whose accounts are given, happened to be still under indenture.

Conditions are agreed to by the cane company, under clauses 1 and 7, by which a habitual idler could be got rid of, for not doing his work "satisfactorily and in the manner directed."

The money paid to the cane company, which, in case of the company shown in Appendix A, amounted to 2s. 2d. per head per day for 216 working days, must not be taken as representing the whole of their earning, as all the members had opportunity of gaining money in other ways. In fact, one of the problems to be solved, in order to make the system a success, is how to provide constant employment for the members of cane companies, whose work on their block does not fill their whole time.

In the crop season there is no difficulty, as the members of the cane companies are also employed in the mills, and form part of the cutting gangs.

In order to set the men free for these purposes, the harvesting of the crop grown by the cane companies should be done by gangs of harvesters from amongst the members of these companies, who, under the direction of the estate management, cut and relieve the blocks in the rotation desired at a fixed rate per ton. This provides attractive earnings at work near at hand for the members of the cane companies, and as each cutter, or pair of cutters—for they usually work in pairs—is paid according to the tonnage of each truck, the men of the gang are as much on individual task work as when doing similar work under indenture. When the labor of any of these men is required on their own blocks, it is found easy to allow them to drop out for a few days without prejudice to the general interests.

Out of crop time many of those engaged in farming blocks devote a portion of their time to raising other crops on waste lands allowed them by the estate. A further means of overcoming the difficulty of providing the members of the cane companies with constant employment, and especially those still under indenture who have a right to demand it, is by allowing each company to take up two or three blocks, on which the operations requiring manual labor would be performed at different times, say, a block of early plants requiring much hand work, with a couple of blocks of ratoons cut early in the season. At odd times work may be found in connection with the maintenance of tramlines, roads, formation and cleaning of drains, and permanent improvements.

In the Hawaiian agreements it is stipulated in almost every case that, when the estate is in need of labor, the cane companies shall furnish as many men as the estate may consider can be spared without prejudice to the cane companies' crops, such extra service being, of course, specially paid for.

In Fiji, the indentured labor readily came forward to work on the system outlined. At first, permission was only granted to those in their last six months of indenture, but it was very soon found desirable to extend it, as it became apparent that the indentured coolies working under the "share system" were beginning to understand the advantages of growing cane fo rsale to the estates. Such experience is wholly absent from their ordinary conditions under indenture, and it appears reasonable to assume that when such coolies become free they will be more likely to continue to supply the estate than those who have worked under the much less heartening conditions of indentured service for five years, at their release from which, the sudden feeling of freedom is found to cause many to seek other pursuits locally, or decide to return to India.

It was universally admitted by those in charage of estates where the share system had been successfully established, that the canes were better tended than when the work formed portion of the daily task under indenture, and one of the principal managers in Fiji, a gentleman of life-long experience among indentured labor in British Guiana, Australia, and the Pacific, was able to report in 1900 that the coolies working under the share system were doing double the task per day that any indentured man ever attempts to perform. A very practical result on the estates under his supervision was that in two years' time, although cultivation had increased, the percentage of indentured labor had decreased by almost 10 per cent., and this although the application of the system was still partial.

The writer feels very deeply his lack of anything approaching expert knowledge of the subject treated on, but the sugar industry in general, and indentured labor employed thereon in particular, have always been of special interest to him, and for some years he has been afforded exceptional opportunities of examining the difficulties which hamper them. These notes, which are the outcome partly of personal observation, and partly of discussion and correspondence with men who have faced and overcome these difficulties, are submitted in the hope that they may assist those with a better knowledge of local conditions, in adapting to those conditions a system which seems to go far to meet the advice given at the Labor Committee by a planter of large experience when he said, "Make a sort of friend of the immigrant so that when he has finished his time he will stick to the estate and not migrate."

APPENDIX A.

Profit made by Planting Company.—

				£	s.	d.
1,843 tons of cane at 4s.				368	12	0
Work done by the mill.—	£	s.	d.			
Stripping and loading	8	18	11			
Work done by Planting Co.—						
Hired labor for cutting	66	0	0			
Wages paid	141	19	11	216	18	10
Profit				£151	13	2

Approximate number of days worked, 2,595, or 1s. 2d. per day bonus; 1s. per day also paid for each day worked, thus making the total earnings of each member of planting company 2s. 2d. per day.

Blocks Nos... consist of 60 acres—30·7 tons per acre.

Aug. 22, 1903.

APPENDIX B.

Planting Company No... Block No... (12 indentured men).

Cost of work done before planting company took over the fields, and of portable tramline and transport:—

	Units.	£	s.	d.
Ploughing out	183	5	2	9
Harrowing	27	1	4	0
Ridging	139	9	8	3
Drilling	24	1	14	0
Replanting	191	18	8	9
Scarifying	103	5	1	0
Ploughing between cane	39	2	12	6
Laying by	14	1	7	9
Portable tramline and transport..	102	5	2	0
Scoops	144	6	12	0
	866	56	13	0
866 coolie units at 5d.		18	0	10
Livestock Units, Supervision, Maintenance, etc.				
289 Horse units at 1s. 7¼d.		23	18	0
466 Mule units at 1s. .0¾d...		24	15	1
898 Bullock units at 2½d.		9	7	1
Supervision, maintenance, etc., 60 acres at 30s.		90	0	0
2,595 Indentured units of planting company, at 5d.		54	1	3
1,843 tons cane at 4s. per ton		368	7	3
		£645	7	3

Total cost of cane, £645 7s. 3d.; tons cut—1,843—7s. per ton.

LOSSES OF PLANT FOODS.

Stable manure is considered an important item on the farm, and the farmer who carefully manages his manure heap is one who also uses fertilizers. The value of the manure in the heap, however, depends upon the materials from which it is produced. Animals fed upon linseed meal and grain will void manure that is richer than that from animals fed upon straw. As the foods vary in quality, so does the manure, for which reason no fixed value can be given the ingredients of the manure heap. A small accumulation of manure may contain more plant food, and produce larger crops, than a large heap made from inferior food and carelessly managed. The quantity of manure broadcasted on an acre one year may not consequently give the same results as an equal quantity on another field the following year. It is this variability and composition of manure that causes disappointment at times when large yields are expected, and the cost of the manure is much greater, proportionately, when manure is inferior, for the reason that the farmer must expend as much in labor for applying inferior manure as for that of better quality. Every farm should be well equipped for converting everything into manure that cannot be sold or utilized on the farm, and the manure should be preserved in a manner to prevent loss and have the plant food in the most available form at the time of its application.

Where experiments have been made to compare exposed and unexposed manures (as was done at some of the experiment farms), it was demonstrated that there was a greater loss of nitrogen and organic matter from exposed manure than from that protected. The former lost one-third of its nitrogen and the latter about one-fifth. Ten per cent more organic matter was destroyed in the exposed than in the protected manure. There is practically no loss of potash and phosphoric acid from protected manure. Exposed manure that is rotted may lose about one-sixth of its phosphoric acid, and somewhat more than one-third of its potash. The chief changes, due to fermentation, take place within the first months of rotting, and experiments show that there is no apparent benefit in rotting the manure longer than for a period of three months. When gypsum was used, three tons of horse and cow manure, mixed in equal proportions, were allowed to ferment without the addition of any preservative, by way of comparison, with any equal weight of the same kind of manure intimately mixed with ground gypsum (land plaster) at the rate of 50 pounds of gypsum with every ton of manure. These lots were fermented at the same time, in separate bins, inside of a building, the manure being fresh and compacted as closely as possible, being undisturbed for four months, when they were weighed and analyzed. The results at the Canadian experiment farms show that gypsum retarded, to a certain extent, the destruction of animal matter. The amounts of nitrogen in both lots were the same, no useful results from the application of gypsum being observed. The proper place to use gypsum is in the stable, as it is in the stable that a great loss of ammonia occurs.

When manure is kept moist, the loss of potash cannot be prevented without a water-tight, non-absorbent floor, but when the manure heap is kept compact and moist, there is no considerable loss of ammonia. It is evident that if manure is exposed to rains, no matter what the absorbent materials may be, the water cannot pass down without carrying the soluble matter with it, and when the water reaches the bottom, it must either go down in the ground or flow off in some other direction. Whatever substance has been dissolved out of the manure, remains in the water and passes off with it. The remaining materials of the heap may be almost worthless, but they receive just as much attention, and as much labor is bestowed in hauling and spreading the substances as though the loss of soluble matter had not occurred. It has been shown that when manure is compacted and the air kept out, the fermentation of the mass is not so rapid, but when loosened and the air admitted, fermentation begins, because the oxygen of the air influences chemical action. When manure is under shelter, the rains do not dissolve the plant food from the heap, and when the liquid manure is thrown upon the solid portions, by pumping or otherwise, the solids become absorbents and assist in retaining the liquids. All locations for manure should have water-tight bottoms, for then any accumulation of liquids can be retained and added again to the heap. The tanks should be so arranged, into which all liquids from the stable should flow, so as to save the soluble matter.—American Fertilizer.

*THE NATURE AND AIMS OF PLANT PATHOLOGY.**

D. McAlpine.

INTRODUCTION.

At the meeting of this Association in Melbourne in 1890, a committee was appointed at the instigation of the late Mr. F. Wright "to investigate the question of Rust in Wheat," and as a result of this, the Government of Victoria, and afterwards the Government of New South Wales, each appointed a Vegetable Pathologist to deal with us, as well as other diseases of plants due to fungi. And now, after the lapse of sixteen years, I propose to deal with the subject of Plant Pathology, pointing out its nature and aims and what it has achieved, incidentally referring to Rust in Wheat, and showing what progress has been made in the solution of the question, as well as the problems connected with it and other diseases still awaiting an answer. Pathology has been defined as the science of disease, as distinguished from Phpsiology the science of health, and Plant Pathology will thus deal with all the diseases of the plant, however caused. But what constitutes disease will require to be considered, for there is sometimes a very narrow margin between being "out-of-sorts" and in perfect health. A departure from the normal life of the plant might be regarded as a diseased condition, but that is what is sometimes actually aimed at by the cultivator, as in the case of the cauliflower which is an abnormal form of the cabbage. So that we will require to qualify the conception of disease as an abnormal condition of the plant, interfering with the use for which it is intended, or threatening its life in whole or in part. It is a derangement of function associated with corresponding changes in structure. It is evident, therefore, that before we can fully understand and appreciate the departure from the normal—this interference with the normal physiology of the plant—we must be conversant with the conditions and results of the ordinary vital activities. In other words, Physiology must be the starting-point for a proper understanding of Pathology or Disease; we must have a knowledge of the normal, before we can detect the abnormal and appreciate its significance.

EARLY VIEWS ON PLANT DISEASE.

When we consider how vague and ill-informed are the views held by many growers, even at the present day, as to the nature

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and cause of disease, it is not to be wondered at that the ancients had very peculiar notions about it. They often associated it with an offended deity, or regarded it as the working of an evil spirit or humor which entered into the plant and deranged its functions. The mildew or rust of wheat has been known from remote antiquity, and the ancient Romans held a festival in honor of the god Robigus on 25th April—the Robigalia or Rubigalia—and offered sacrifices in order to protect their fields against the disease The philosophers of Greece and Rome, however, speculated as to the causes of it and Aristotle even noticed the epidemic nature of rust about 350 B. C. In Shakespeare's time it was also recognized in England, for he writes in *King Lear:* "This is the foul fiend Flibbertigibbet. He mildews the white wheat." Even as late as 1733, Jethro Tull considered that it was caused by insects, and that the black spots upon the straw were nothing but the excrements of the young insects. But the use of the microsope soon exploded the idea, for in 1767, Felice Fontana published an account of the fungus with drawings, and thirty years later Persoon gave it the name which it still bears, *Puccinia graminis.* Although the rust is thus known to be a fungus, it is still so firmly believed by many to be due to the weather, or a special dispensation of Providence, or the oozing out of the juices of the plant, that they refuse to believe in any possibility of counteracting it. Even Jethro Tull, with his imperfect knowledge, was further advanced, for he writes: "The most easy and sure remedy that I have yet found against the injury of these rusts, is to plant a sort of wheat that is least liable to be hurt by them."

While there is no doubt as to the antiquity of the mildew or rust, the smut of wheat apparently was not known in ancient times, for there is no word to express it in the language of Greece or Italy. It is sometimes considered that the "blast" or "blasting" spoken of in Scripture refers to this disease, but there are others who regard the expression as equivalent to blight. However that may be, the smuts have become celebrated in historical times on account of the different views held as to their nature and origin. Smut was at first thought to be a degeneration of the grain, and atmospheric conditions were generally assigned as the cause. When the spores were observed at first they were regarded as foreign bodies and even taken to be infusoria, but their resemblance to fungus spores was soon recognized. Persoon placed them in the genus *Ustilago* in 1831, and so the rusts and smuts were definitely assigned to the fungi.

But there was still one fatal error which prevented this knowledge bearing fruit, and that was the mistaken idea that the parasitic fungi were not produced from spores or seed-like bodies like ordinary plants, but were diseased outgrowths from the plant itself —morbid conditions (eruptions) of vegetable matter. As late as 1833 this view was put forth by such a good observer as Unger, in his work "Die exantheme der Pflanzen," and adopted by

Schleiden even in 1846. The views which prevailed concerning disease in general and smut in particular towards the end of the eighteenth century are well summed up in an article on the subject of smut in the fifth volume published by the Bath Agricultural Society in 1790: "Premiums offered for preventing evils which originate from intemperate seasons and destroying blights, may excite invention, artifice, cunning, imposture, and deception, but can never extend the boundary or expand the circle of human knowledge or human power. He, and He only, who can repel the malignant blasts of the East, fraught with myriads of consuming insects, which originate from what or where none but Omniscience knows, and substitute the soft, healing, balmy zephyrs of the West, can reward the labors of the industrious husbandman with plenty and happiness."

PLANT PATHOLOGY AS A SCIENCE.

It is only within the last forty years that the study of Plant Diseases has advanced sufficiently, and has been placed on such a sure foundation as the result of exact scientific method, as to come within the circle of the sciences. Previous to 1874, when Sorauer wrote his first treatise on the subject, the way was being prepared for modern methods and definite results. Sachs and De Bary had greatly advanced our knowledge of the Morphology and Physiology of Plants, the former by his great discovery in 1860 that the grains of starch in the green chlorophyll-corpuscles were the result of photosynthesis or carbon-assimilation, and the latter by his brilliant researches into the nature of parasitic diseases and infection, the results of which were given in his work published in 1866, *Morphologie und Physiologie der Pilze*, &c. Berkeley, in England, had also paid special attention to plant diseases, and studied systematically the fungi to which they were due But it was mainly owing to the methods introduced by Pasteur and Cohn in building up the modern science of bacteriology that such wonderful progress was made. It was not that bacteria were discovered, which accounted for some of our worst diseases in plants, although they bear their fair share, but from the method of "pure cultures" which enabled the parasite to be isolated and grown free from contamination. In the study of the Smuts by Brefeld, and our own researches into Australian Smuts, the study the spores and their germination and infection are all carried out of in sterilized media. Plate cultures are made of the spores which germinate and grow upon nutrient fluids, though occasionally solid media such as agar are used. The water and the nutritive solutions in which the spores are germinated are sterilized by discontinuous boiling on three successive days, and a sterilized plug of cotton wool inserted in the mouth of the flask keeps out the floating organisms of the air and prevents contamination of the medium. It is by such simple and exact methods that definite results are obtained, and that many of our obscure diseases are traced to their causes. Even as late as the middle of last century, disease was regarded as an "abnormal process of cell-formation," and the rust or smut associated with it as "devoid of individuality," while others considered it to be an "independent organism." The present point of view is—and it stands in marked contrast to what has gone before—that the parasitic fungus is as much an individual plant as that on which it preys, and that *both* require to be studied with reference to each other, and to their non-living environment.

Not only has our knowledge of the nature and causes of disease been vastly increased as the result of improved methods of investigation, but in treatments for the prevention of disease there has also been a corresponding advance. Time would fail me to enter into detail, but in connection with the control of insect pests, fumigation with hydrocyanic acid gas has been found successful, and it is now largely used not only for the destruction of scale insects, but for fumigating nursery stock. Another method successfully used against certain scale insects is to pit Nature against itself by employing the insect parasites which prey upon them, and in this way the orange orchards of California infested with the cottony cushion scale were saved by the introduction of a lady-beetle from Australia. A third method, which is now being extensively used in Australia to reconstitute our vineyards destroyed by phylloxera, is that of grafting *Vitis vinifera* upon hardy American species which are known to be resistant. By crossing, a raisin grape has been obtained, resistant to *coulure*, the non-setting or incomplete development of the grapes.

In the control of many fungus parasites equal success has been obtained, and some of the methods, at first accidentally discovered, have received a wide application by carefully-conducted scientific experiments. The well-known Bordeaux mixture, consisting of bluestone and lime, was originally used by the French peasants to sprinkle over grapes near the roadsides to give them the appearance of being poisoned, and thus prevent the depredations of children and travellers. But it was observed in the year 1882, when the downy mildew had been particularly injurious, that the vines so treated retained their leaves; and Professor Millardet was the first to see the importance of this discovery, and to perfect the mixture for the prevention of mildew. It was at first applied with a broom; but soon it was found effective for other fungus diseases, and spraying apparatus was brought to great perfection. Properly prepared Bordeaux mixture, applied at the right time in the form of a spray, is now recognized as the most generally useful preventive, and is regularly employed for diseases of the vine, potato, tomato, and fruit-trees generally. It has been the salvation of the apple and pear industry when threatened with extinction from the ravages of black spot; and in the single disease of peach leaf-curl alone, in the State of California, it is estimated that it saved £80,000 in one year.

Steeping of the seed of cereals for the prevention of smut was also an accidental discovery. About the middle of the seventeenth century, a shipload of wheat was sunk near Bristol in the autumn, and recovered at ebb tide after a thorough soaking in the sea-water. As it was unfit for making bread, a farmer sowed some of it and it grew well; then the whole cargo was sold at a low price and planted in various districts. In the following harvest the wheat happened to be very smutty, with the exception of the brined seed, and the practice of steeping has since been followed. There must have been some cause for the freedom from smut other than steeping the seed in brine, for I have tried it at Port Fairy without result; but the practice became established, and now various steeps, such as bluestone, formalin, and hot water are found to prevent at least the stinking smut of wheat. Just as insect parasites have been employed for fighting certain injurious insects, so fungus parasites have been tried for the same purpose. Some of our most dreaded insects, such as codling moth and San Jose scale, have their fungus parasites, and the spores can be readily disseminated by means of a spray; but their application has not been entirely successful. The germination of the spores and the luxuriant growth of the fungus are so dependent on climatic conditions that they cannot be relied on with the certainty of a deadly chemical spray. Still, there is here a promising field of research, particularly in connection with the codling moth in Australia. Bacterial diseases, such as the gumming of the sugar-cane, can be avoided by the selection of healthy cuttings, as shown by Dr. Cobb; and the breeding of rust-resistant wheats is solving the most serious problem of the wheat-grower.

In avoiding those conditions as far as possible which favor disease, and adopting those which tend to ward it off, the hope of the future lies; and it is safe to predict that, as regards wheat alone —by a proper rotation, by manuring, by irrigation and drainage where necessary, by improved and rust-resisting varieties, and by treatment of the seed for certain smuts—the average yield of the entire Commonwealth could be so raised as to equal that of older lands. Continuous cropping with one crop is a sure means of reducing the yield.

COMPARISON BETWEEN ANIMAL AND PLANT PATHOLOGY.

It would seem at first sight as if there was hardly any room for comparison between the diseases which affect the active animal and those which attack the passive plant. The organs and the tissues are so different when looked at from the purely morphological point of view, and the presence of a central organ such as the heart and a nervous system extending to every part, apparently distinctly separates the two.

But there is a general pathology which rises superior to these limitations, and discarding the idea that structural changes are the be-all and end-all of pathology, it lays stress upon the fundamental fact that the investigation of functional derangement and of interference with the normal processes of life is its principal aim.

The causes which influence and bring about these changes are also similar in their nature. There is the large field of what has been called "bacterial pathology" in which bacteria are recognized as causes of disease both in plants and animals. No doubt bacteriology in its relation to animals has hitherto received much more attention than in its relation to plants, but there is now considerable activity in this line.

Bacteria are chiefly of interest in connection with the diseases of man, such as typhoid, tuberculosis, diphtheria, and cholera, and they are not usually associated with the diseases of plants, but at present quite a number of serious diseases due to this cause are recognized. Mention may be made of apple and pear blight, sorghum blight, gumming of the sugar-cane, black rot of cabbage, bacterial blight of tomato, and bacterial shot-hole of stone fruits. Then the action of microscopic parasites in the causation of disease is being diligently studied both in plants and animals. Malarial fever is now known to be due to parasites in the blood, and the spores of the parasite are transmitted from sick to healthy persons by the bite of a mosquito. Yellow fever is conveyed by another mosquito, and sleeping-sickness by a tsetse fly. Diseases in plants, such as rust and smut, are due to parasitic fungi, and insects are often carriers of infection, so that in many of these diseases the part played by insects must not be overlooked.

The late Sir James Paget, in an address before the British Medical Association in 1880 on "Elemental Pathology," pointed out that there were many points of resemblance between the morbid processes in plants and animals, but that in the former, owing to the absence of a central distributing organ or heart and of a definite nervous system there was an opportunity of studying the various changes induced by disease in a simpler or more elementary form than in the latter. After referring to the repair of injuries and fractures in both, to hypertrophies or overgrowths, atrophies or degenerations and inflammation, he remarked: "But of all morbid processes in plants, none I think are so suggestive as are those produced by parasites whether animal or vegetable"; he then refers to the changes produced by insects in the formation of galls as illustrating what would be regarded in human pathology as inflammatory hypertrophies. And he goes on to draw a comparison with cancer which may be suggestive at the present time. The gall usually begins to grow immediately after the deposit of the egg, but sometimes there is a delay of many months. "In the case of these long-delayed galls, either the egg, after being laid, requires a long time for the completion of changes ending in the production of the necessary morbid poison, or the plant-structure in which it is laid requires the time for changes to make it susceptible of the poison; or both egg and plant may need to change.

So with cancer; a general tendency may be inherited, but it must wait till the material of some structure is, by age, or injury, or long-continued irritation changed into fitness for concurrence in morbid action with the material on which the general tendency depends. Then when the two materials meet in mutual fitness, the result may be a change so great that we may compare it with that from an act of impregnation. I have often thought of this comparison, when seeing the almost sudden appearance of cancer in a breast, or a tongue, or in a scar long irritated." As our knowledge of the deep-seated causes of disease increases, so will our comprehension of the wider field of comparative pathology. The study of animal, including human diseases, has been pursued during the last quarter of a century with almost feverish activity, and the most highly-trained minds with the most exact methods known to science are engaged in fighting and investigating disease. The brilliant results already obtained are but a foretaste of what may be expected, and the plant pathologist is beginning to realize that if he would attain to equal success in unraveling plant diseases he must adopt similar methods. The idea that spraying the plant and steeping the seed is the final goal must be given up, and he must recognize that the living organism, whether plant or animal, is the great object of study. Not only will elemental pathology form a common starting-point, but the younger science of plant pathology will adopt the methods and profit by the progress of its great forerunner.

SOME OF THE PROBLEMS OF PLANT PATHOLOGY.

The exact study of plant diseases has only been undertaken towards the end of the nineteenth century, and it may naturally be asked why was the study so long delayed, seeing that plant diseases are as old as the cultivation of plants themselves. Various answers may be given to this question, but I consider that the main reason was that other branches of science were not sufficiently advanced to allow of this being done—that our knowledge of plant physiology and methods of research were too imperfect to enable abnormal physiology or pathology to be properly understood and investigated. To use a cover-slip for microscopic preparations and to substitute thin glass for mica seems at the present time to be so simple and fundamental as hardly to require mention, yet the introduction of this method by Jean Ingenhousz was a great step in advance. Similarly, the isolation of the parasitic fungi and their cultivation in pure cultures is now a common practice, and yet without it many of our worst diseases could not be traced to their causes. And just because plant pathology as a science is of such recent origin, and awaits a more intimate knowledge of the complex chemical and physical processes going on within the cell of the plant, so there are various problems still to be investigated and always will be.

My own studies have led me to deal more particularly with the action of parasitic fungi on plants and I will draw my illustrations from that source. Among the parasitic fungi which are most widespread at the present time, and which have been known from remote antiquity to be most injurious to cultivated crops, there are the rusts and the smuts. For convenience, and with special reference to our Australian conditions, the problems connected with the rust and smut of wheat will be specially referred to.

Rust Problems.—The resting spores or teleutospores are known to germinate in the spring on the decaying straw or stubble and to give rise to minute reproductive bodies known as *sporidiola.* These bodies are known in Europe and America to infest the leaves of the barberry and produce the *aecidium* or cluster-cup stage, but in Australia this does not occur and the question arises what purpose, if any, do the teleutospores serve here in the economy of the rust fungus. The *sporidiola* are incapable of infecting the wheat plant directly, and so far as known at present they have lost the power here of infecting the barberry or any other shrub.

Again, *Puccinia graminis* is known on several grasses, such as *Agropyron scabrum,* Beauv., *Bromus sterilis,* L., *Dactylis glomerata,* L., and *Hordeum murinum,* L., but it has still to be determined how many, if any, of these grasses are capable of infecting the wheat-plant. Besides the reproductive bodies other portions of the fungus such as the mycelium may be capable of conveying the disease, and the question arises does it persist from season to season in the seed or other portions of the wheat plant in a form capable of transmitting the disease. One is naturally reminded here of Eriksson's mycoplasm theory, in which it is supposed that in certain cells of the seed the protoplasm is associated with the plasma of the fungus-mycoplasm, and if the conditions are favorable the mycelium of the rust fungus is developed independent of external infection. Of course one must distinguish here between the source of rust being inside the seed and that arising from spores attached to the surface of the seed. In connection with the rust-in-wheat problem all these are minor questions compared with that of the immunity or susceptibility of the host-plant to the parasite. Why are some individuals susceptible to the disease and others resistant; and why are some more so at one stage of their existence or at one period of the year than another? And bound up with this is the matter of toxins and anti-toxins in the plant, as suggested by Ward; and, when we can answer these questions, when we know exactly the conditions which induce the disease, then we may be able to avoid these conditions and encourage those which make for health. It is better to grow the strong and the healthy rather than to doctor the weak.

Smut Problems.—Up till recently it was considered that smut as a disease was pretty well mastered. In the case of stinking smut or bunt, for instance, we knew that the spores were mixed up with the grain, that they germinated there and produced reproductive bodies which infected the young plant just at the stage when it burst through. Then the fungus grew with the plant until the grain was again produced and the mass of foetid spores was developed by the fungus. By sterilizing the seed by means of steeps the spores or their germinating powers were destroyed and the disease did not appear.

But it is now known that there are smuts, such as the naked smut of barley, in which the spores do not infect the young seedling, but do so through the flower, producing the mycelium in the seed. Where such is the case the ordinary treatment does not reach the seat of the disease and these grains, infested with mycelium, will produce smutted plants, and for such cases smut-resisting plants are being experimented with.

The employment of parasitic fungi for the destruction of insect pests, already referred to, is a problem well worthy of immediate attention and the diseases of our native timbers are still practically untouched.

AIMS OF THE SCIENCE.

We have now dealt with the nature of Plant Pathology and some of the problems with which it is concerned, and shown that it embraces all those conditions of plant life which interfere with the proper working and complete development of the organism, that it recognizes every departure from the normal healthy action which disturbs the equilibrium so that a diseased conditoin is set up. It is not always easy to tell what constitutes disease, but in practice it becomes evident, from the impaired vigour, the stunted growth, or the failure to produce satisfactory results.

The aims of this science are seen to be of a twofold character —first, a knowledge of causes; second, methods of treatment either to prevent diseased conditions or to mitigate their effects.

The etiology or causation of disease is a necessary preliminary study to the rational treatment of disease, so that these two factors hang together. In tracing the causes of disease in the plant, as well as in the animal, there is required not only an intimate knowledge of the nature of the organism, both in health and in disease, but also of its environment, of all those conditions which render a plant predisposed to disease, or which tend to render it immune. Much of this knowledge has still to be acquired, but meanwhile the effects of various agencies are being studied, such as soil and climate, light, heat, and moisture among inorganic agencies, and of the various animal and plant parasites among the organic agencies. The coöperation of the chemist, physicist, and the physiologist is required to elucidate these problems, and it is only when this is recognized by our legislators and our University authorities, and the subject is scientifically studied in our seats of learning that the highest and best results will be secured. But meanwhile, and taking into account our Australian conditions, much may be done in helping the producer to secure the full results of his toil. There has been too much haphazard experimenting and waste of energy in the past, and the time is now ripe for continuous, well-directed, and united effort in dealing with a number of those diseases which have hitherto been allowed to continue their course unchecked, and to produce epidemics in season favorable to their development.

Speaking from an experience of sixteen years as consulting Vegetable Pathologist to the Victorian Department of Agriculture, I may say that while successive Governments have realized, to a certain extent, the importance of the subject, and have, in connection with the administration of a Vegetation Diseases Act, encouraged the investigation and treatment of disease, still there has been too great a tendency to expect immediate results without corresponding laboratory and field work, and a want of recognition of that continuity of effort which is necessary to ensure success in the difficult and delicate problems with which plant pathology deals. It is also gratifying to find that in our Agricultural and Horticultural Colleges the subject of plant pathology is being taught, and this encourages the hope that the students sent forth from these institutions will not only know how to grow healthy plants, but also know how to treat them when disease first appears, and before it has become chronic or epidemic.

As an illustration of the official method of dealing with matters pertaining to plant diseases, I may take the rust-in-wheat problem, which is such a burning and practical question for Australia. After the disastrous year of 1889, when the loss to the Commonwealth from this disease alone was estimated at between two and three millions sterling, the different States combined and offered £10,000 for a remedy for the disease. As might have been anticipated from our state of knowledge of the disease at that period, there were numerous remedies offered, but none were effectual. And now, after years of patient study and experiment, when so much light has been thrown upon the nature of rust and its method of propagation, and when it is generally recognized that the solution of the problem lies in the breeding of wheats suited to our conditions and fitted by their constitution to offer resistance to the disease, even one-hundredth part of the sum originally offered by the States is not forthcoming for investigation in this promising field of research. If this sum had been capitalized, and the interest applied for the endowment of research in this particular line, through the Rust-in-Wheat Conferences which met for a number of years, I venture to predict that there would have been a much greater advance in the production of rust-resisting wheats. To the credit of the Government of New South Wales be it mentioned that the epoch-making work for Australia of the late Mr. Farrer on the breeding of wheats suited to Australian conditions, received every encouragement at their hands; but this is a work in which all the States are interested, and from which important results are expected, and it is to be hoped that it will be continued with unabated vigor. In some of the American Experiment Stations plant-breeding is a recognized portion of the work, and why not here?

HOW THESE AIMS ARE TO BE REALIZED.

There is a wide diversity of soil and climate in Australia, and consequently in the nature of the products grown, so that each State of the Commonwealth has its own particular problems; but, on the other hand, there are great groups of diseases common to them all—such as the rusts and smuts of cereals—and on these grounds I would make a few practical suggestions. The field of plant pathology is seen to be a very large one, but it is practically confined in Australia, to the investigation of diseases caused by insects on the one hand, and fungi on the other. There are undoubtedly diseases requiring investigation, which do not strictly come under either of these two heads, such as the gouty or eelworm disease of the onion, and the constitutional disease of the apple known as bitter pit; but, generally speaking, plant pathology here resolves itself into a study of insect pests and plant diseases due to fungi. The entomologist and the mycologist share the field between them, and it is only fair to state that their services to the agricultural, viticultural, and horticultural community, are becoming more and more appreciated. The time is not so far distant when the bug and beetle hunters were simply regarded as harmless lunatics, and the fungus manias as something worse, if possible. But now, thanks to the great awakening which has taken, and is taking place in connection with agricultural education, they are coming to be regarded as useful and even necessary members of society.

In the various States the services of the official entomologist are in demand, because the insects, and their work of destruction, are too patent to escape notice. There is a Government Entomologist in Victoria, New South Wales, Queensland, Tasmania and West Australia, while in South Australia the services of the Museum Entomologist are utilized. Their reports are widely circulated in the official journals of their respective Governments, and in many instances valuable handbooks are issued, which are much appreciated by the growers. But if we turn to the mycologist or the investigator of the fungus diseases of plants, there the case is different. This branch is only officially recognized at present in Victoria, as the Pathologist to the Agricultural Department of New South Wales, Dr. N. A. Cobb, resigned some time ago and went to Hawaii. The reason for this apathy is not far to seek. The diseases due to fungi are so subtle in their nature, and the results produced are so evidently associated with certain states of the weather, that the common cry is, whenever there is an outbreak of rust or smut or take-all in the cereals, it is the *season*; and this cry has done more to hinder the progress of plant pathology in Australia, and to prevent encouragement being given to the investigation of such diseases, than all other causes combined—

"A lie which is all a lie may be met and fought with outright,
But a lie which is part a truth is a harder matter to fight."

The spores or germs of the fungus are certainly favored or hindered in their development by the kind of weather prevailing at certain seasons of the year, but to say that the weather is the determining and only cause, is simply to confess that we are helpless and hopeless, as we cannot control the weather.

A recent case of rust in a flax crop in Victoria, well illustrates this point. Sixty acres grown from a particular kind of seed and sown in May, were completely ruined by rust, while alongside of that was an equal number of acres sown about the same time, of a different variety, and the crop was particularly clean and fine. But the most convincing portion of the field was that in which the drill had sown the two seeds mixed, and while the one set of plants were blackened and ruined, the other were healthy and clean. The season was evidently out of the question there, and in those cases where we can completely prevent the disease by appropriate treatment in spite of the weather, as in the black spot or scab of the apple, and leaf curl of the peach, the intelligent grower recognizes that the cry of the weather has been used too much by the legislators in order to justify their own neglect.

In order to remedy this state of matters, there must be a more intelligent appreciation of the work among our legislators and producers, and a better knowledge of what is being done in other parts of the world, such as the United States, where there are at least fifty Experiment Stations where the subject may be studied. For present needs I would make the following practical suggestions.

1. That there be established a Central Laboratory for the study of diseases due to fungi, where the necessary equipment would be provided for investigating the nature and life-history of the organisms concerned in causing disease. The present time seems particularly favorable for carrying out this idea, as no individual state has gone to the expense of fitting up such a laboratory, and consequently there are no vested interests to consider. The advantages of this arrangement are so evident that little need be said to support it. Many of our fungus diseases are common to the different States, and instead of each State wasting time, energy, and money, in more or less imperfect attempts, a thorough and continuous investigation could be made with all the necessary appliances for so doing. This view has not escaped attention, for it was brought forward in the Agricultural Bureau of South Australia many years ago, and in the pro-Federal days, I submitted a somewhat similar scheme to the then Minister of

Agriculture, and to this he affixed the short and expressive memo. —"Pending Federation." But the study of disease, if it is to result in methods of treatment, should not be confined to the laboratory. The progress of the disease must be followed on the farm or in the orchard, and its various developments traced, so that the measures recommended for overcoming it may be such as will commend themselves to those who are engaged in the business. There are many of these diseases which seriously affect important industries, such as grain rusts, fruit blights, and potato rots, and it is not always possible for an individual grower to undertake experiments for treatment. They make no experiments because they do not pay, and besides they are regarded as belonging to the duties of an Agricultural Department, being for the general welfare of the country, so that Experimental Stations become a necessity, and that is my next suggestion.

And here I might throw out the hint that a properly-equipped and well-officered Experiment Station, for the special purpose of breeding cereals and carrying out variety tests under scientific direction, is a desideration for Australia; and if some of our wealthy citizens would found and endow such an institution, such a step would not only exercise an important influence on the agriculture, and consequently on the development of the country, but it would form a lasting memorial to the far-seeing and patriotic donor.

2. That Experiment Stations are absolutely essential, where not only normal growth under suitable conditions can be studied, but where abnormal growth or diseases due to fungi and insects can be investigated.

Since the aim of plant pathology is not only to investigate disease and determine its cause but also to provide means whereby such diseases may be prevented or mitigated, practical experiments are always necessary. It is not altogether a laboratory study nor a field study, but a combination of both. It requires the exact laboratory methods for the microscopic examination not only of the parasite, but of the host-plant, as well as of the preparation of "pure cultures," and the experiment station, where the results obtained or suggested in the laboratory may be tested and applied in the field. And just as all the arguments for efficiency and convenience are in favor of a central laboratory, so are they all in favor of experiment stations in the different States. While experiments in connection with rust and smut and take-all in cereals, bitter pit in apples, mould in tobacco, etc., could be duplicated in the different States, where there are special crops grown, such as sugar cane, bananas, or rice, arrangements could be made for carrying out local experiments with their respective diseases after the nature and life-history of the fungus had been studied in the laboratory.

3. That it is necessary to have men properly trained for the work in all the modern methods of pathological research, both in

the laboratory and in the field, and to provide means for so doing.

The subject is really a branch of agriculture, just as human pathology is of medicine, and must be taught in a well-equipped agricultural college. In such a college, the diseases of animals or veterinary science would be specially studied, as well as the diseases of plants or plant pathology.

In America, which has taken the lead in matters pertaining to plant pathology, Erwin F. Smith remarks that "at present and for some time to come the demand for well-trained plant pathologists is likely to be considerably in excess of the supply." And this is mainly owing to the fact that farmers and fruit-growers have realized that disease may be controlled, or at least mitigated, when its true nature is understood, and that it is necessary to produce the best possible crop free from disease at the lowest possible cost to meet increasing competition. He has also come to the conclusion that on account of the great and growing importance of the subject, a distinct chair of plant pathology will soon be established at some of our universities.

SOME POPULAR FALLACIES CONCERNING PLANT PATHOLOGY.

By way of summing up, I may point out a few of the popular fallacies which will survive, in spite of all the evidence to the contrary, and it is hoped that the mere mention of them, in the light of what has already been said, may lead to views more in accordance with our present state of knowledge, or at least to an examination of the facts on which they are based.

1. That the weather is responsible for the disease where fungi are concerned.

This is shown to be a fallacy, from the fact that similar plants may be grown under exactly the same conditions, from different varieties of seed obtained from various sources, and yet the one will be free from disease, while the other is destroyed by it, as in the case of flax rust already mentioned.

Further, it is well known to orchardists that apple trees of the same variety and age in the same orchard can be treated for black spot, and the disease prevented, while trees alongside untreated will be badly affected, showing that we can control the disease, although not the weather.

2. That fungus diseases are so obscure, and so imperfectly understood, that no special training is required to diagnose them.

This is simply an apology for ignorance, since there are quite a number of diseases whose life-histories have been carefully studied, and their true nature clearly understood; but because of this belief, often no provision is made by our legislators for making this knowledge available, and any self-constituted authority is regarded as quite capable of pronouncing a disease to be "fungoid," whatever that may mean.

3. That practical work in the field is alone necessary to understand and study disease.

This is only half a truth, and we sometimes hear the other half from the pseudo-scientific man, who maintains that technical knowledge and work in the laboratory is all that is required. Let it be clearly understood that a thorough knowledge of the diseases as they occur in the field is just as necessary as that acquired by the exact methods of the laboratory, and that a combination of both is required, in order to secure the best results as regards their proper treatment. The best practical knowledge available has to be supplemented by the best scientific knowledge, and this is afforded by the Experiment Station, where practice and science go hand-in-hand.

4. That the plant itself is only a passive agent, and its surroundings, such as soil, manure, etc., are the main factors of health or disease.

It is at last beginning to dawn on the farmer and fruit-grower that the variety he plants, whether of wheat or fruit tree, has an important bearing on the future growth, and that some varieties are more or less susceptible to disease, even the same variety may be more liable to disease at one age, or at one season than another. There is something in the nature of the plant itself which determines its behavior under certain conditions, and this has to be investigated and understood, before we can devise methods for avoiding or controlling this liability to disease. It often involves breeding a new plant to suit the conditions, and this means an intimate knowledge of plant life.

5. That certain diseases, such as rusts and smuts, affect plants indiscriminately.

There is a very widespread belief, based upon superficial observation, that all rusts for example, are very much alike, and that the same rust can attack all sorts and conditions of vegetation. Thus the late Dr. Schomburgh, of Adelaide, in giving evidence before a Commission on Cereal Diseases stated that "The red rust attacks generally only gramineous plants; but in the Botanic Garden it attacked also the roses." Now the rose rust is quite a distinct kind from the wheat rust, and the one is incapable of infecting the other. Farmers have often sent to me rust on the native flax, with the remark that as it could pass to the wheat, there was no hope of preventing rust in the latter; but I had to inform them that here again the rusts were quite distinct, and did not pass from one plant to the other. That the various rusts confine themselves to definite plants is strikingly shown in the wheat, oat, and barley rust. The spores from wheat will neither infest oats nor barley, nor those of oats infect wheat or barley, and the spores from barley will not infect wheat or oats as a general rule.

Old beliefs and superstitions die hard, and it is surprising how many of the old notions still persist, in spite of all that modern science has taught, and that well planned experiments have shown to be fallacious.—Agricultural Gazette.

MAURITIUS SUGAR DEPRESSION.

AN INCREASED PRODUCTION AND DECREASED EXPORTATION.

Consul Theodosius Botkin, of Port Louis, supplies the following information concerning the sugar output of Mauritius in 1906 and the depressed condition of the industry:

The present sugar crop of Mauritius is the largest in the history of the industry, the output amounting to 205,000 tons, possibly 210,000 tons. The crop year begins August 1. On July 31, 1906, there were 31,756 bags in store, and from that date up to January 25, 1907, 2,585,571 bags have been received from the estates. This is an excess of 281,708 bags over the quantity received from the estates during the same period of the preceding crop year. There were in store on February 1, 1907, 1,282,832 bags against 927,201 at the same date last year. The exports from August 1, 1906, to January 25, 1907, were 102,715 metric tons of 2,204.6 pounds each against 109,195 tons during the same period of the preceding year.

The Bombay market controls sugar prices at Port Louis, and the slump on that market early in the season has persisted and brought great discouragement to Mauritius planters. The latest market advice from Bombay quoted Mauritius sugar at $2.44 to $2.52 per 110.23 pounds. It seems that the Java and German sugars are taking the Indian markets and crowding out the raw sugar of Mauritius. The situation has been further aggravated by the recent campaign of the Hindoos against using sugar in the manufacture of which they suspect the use of animal agencies, and they have been wrongfully told that such is the practice here. But regardless of this it appears from the report of the chamber of commerce that exports have fallen off to every country hitherto buying Mauritius sugar, except to the United Kingdom, to which there has been an increase of 4,000 tons over each of the two preceding years. The exports to Indian ports have fallen 2,500 tons and those to South Africa nearly 7,000 tons, as compared with the same period of the preceding year.

WORLD'S SUGAR CONSUMPTION.

UNITED STATES GREATEST AND SOUTH EUROPE THE LIGHTEST USERS.

Consul J. E. Dunning, of Milan, reports as follows on the world's consumption of sugar:

The number of pounds consumed per capita for the year between August 31, 1905, and September 1, 1906, is stated as follows in the Milan market: United States, 92.46; Great Britain, 77.83; Denmark, 71.21; Switzerland, 53.35; Sweden-Norway, 46.97; Germany, 43.40; Holland, 39.16; France, 36.17; Belgium, 33.04; Austria-Hungary, 23.87; Russia, 19.32; Portugal, 15.69; Spain, 10.27; Greece, 10.07; Turkey, 9.75; Bulgaria. 7.78; Roumania, 7.52; Italy, 7.45; and Servia, 6.75. Italy's low consumption is interesting from the fact that in this country sugar retails for about 16 cents per pound. Considerable discussion is now on foot with reference to the high taxation on sugar, which, as says a recent writer in one of the foremost Italian reviews, "instead of being, as in other countries, a common ingredient of the food of the people, is looked upon as a luxury to be used only on some grand fete day or in sickness."

Though the Brussels Convention of 1903 established $1.20 as the difference which should exist between import duties on sugar and the tax on its manufacture in all sugar-exporting countries, Italy, which is not an exporter, so taxes sugar in both its manufacture and its importation as to create a difference of from $4 to $6, according to the quality of the stock. Every quintal (220 pounds) of sugar manufactured in Italy is taxed $13.40 on its fabrication. Sugar importations are taxed $19.10 per quintal for first-grade stock and $16.98 for second grade, the total tax on sugar amounting in Italy to about 340 per cent of its true value. Sugar imports into Italy from July 1, 1906, to February 28, 1907, amounted to 7,825 tons, an increase over the amount imported during the same period of 1905-6 of 1,261 tons.

SUGAR TRADE OF FIJI ISLANDS.

Consul-General J. P. Bray, of Melbourne, reports that the sugar trade of the Fiji Islands has been steadily growing during the past few years, the exports having increased from 31,741 tons, worth $1,850,024 in 1901, to 58,488 tons valued at $2,625,934 in 1905. The total area under cultivation is estimated at 40,112 acres, the production in 1905 being 396,090 tons of cane. Out of the six sugar mills in Fiji four are owned by an Australian concern. Next to sugar, the most important article of export from Fiji is copra, of which 10,200 tons, valued at $612,653, were shipped in 1905.