1903.

QUEENSLAND.

ANNUAL REPORT OF THE BUREAU OF SUGAR EXPERIMENT STATIONS.

Presented to both Houses of Parliament by Command.

TO THE HONOURABLE THE MINISTER FOR AGRICULTURE.

Brisbane, November, 1903.

SIR,—I have the honour to submit the Third Annual Report upon the Sugar Experiment Stations, the administration of the Sugar Fund, and upon the state of the Sugar Industry in Queensland, as required by "*The Sugar Experiment Stations Act of* 1900."

I have, &c.,
WALTER MAXWELL, Director.

The investigation of practical and economic questions, either in agriculture or manufacture, has to follow certain determined lines, which rest upon fixed laws in Nature, whose dominating factor is continuity of operation. Because of this basic fact, the work set forth in this report must be a continuation and extension of the scientific and practical examinations recorded in the report of the Bureau of Sugar Experiment Stations of last year. The statement of the work is resolved for consideration into its several natural divisions—

TECHNICAL AND EXPERIMENTAL.—AGRICULTURAL.—MANUFACTURE.—ECONOMICS.

As explained in the report of last year, "Such a mode of examination is required in view of the possible expansion or retrogression of the industry, and in order that whichever of these results may follow the precise causes can be known."

TECHNICAL AND EXPERIMENTAL.

(A) WORK OF THE LABORATORIES.

The laboratories have proceeded with the examination of soils, irrigation waters, limes, manures, sugar-canes and products, and other sundry materials. The greater part of the analytical work, however, has continued to be concentrated upon soils.

In the examination of soils the first act, as explained in last year's report, is the taking and preparing of samples. Because of the high importance of this matter, all samples are taken by an officer of the Sugar Bureau, and the work of the laboratories is exclusively restricted to samples thus taken. Farmers are appreciating the strict conditions observed in obtaining samples for analysis, because they now see that, unless the soils taken are representative of the areas of land under examination, the results of analysis can be not only worthless but actually misleading.

The farmers are also bestowing a better understanding upon the reasons showing why the Bureau is studying and classifying the soils of the different districts according to "types," instead of dealing in an unmethodic way with haphazard samples sent in from individual farms. The reasons given for the Bureau's method of procedure upon page 1 of the Report of 1902 are becoming apparent. The farmers begin to see, from examples set forth, that, notwithstanding small local differences, the soils do fall within a few leading types, the characteristics of each type recurring wherever the type is found, and that to duplicate analyses of limited areas of land of the same type would be an unwarranted use of the laboratory's means and time. Moreover, since the explanation has been made, the cane-growers see that the examination of the soil of each farmer is not only unnecessary but plainly impossible at this time. There are some 2,600 farms, excluding large plantations; and one sample of soil from each farm would, at the present rate of examination with five chemists, keep the laboratories engaged for over twelve years in getting round the districts the first time. By aid of the method now in practice the laboratory is enabled to furnish the Director with precise data covering large areas in all the districts, in order that advices can be made available at the earliest time to the greatest number. Excepting the more southern localities in the district of Bundaberg, general analytical statements, with actual advices upon the requirements of the soils, have been made by the Director to each locality in the three sugar districts. It was apparent in advance that each locality could not receive all the attention for which, naturally, it would ask. Again, all localities could not receive attention at once. The soils of given localities in two districts were examined nearly two years ago, and advices placed before the farmers. On the other hand, there are localities in the southern part of the Bundaberg district which the laboratory cannot reach until far into next year. The Director has sought to deal with the localities of the three districts in the order of their most immediate needs. Generally, the districts of Mackay and of Cairns received the earliest attention, yet the soils of a representative locality (Isis) of

the Bundaberg district were examined and advised upon nearly two years ago; while the soils of the Burdekin locality, in the district of Mackay, were completed, and the results and advices placed before the farmers for the first time, only one month ago. It has to be said that, with only a very few exceptions, the localities in all the districts have shown an appreciative understanding of the extent of the work devolving upon the Bureau, and are prepared to await attention in the order that appears due and necessary.

The Districts, with their Sub-districts, from which samples have been taken are as follows:—

District.	Sub-district.	No. of Samples.	No. of Sub-samples.
Cairns	Mossman River	32	128
	Cairns	44	176
	Johnstone River	60	240
	Herbert River	52	208
Mackay	Burdekin Delta	54	216
	Proserpine	41	164
	Mackay	147	588
Bundaberg	Bundaberg	101	404
	Isis	74	296
	Maryborough	94	376
	Logan	50	200
		749	2,996

It is seen that sub-samples of soil have been taken from 2,996 places, affording approaching 800 samples for examination in the laboratories.

Soil Analysis.—It is unnecessary to repeat in this report the detailed explanation of the purpose of soil analysis which is found on page 5 of the report of 1902, it being enough merely to restate so much, and to the effect, that "soils are analysed in order to ascertain the proportion present of those elements that are necessary to plant growth, and for guidance in the matter of supplying fertilising materials to special soils for the production of special crops. Some soils are naturally deficient in given essential elements, and others have become so as a result of exhausting cropping. The laboratory reveals these conditions very precisely, and indicates the course to be followed in order to restore the impoverished soils to an economic crop-bearing condition."

Results of Soil Analyses.—(1) *Cairns or Northern District.*—In the report of last year it was stated that the analyses were not advanced enough to provide full data showing the "total amounts" of lime, potash, phosphoric acid, and nitrogen in all the soils of the Northern district. The results that were given were limited to the "amounts of available elements in the soil," and to a table showing the "pounds per acre to a depth of 1 foot" of lime, potash, and phosphoric acid found to be present. In this report, the further completion of the examinations makes it possible to give the "total amounts" of lime, potash, phosphoric acid, and nitrogen in all the soils, in average, and also to complete the statement of "amount available" and the "pounds per acre to the depth of 1 foot." These data are set forth in the following tables:—

Soils of the Cairns or Northern District.

Cairns.	Total Amounts of Elements in Soil.				Amounts of Elements Available.		
Localities in Sub-districts.	Lime.	Potash.	Phosphoric Acid.	Nitrogen.	Lime.	Potash.	Phosphoric Acid.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Mossman River	·237	·516	·112	·128	·0659	·0137	·0009
Kamerunga	·150	·272	·141	·092	·0430	·0082	·0014
Hambledon	·250	·465	·148	·122	·0678	·0108	·0013
Mulgrave	·288	·407	·184	·120	·0996	·0148	·0011
Geraldton	·128	·249	·237	·167	·0365	·0149	·0005
Mourilyan	·174	·218	·089	·166	·0311	·0137	·0006
Halifax	·494	·244	·125	·117	·1035	·0138	·0012
Ingham	·301	·195	·126	·095	·0508	·0121	·0010
Ripple Creek	·407	·226	·113	·104	·0908	·0171	·0009
Means	·292	·310	·141	·122	·0654	·0132	·0010

The analyses given in averages in the above table represent soils taken from 752 places.

In commenting upon the situation as indicated by the data that were to hand at the time of preparing the report of last year, it was said: "These data make it unmistakable that the soils of the Northern district are uniformly low in available proportions of the vital elements (lime, potash, phosphoric acid, and nitrogen). As far as the analyses have proceeded, it is also indicated that the total amounts of those elements are also low in most of the sub-districts. This, however, is not without exception. In the Mossman sub-district the total amounts of potash are found to be high, although very unavailable." These comments are absolutely confirmed by the more complete data that have been furnished, and which are expressed summarily in the table given. Excepting the Herbert River localities, the "total amounts" of lime are below the established minimum of 0·3 per cent. Excepting the Mossman and Cairns localities, the "total" potash is below the minimum. In all the localities the "total amounts" of nitrogen, also of phosphoric acid, are extremely low, while the "available amounts" of all the elements are far below the minimum in the localities of the whole district. These conclusions are more clearly shown in the following table, setting forth the total and available amounts of the elements in one acre to the depth of one foot:—

ELEMENTS PER ACRE TO THE DEPTH OF ONE FOOT.

CAIRNS.	TOTAL POUNDS PER ACRE.				POUNDS AVAILABLE PER ACRE.		
Sub-districts.	Lime.	Potash.	Phosphoric Acid.	Nitrogen.	Lime.	Potash.	Phosphoric Acid.
Mossman River	7,110	15,480	3,360	3,600	1,977	411	27
Kamerunga	4,500	8,160	4,230	2,760	1,290	246	42
Hembledon	7,500	13,950	4,440	3,660	2,034	324	39
Mulgrave	8,640	12,210	5,520	3,600	2,988	444	36
Geraldton	3,840	7,470	7,110	5,010	1,095	447	15
Mourilyan	5,220	6,540	2,670	4,980	933	411	18
Halifax	14,820	7,320	3,750	3,510	3,105	414	36
Ingham	9,030	5,850	3,780	2,850	1,524	393	30
Ripple Creek	12,210	6,780	3,390	3,120	2,725	513	27
Means	8,760	9,300	4,230	2,660	1,962	396	30

(2.) *Mackay or Central District.*—The soils of the Central district differ somewhat notably from those of the localities composing the Northern district, a difference due in part to their dissimilar geological origin, and also to climatic conditions, the rainfall of the most Northern localities being in some cases 50 per cent. and in others 100 per cent. greater than the mean rainfall of the district of Mackay.

SOILS OF THE MACKAY OR CENTRAL DISTRICT.

MACKAY.	TOTAL ELEMENTS IN SOIL.				AVAILABLE ELEMENTS IN SOIL.		
Localities and Sub-districts.	Lime.	Potash.	Phosphoric Acid.	Nitrogen.	Lime.	Potash.	Phosphoric Acid.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Homebush	0·480	0·185	0·193	0·082	0·0591	0·0182	0·0013
River Banks	0·501	0·171	0·149	0·096	0·0748	0·0136	0·0014
North Eton	0·606	0·212	0·121	0·080	0·0760	0·0203	0·0009
Plane Creek	1·290	0·133	0·106	0·136	0·1170	0·0079	0·0015
North of River	1·309	0·375	0·230	0·299	0·1876	0·0207	0·0017
Farleigh Estate	0·940	0·176	0·181	0·132	0·1037	0·0176	0·0009
Sunnyside	0·676	0·246	0·172	0·149	0·0963	0·0236	0·0011
Proserpine	0·784	0·166	0·185	0·139	0·1277	0·0139	0·0041
Burdekin	0·916	0·344	0·188	0·104	0·1636	0·0244	0·0078
Means	0·829	0·223	0·185	0·122	0·1119	0·0232	0·0020

The table represents soils taken from 988 places.

It is in the first place observed that a similarity exists been the soils of the several localities composing the Mackay or Central district. The Homebush and River Bank localities are the weakest, while the soils of the Burdekin delta are uniformly of more fertile quality. The soils from the "North of River," with the exception of the Farleigh soils, represent chiefly low flat lands which have received the wash from the surrounding hill slopes.

ELEMENTS PER ACRE TO THE DEPTH OF ONE FOOT.

MACKAY.	TOTAL POUNDS PER ACRE.				AVAILABLE POUNDS PER ACRE.		
Localities and Sub-districts.	Lime.	Potash.	Phosphoric Acid.	Nitrogen.	Lime.	Potash.	Phosphoric Acid.
Homebush	14,400	4,550	5,790	2,460	1,773	546	39
River Banks	15,030	5,130	5,470	2,880	2,244	408	42
North Eton	18,180	6,360	3,630	2,700	2,280	600	27
Plane Creek	38,770	3,990	3,180	4,080	3,510	237	45
North of River	39,000	11,190	8,700	6,120	5,628	621	51
Farleigh Estate	27,300	5,280	5,430	3,960	3,111	828	27
Sunnyside	20,280	7,380	5,160	3,570	2,907	738	33
Proserpine	23,520	4,980	5,550	4,170	3,831	990	33
Burdekin	27,480	10,320	5,640	3,090	4,950	1,032	234
Means	24,880	6,575	5,394	3,670	3,359	666	59

(3.) *Bundaberg or Southern District.*—The Southern district comprehends more, and more radical diversities of soils than are found in any other sugar district. In contrasting the soils of the Isis with those of Mackay in the report of last year, page 6, it was stated: "The soils of Mackay differ radically from those of the Isis. This great constitutional difference will only be made clear by the absolute or full analyses of the two types of soils. As already stated, the Isis soils are derived from basaltic lavas, while the larger areas around Mackay have been formed by the deposition of sedimentary soils derived from the decay of mixed siliceous rocks."

Even greater differences exist amongst the soils of the Southern district than have been noted between the soils of the Isis and of Mackay. This is due to geological origin. In this Southern district a geological formation is prominent (Trias-Jura) which does not occur in any other district upon the coast, and perhaps not in Queensland; in a similar manner that the "Devonian" obtains in the farther North, and has contributed to the formation of the delta lands of the Burdekin, which has resulted in a notable difference between those lands and the delta and non-volcanic soils of the Burnett district.

The table of analyses is arranged in order to show—in the first place, the composition of exclusively red soils, derived from true basaltic lavas; second, the composition of mixed dark and light red and yellow-red soils, the lands of which have been derived partly from basaltic lavas, and partly from eruptive action upon other rock formations; third, the composition of soils more rather than less sedimentary in origin; and, finally, soils derived more exclusively from older rock formations.

SOILS OF THE BUNDABERG OR SOUTHERN DISTRICT.

BUNDABERG.	TOTAL ELEMENTS IN SOIL.				AVAILABLE ELEMENTS IN SOIL.		
Localities and Sub-districts.	Lime.	Potash.	Phosphoric Acid.	Nitrogen.	Lime.	Potash.	Phosphoric Acid.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
(1)							
Isis (Level lands)	0·456	0·189	0·242	0·202	0·1841	0·0197	0·0011
Isis (Hill sides)	0·294	0·173	0·259	0·164	0·0842	0·0161	0·0013
Woongarra	0·636	0·144	0·404	0·220	0·2554	0·0234	0·0012
(2)							
Bingera	0·310	0·197	0·198	0·104	0·1461	0·0245	0·0016
Watawa	0·475	0·167	0·183	0·136	0·1279	0·0207	0·0010
Birthamba	0·245	0·082	0·207	0·149	0·1280	0·0290	0·0005
Gin Gin	0·873	0·258	0·212	0·128	0·1574	0·0211	0·0057
Sharon	0·880	0·328	0·195	0·159	0·1582	0·0409	0·0033
Kalabar	0·623	0·233	0·121	0·120	0·1320	0·0243	0·0034
Oakwood	0·287	0·128	0·086	0·108	0·1092	0·0328	0·0012
(3)							
Fairymead	0·510	0·467	0·478	0·133	0·1086	0·0235	0·0015
Waterview	1·106	0·453	0·141	0·153	0·2391	0·0441	0·0106
Avondale	0·675	0·320	0·176	0·146	0·1395	0·0327	0·0021
Invicta	0·373	0·257	0·211	0·193	0·1028	0·0321	0·0031
(4)							
Gooburrum	0·168	0·113	0·136	0·116	0·0680	0·0292	0·0006
Pialba	0·080	0·040	0·080	0·060	0·0272	0·0039	0·0008

As already shown, in the Southern districts soils were taken from 1,270 places.

The characters and compositions of the soils of the several localities set forth in the above table are so extremely divergent that any general average, covering the district generally, can have no meaning or value.

The arrangement of the localities according to the origin and nature of the soils is not, and cannot be, exact, since in some localities eruptive, sedimentary, and residual soils all occur, and it is rather a question of the "type" which appears to be the more dominant.

In the third division, which represents more generally sedimentary origin and conditions, an exception appears to obtain in the Waterview soils on account of the high content of "total" and "available" lime. This is due, probably, to the liberal use of carbonate of lime, which is the refuse of the Millaquin Sugar Refinery, that is located near by. Waterview is managed by the refinery.

ELEMENTS PER ACRE TO THE DEPTH OF ONE FOOT.

BUNDABERG.	TOTAL POUNDS PER ACRE.				AVAILABLE POUNDS PER ACRE.		
Localities and Sub-districts.	Lime.	Potash.	Phosphoric Acid.	Nitrogen.	Lime.	Potash.	Phosphoric Acid.
(1)							
Isis (Level lands)	15,960	6,615	8,470	7,070	6,443	689	39
Isis (Hill sides)	10,290	6,055	9,065	5,740	2,947	563	45
Woongarra	22,260	5,040	14,140	7,700	8,939	819	42
(2)							
Bingera	9,300	5,934	5,940	3,120	4,483	735	48
Watawa	14,250	5,010	5,490	4,080	3,837	621	30
Birthamba	7,350	2,460	6,210	4,470	3,840	870	15
Gin Gin	26,211	7,740	6,360	3,840	4,722	633	171
Sharon	26,400	9,840	5,850	4,770	4,746	1,227	99
Kalbar	18,690	6,990	3,630	3,600	3,960	729	102
Oakwood	8,610	3,840	2,580	3,240	3,276	984	36
(3)							
Fairymead	15,300	14,010	14,340	3,990	3,258	705	45
Waterview	33,180	13,590	4,230	4,690	7,173	1,323	318
Avondale	20,250	9,600	5,280	4,380	4,185	981	63
Invicta	11,190	7,710	6,330	5,790	3,084	963	93
(4)							
Gooburrum	5,040	3,390	4,080	3,480	2,040	876	18
Pialba*	2,400	1,200	2,400	1,800	816	117	24

* Only a part of Pialba Sub-district is completed.

The tables of averages which have been given, and which set forth the mean compositions of the soils in the several localities of the three sugar districts, convey a general knowledge only of the dominant characteristics of each district. In giving field advices, the Director of the Sugar Bureau meets the farmers of each locality, and places before them the special nature and soil requirements of each such locality, in order to cover particular local needs with definite and specific advices.

In reviewing summarily the results of the further examination of the soil conditions and requirements of the respective districts, the conclusions reached may be briefly stated as follows:—

Cairns.—The completion of analysis of the soils in hand from all localities of this district does not require any change to be made in the general conclusion stated on page 8 of last year's report: "Lime, potash, nitrogen, and some phosphoric acid are shown to be urgently needed by most of the soils of this district. In the sub-district of the Mossman some small areas are moderately good in lime. Also, throughout the Mossman localities the potash is above the average. Very thorough treatment of the soil, by cultivation and liming, is required to bring that element within reach of the crop." The low state of availability of the elements is due in some part to the geological constitution of the soils and the rocks from which they have been formed; but much more to the great rainfalls of the localities making up the Northern district.

Mackay.—"It has been shown that all the soils in that district are fair, and some are very high, in total content of lime. This element, however, is in a very insoluble and inactive state. Deep and very thorough cultivation and exposure of the largest possible mass of soil to the air and sun are the most effective means of bringing these large amounts of lime into an available state. In potash, nitrogen, and phosphoric acid the Mackay soils are generally very low." The extension of the analytical work during the present year has shown that the sub-districts of the Proserpine and of the Burdekin stand somewhat more favourably in respect of their soil conditions, particularly the Burdekin, whose lands are deep and well furnished with lime and potash, which elements are also in a more available state.

Bundaberg.—It has already been said that the soils of the several localities composing this district are distinguished by very great differences of constitution.

The analyses show that wide areas of land, including the true basaltic reds, certain of the mixed red and emptive lands, and most of the alluvials, contain ample amounts of lime which are in a good or moderately available state; they also detect lime contents in the residual and in some of the mixed soils, which are extremely low. Extreme variations occur also in the potash contents, ranging from 14,000 lb. down to 1,200 lb. per acre in the surface foot of soil. These chemical differences in the soils of the several localities of the Southern district are also accompanied by other differences, such as depth of staple and mechanical condition, that largely operate in determining the producing power. These differences and determining factors have to be held conjointly in view by the Director in the examinations made in the laboratory and in the advices given in the field.

In addition to the examinations of soils, the laboratories have given much time to the analysis of waters intended for irrigation uses, to manure analyses, and to the examination of miscellaneous materials. The Director of the Sugar Bureau, in connection with the soil work, has constantly impressed upon the farmers that the purpose of soil examinations, on the one hand, is to ascertain which essential elements are deficient in given soils; and that the purpose of buying manures, on the other hand, is to furnish the precise elements that the soils lack. This is now being more generally understood, and as a consequence the bureau is being consulted concerning the elements to be supplied in a special manure, while the laboratories are engaged in telling the farmers whether they are receiving the goods that they order and are paying for. Very satisfactory progress has been made along these lines. Not only has the principle of artificial fertilisation become understood, there are now planters and cane farmers who never give an order for manures without consultation as to what is to be bought, and who do not make payment until they are satisfied, by control analysis, that the goods delivered are according to contract. The principle is now moving into practice.

The actual work of the laboratories up to the present date is set forth in the report of the First Assistant Chemist, Dr. A. Gibson, to the Director.

FIRST ASSISTANT CHEMIST'S REPORT.

Materials.	Method of Analysis.	No. of Samples Analysed.	No. of Analyses.
Soils	Agricultural Method	668	1,336
Ditto	Maxwell's Aspartic Acid Method	621	621
Ditto	Soluble Silica—Special	20	40
Ditto	Humus—Special	636	1,272
Ditto	Nitrogen—Special	700	1,400
Ditto	Mechanical Analyses	700	700
Waters	Irrigation Waters	148	296
Manures	For Fertilisation Uses	72	144
Limes	ditto	32	64
Cane	Polarisation Tests	81	162
Sugars	ditto	3	6
Miscellaneous Analyses		7	7
	Totals	3,688	6,048

The analyses by the agricultural method comprise 11 constituents and 22 separate determinations in each soil. By the aspartic acid method 3 constituents are determined.

Credit is due to Messrs. O Brien, Patten, Andersen, and Macready, who have shown great diligence and care in the work.

ARTHUR J. GIBSON, First Assistant Chemist.

(B) WORK OF THE EXPERIMENT STATION.

It has already been explained that the purpose of the Experiment Station is to act conjointly with the laboratories in demonstrating all matters under investigation. In the course of soil studies the laboratory may indicate the advisability of special modes of cultivation, manuring, or of irrigation for certain crops. The experimental field puts these advices to the test; the laboratory again coming into service in checking or verifying the conclusions of the field.

The work of the Central Experiment Station, at Mackay, has been made to embrace experiments in cultivation, fertilisation, irrigation, selection of varieties of cane, and green manurial crops. To these have been added general agricultural crops, such as roots, grain, and green fodders. As explained on page 9 of last year's report, these tests are being made in order to advise the farmers concerning crops that can be grown to provide all that is required upon the farm by horses and cattle, and which may be made supplementary to but not a substitute for the sugar crop.

Cultivation Experiments.—The experiments in cultivation are for the purpose of demonstrating the primary necessity of deep, thorough, and subsoil treatment of the soil. In the course of addresses given to the farmers in all districts, the Director has insisted upon the fact that such cultivation must precede all other devices for increasing production. The experiments that have been conducted at the Mackay Station, the results of which are now in hand, were to demonstrate the effects of deep, thorough, and subsoil cultivation in comparison with cultivation of the more ordinary kind.

(*a*) *Deep, Thorough, and Subsoil Cultivation.*—This mode of treatment included: First, breaking up and turning over the land with a swing plough to the depth of not less than 1 foot; second, the thorough stirring of the subsoil by a subsoil plough to a further depth of from 6 to 8 inches, furnishing thus a mass of loose soil of 18 to 20 inches in depth. The subsoiling can be done after the first ploughing or after the last ploughing, and just previous to planting. When broken up, the land is repeatedly cross-ploughed, and to the depth of the first ploughing, in order to bring the soil into the finest state of tilth. The actual number of ploughings and other acts of cultivation will be set forth in the statement of "Cost of Production."

Analysis of the Cane.

Deep Cultivation.	No. of Tests.	Density of Juice.	Sucrose in Juice.	Glucose in Juice.	Purity of Juice.	Fibre in Cane.	Sugar in Cane.
Three plats	12	Per cent. 16·48	Per cent. 15·31	Per cent. 0·68	Per cent. 92·8	Per cent. 9·07	Per cent. 13·91

(*b*) *Ordinary Cultivation.*—In the ordinary cultivation the land was first ploughed light, and then again to a depth of 8 inches. No further ploughing was done. The land was not subsoiled. The full account of the cultivation will be given with the statement of cost of production.

Analysis of the Cane.

Ordinary Cultivation.	No. of Tests.	Density (Brix).	Sucrose in Juice.	Glucose in Juice.	Purity of Juice.	Fibre in Cane.	Sugar in Cane.
Three plats	12	Per cent. 16·33	Per cent. 14·95	Per cent. 0·71	Per cent. 91·5	Per cent. 10·53	Per cent. 13·04

Yield of Cane and Sugar per Acre.

Method of Cultivation.	Weight of Cane per Acre. (English Tons.)	Per Cent. of Sugar in Cane.	Sugar per Acre. (English Pounds.)
(*a*) Deep cultivation	49·3	13·91	15,423
(*b*) Ordinary cultivation	29·5	13·04	8,616

The money values of the respective yields will be furnished later in connection with the cost of production.

The land upon which the above experiments were carried out is all in one piece, and strictly uniform in depth of soil and other characteristics.

The plats were all planted at the same time, with the same kinds of plants, and with the same care; the sole difference lying in the two modes of cultivation. In the analysis of the cane, 50 running feet, including all stoles and all canes big and little, were taken and crushed to obtain the samples of juice. Individual sticks or individual stoles are utterly untrustworthy in furnishing actual field results. As 50 running feet were taken from each plat, and as three plats are included in each average, no less than 150 running feet of cane were used in procuring samples for the juice analysis representing the quality of the cane grown by each method of cultivation. As stated in the tables, twelve tests or analyses were made, furnishing the averages given of density, sucrose, glucose, and purity. These details of analysis are given fully at this place, and it will be understood in the statement of results of further experiments that all averages are based upon the same mode of analytical procedure.

The "weights of cane per acre" are the weights of cane actually delivered at the Meadowlands Mill, with the weights of cane used in the analyses added.

From the tables of analysis it is seen that the cane grown by "deep, thorough, and subsoil cultivation" had a higher density, higher sucrose, lower glucose, higher purity, and a very notably less content of fibre, thus resulting in a higher total amount of sugar in the cane, a greater proportion of which is "obtainable sugar," than the cane grown by "ordinary cultivation." The higher fibre content of the "ordinary cultivation" cane is due to the thinner sticks and shorter joints. The higher quality of the juice of the "deep cultivation" cane is in part due to the treatment of the soil, and in part to the treatment of the growing cane. The "deep cultivation" plats were twice trashed during growth; the "ordinary cultivation" cane was not stripped until the time of cutting.

It has been said that the land upon which the above-stated experiments were carried out is all in one piece, "and strictly uniform in depth of soil and other characteristics." This is not the case throughout the whole areas used in experimentation. The greater portion of the land is of a uniform depth of 15 inches of true soil, resting upon the gritty clay subsoil. A ridge running through the main experimental area is covered with the same earth chemically, but to a depth of only some 8 or 9 inches of true soil. On account of these inequalities in the depth of soil, the Director, at the time of laying

out the experimental plats, determined to have all the experiments made in duplicate in order to guard against minor soil differences that could exist in the field generally, and particularly to anticipate the great differences in crop results that would be found between the plats with the 15-inch depth of soil and the plats upon the ridge where the soil is notably thinner. The outcome has fully confirmed the necessity of the provision that was made to guard against the *influence of depth or mass of soil* upon the results, which is illustrated by the yields of cane per acre and in both the series of experiments with and without irrigation.

INFLUENCE OF DEPTH OF SOIL ON CROP RESULTS.

Depth of Soil.	Non-irrigated. Cane per Acre (Manured).	Irrigated. Cane per Acre (Manured).
Fifteen inches	52·1 tons	49·8 tons
Nine inches	45·7 „	40·1 „

With the same deep cultivation, the same manures, the same acts of cultivation, and all other conditions equal, differences are found of 6½ tons in the "non-irrigated" and over 8 tons in the "irrigated," these differences in crop results being due to the differences in depths of soil stated in the table.

The Director, in addressing farmers in many localities and on several occasions, has insisted upon the attention that should be given to depth of soil in the primary selection of land for cane-growing. Farmers have been advised that a mistake made at the outset by settling upon land with a shallow soil could not be fully remedied by the best cultivation, by manures, or by irrigation. The occurrence of the shallow-soiled ridge in the experimental field, although in no wise an extreme example, offers an opportune illustration of the matter. It has to be said, however, that farmers are using greater care and judgment in this respect. It is now common to see men, who are prospecting for agricultural land, going to the work with a spade over their shoulder, and making the "depth of soil" the first factor in the examination.

It has been explained that the soil of the Mackay experimental field is not uniform in depth and producing power, which is illustrated by the preceding table of results showing the "Influence of Depth of Soil on Crop Results"; and it has also been stated that, on account of that absence of uniformity in the soil, all the experiments have been made in duplicate, the first series being on one side of the field, and the second series on the other side, the two parts being divided by the ridge of thin soil already spoken of. There are nine separate experiments within each series, the details of which will be considered under *fertiliser experiments*. The two different series, although planted at the same time and in all other respects having received precisely the same treatment, were harvested at different times, there being seven weeks between the cutting of the first and the second series. For this reason the average results of each series are given separately in order to note the effect of further time upon the condition and maturity of the cane.

NON-IRRIGATED CANE.

ANALYSIS OF THE JUICE.

Series.	Age of Cane.	Density (Brix)	Sucrose in Juice.	Glucose in Juice.	Purity of Juice.	Fibre in Cane.	Sugar in Cane.
	Months.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
(1) Series	17	16·15	14·68	0·68	90·9	9·07	13·35
(2) Series	19	16·80	15·39	0·66	91·4	10·30	13·80
Means	18	16·47	15·03	0·67	91·2	9·68	13·68

YIELD OF CANE AND SUGAR PER ACRE.

Series.	Age of Cane.	Number of Experiments.	Weight of Cane per Acre. (English Tons.)	Sugar in the Cane.	Total Sugar per Acre. (English Pounds.)
	Months.				
(1) Series	17	9	48·3	13·35	14,443
(2) Series	19	9	50·8	13·80	15,703
Means	18	9	49·6	13·68	15,073

The effects of allowing seven weeks' more time in the maturing of the cane are seen in the increase of density, sucrose, and purity of the juice, and in the rise of fibre in the cane. The differences in weight per acre of cane, and of yield of sugar per acre, in the two series are in part due to greater maturity, but also to the differences in the quality of soil, already explained.

Two series, or duplicates, were also conducted in the experiments with *Irrigation*, the same number being included in each series as in the non-irrigated examples. The results of these are now given.

IRRIGATED CANE.

Analysis of the Juice.

Series.	Age of the Cane.	Density of Juice (Brix.)	Sucrose in Juice.	Glucose in Juice.	Purity of Juice.	Fibre in Cane.	Sugar in Cane.
	Months.						
(1) Series	12	16·28	14·65	0·80	89·9	8·97	13·34
(2) Series	14	17·10	15·80	0·69	92·6	9·75	14·27
Means... ...	13	16·69	15·22	0·70	91·2	9·36	13·80

Yield of Cane and Sugar per Acre.

Series.	Age of Cane.	Number of Experiments.	Weight of Cane per Acre. (English Tons.)	Sugar in Cane.	Total Sugar per Acre. (English Pounds.)
	Months.				
(1) Series	12	9	43·8	13·34	14·065
(2) Series	14	9	47·3	14·27	15·119
Means	13	9	45·5	13·80	14·592

It is noted that the same chemical changes took place in the examples of "irrigated" cane which were observed in the "non-irrigated" as the result of time and increased maturity.

FERTILISING EXPERIMENTS.

In the report of last year it was explained that one purpose of the several series of experiments which were being carried out and have now come to maturity, the results of which are set forth in the preceding tables, was to test the action of given fertilising elements, singly and in combination, upon the crop. It was stated in advance, however, that, on account of the deep and subsoil cultivation practised, and the direct effects of this cultivation upon the crop, small results would probably issue from the use of fertilisers the first year.

Experiments with Mixed Fertilisers.

Nitrogen, Potash, Phosphoric Acid.	Ordinary Cultivation. (Three Tests.)		Deep, Thorough, and Subsoil Cultivation. (Three Tests.)	
In the Mixed Fertiliser.	Cane per Acre. (English Tons.)	Sugar per Acre. (English Pounds.)	Cane per Acre. (English Tons.)	Sugar per Acre. (English Pounds.)
(1) Fertiliser	31·6	9,180	52·1	16,233
(2) No Fertiliser...	28·6	8,642	48·0	14,956
Difference...	3·0	538	4·1	1,277

The results from the application of a mixed fertiliser in these examples are not very great. It is noted that the manure gave a higher increase of return in cane, and more notably in sugar, upon the "deep cultivation" land than where "ordinary cultivation" was practised. During the first nine months of the life of the cane in these experiments the weather was extremely dry and rainless. The cane under ordinary cultivation ceased growing several months before the deeply cultivated cane did, which may account for the smaller use it made of the manure. Had rain been abundant, the fertiliser, with ordinary cultivation, would probably have given the highest results.

FERTILISER EXPERIMENTS WITH SINGLE ELEMENTS.

These experiments were carried out in order to try to determine the fertilising action of each of individual chemical elements. The experiments were made in two series or in duplicate and upon the "irrigated" and "non-irrigated" areas of cane. To economise space, the number of trials in each series are run together, and results given in average.

The results represent the actions respectively of nitrogen, potash, lime, and phosphoric acid, in comparison with results where no fertiliser was used :—

Action of the Elements on Non-irrigated Cane.

Fertilising Elements.	Weight of Cane per Acre.	Sugar in Cane.	Total Sugar per Acre.
	Tons.	Per cent.	Lb.
(1) Nitrogen	51·5	13·60	15,689
(2) Potash	51·5	13·50	15,574
(3) Lime	50·5	13·05	14,762
(4) Phosphoric Acid	48·9	13·90	15,225
(5) No Fertiliser	48·3	13·70	14,822

ACTION OF THE ELEMENTS ON IRRIGATED CANE.

Fertilising Elements.	Weight of Cane per Acre.	Sugar in Cane.	Total Sugar per Acre.
	Tons.	Per Cent.	Lb.
(1) Nitrogen	48·9	13·70	15,006
(2) Potash	49·5	13·60	15,079
(3) Lime	46·7	13·30	13,912
(4) Phosphoric Acid	43·2	13·60	13,160
(5) No Fertiliser	40·5	14·60	13,259

The respective actions of the several elements are distinctly set forth in the above table. It is, in the first place, observed that the fertilising action throughout was notably greater in the series where irrigation water was applied than where the crop was grown by rainfall only. This result appears to confirm the observation made in connection with the "mixed fertiliser" results—viz., that "had rain been abundant the fertiliser, apart from cultivation, would have given greater results." Nitrogen and potash not only give the highest results, they give practically identical returns in each of the two series—with and without irrigation. These results, although not so striking as the results will be in following crops, are strictly in agreement with the findings of the Laboratory, the soil analyses having indicated that nitrogen and potash were the elements more emphatically in request.

Previous to entering into a consideration of the cost of production, and the financial outcome of the experiments, the data furnished in the preceding tables of results are brought together in a statement of averages.

GENERAL STATEMENT OF CROP RESULTS.

Methods of Cultivation.	Age of Cane.	Weight of Cane per Acre. (English Tons.)	Total Sugar per Acre. (English Pounds.)
	Months.		
(*a*) Ordinary cultivation	18	29·6	8,821
(*b*) Deep, thorough, and subsoil cultivation	18	49·6	15,073
(*c*) Deep, thorough, and subsoil cultivation and irrigation	13	45·5	14,592

In all experimental work the final results are expressed in "Total Sugar per Acre." The "obtainable sugar" is a manufacturing question, and is governed mainly by the character of the mill and in part by the degree of purity of the sugar juice that is being worked. In Queensland there are mills which recover for sale 85 per cent. of the total sugar in the cane, while other mills are doing such inferior work that only 75 per cent. to 80 per cent. of the total sugar is "obtained."

THE FINANCIAL OUTCOME OF THE CROP.

In the preceding paragraphs and tables of data the methods of cultivation and fertilisation, with the results, as shown by the yields of cane and of sugar, have been discussed. It is now necessary to consider the items making up the "Cost of Production," in order that the practical and commercial value of the experimental work may be understood and assessed.

The hours of manual and animal labour consumed in the several acts of preparing for and making of the crop, and in the care and the harvesting of it, have been carefully recorded, and the cost of each operation and of the total production fully worked out. It has to be understood that the labour used is exclusively white labour, and at the highest cost of agricultural work. It has also to be explained that the exclusive use of white labour has entitled the cane grown upon the Experiment Station to receive rebate of excise under the regulations for administering the sugar provisions of the Commonwealth Tariff Act. This "rebate," in the district of Mackay, amounts 4s. 8d. per ton, which amount is an additional value put upon the common price of the cane.

(*a*) *Ordinary Cultivation.* With Mixed Manure.	*Cost per Acre.* Unfertilised. £ s. d.	Fertilised. £ s. d.
1 Light ploughing	0 5 0	0 5 0
1 Ploughing, 8 inches deep	0 7 6	0 7 6
1 Disc harrowing	0 2 6	0 2 6
Drawing furrows	0 2 6	0 2 6
Seed cane, 1¼ tons	2 10 0	2 10 0
Cutting, selecting, and planting cane seed ...	1 12 0	1 12 0
4 Hand hoeings	2 0 0	2 0 0
6 Horse cultivations	0 9 0	0 9 0
Stripping and cutting cane, at 5s. per ton ...	7 2 6	7 17 6
Mixed manure	...	3 3 0
Rent of land and taxes	1 0 0	1 0 0
	£15 11 0	£19 9 0

(*b*) *Deep Subsoil Cultivation.*

Mixed with Manure.	Cost per Acre. Unfertilised. £ s. d.		Fertilised. £ s. d.
1 Deep ploughing, breaking up 12 inches ...	0 10 6	...	0 10 6
5 Deep cross ploughings	2 0 0	...	2 0 0
1 Subsoiling, 6 to 8 inches	0 10 6	...	0 10 6
3 Disc harrowings	0 7 6	...	0 7 6
2 Common harrowings	0 1 6	...	0 1 6
2 Rollings	0 2 0	...	0 2 0
Drawing furrows	0 2 6	...	0 2 6
Seed cane, 1¼ tons	2 10 0	...	2 10 0
Cutting, selecting, and planting cane seed ...	1 12 0	...	1 12 0
4 Hand hoeings...	2 0 0	...	2 0 0
12 Horse cultivations	0 18 0	...	0 18 0
2 Trashings during growth	3 0 0	...	3 0 0
Cutting, at 3s. 6d. per ton	8 8 0	...	9 2 3
Mixed manure	...	...	3 3 0
Rent of land and taxes	1 0 0	...	1 0 0
	£23 2 6	...	£26 18 9

(*c*) *Irrigation and Deep Cultivation.*

With Mixed Manure.	Cost per Acre. Unfertilised. £ s. d.		Fertilised. £ s. d.
1 Deep ploughing, breaking up 12 inches ...	0 10 6	...	0 10 6
5 Deep cross ploughings, 12 inches ...	2 0 0	...	2 0 0
1 Subsoiling 6 to 8 inches	0 10 6	...	0 10 6
3 Disc harrowings	0 7 6	...	0 7 6
2 Common harrowings	0 1 6	...	0 1 6
2 Rollings	0 2 0	...	0 2 0
Drawing deep furrows	0 7 6	...	0 7 6
Seed cane, 1¼ tons	1 5 0	...	1 5 0
Cutting, selecting, and planting cane seed ...	1 5 0	...	1 5 0
5 Hand hoeings	2 10 0	...	2 10 0
Trashing during growth	2 10 0	...	2 10 0
Irrigating (Hawaiian system)	6 10 0	...	6 10 0
Mixed manure	...	...	3 3 0
Cutting, at 3s. 6d. per ton	7 1 9	...	8 19 2
Rent of land and taxes	1 0 0	...	1 0 0
	£26 1 3	...	£31 1 8

Certain of the items in the statements of "Cost of Production" may appear low, and others will read high. Each item is based upon the actual hours occupied upon a given operation and upon the actual costs of the manual and horse labour engaged. The manual labour was at the rate of 5s. per day; the horse labour at 1s. per horse per day. The rate allowed for horse labour will appear low. The practice exists amongst farmers of assessing the value of the labour of their own horses or teams, when occupied upon a given occupation, at a rate similar to that paid for teams that are hired by day. The error of such a valuation is patent. The owner of the hired team usually lives in the town, and has to pay stable rent, the middleman's charges for feedstuffs upon which his horses are wholly or largely fed, and even it may be a tax upon the water which they drink. Moreover, his occupation is irregular, which compels him to demand a high pay for the day that himself and his team are actually engaged, in order to provide for the time when they do not work but have to be fed. On the other hand, the horses of the farmer, in most cases, live upon the waste products of the farm; and in many situations, and during much of the time, they feed themselves upon the waste, uncultivated lands. Many farmers purchase little or no corn, and even get molasses for nothing, which are mixed with chop-chop cane tops or sorghum. All situations are not alike in these respects, which causes the cost of maintenance to vary according to the amount of feedstuffs that the farmer actually has to purchase. If a farmer places a daily value for the year upon an outfit, consisting of a man and three horses, similar to the daily charge made by a hired team, the error is at once apparent. At a rate of £1 a day for 300 days, the man and the team would cost £300; and at 12s. per day, the annual amount for 300 days would be £180. It is also clear that, if a team of horses is maintained for the year, the annual cost of maintenance must not be charged against crops upon which only three months of labour have been bestowed. At the Mackay Station four horses are kept constantly. The total cost of maintenance, which includes also an addition of one-eighth of the purchase price as depreciation and 5 per cent. interest, is divided by four, which gives the annual cost of each horse; and the division of the annual cost by 313, the number of working days in the year, gives the amount of each horse's cost per day. This amount is charged per horse per day against any crop upon which horse labour is engaged. The Mackay Station horses receive corn only when they are at

specially heavy work, and the number of these days does not exceed one month in the year. At ordinary work they are fed with chop-chop cane tops or sorghum and molasses, and run out to pasture; when not working they are not brought into the stable. The actual cost per day per horse for the year is rather less than 1s., but 1s. per horse per day has been charged in the foregoing statements of "Cost of Production," which, with 5s. per day for the man, makes 8s. per day for the man and team of three horses. In the heavy ploughing or breaking up and in subsoiling, the team ploughed three-quarters of an acre per day. In stirring or cross-ploughing, somewhat over an acre was done daily. After these explanations, a further table is now given showing the "Cost of Production," the "Money Value of the Crop," and the "Balance of Value over Cost." The "Money Value" stated is the actual price paid for the surplus cane delivered to the Meadowlands Sugar Mill, which is 15s. per ton, to which is added the rebate of excise, 4s. 8d. per ton, making a total price of 19s. 8d. per ton, the mill doing the cartage.

VALUE OF THE CROP, COST OF PRODUCTION, PROFIT.

(A) Ordinary Cultivation.

Fertilisers.	Value of Crop per Acre.	Cost of Crop per Acre.	Profit per Acre.
	£ s. d.	£ s. d.	£ s. d.
(1) Mixed Fertiliser	31 1 6	19 9 0	11 12 6
(2) No Fertiliser (2 tests)	28 2 5	15 11 0	12 11 5

(B) Deep, Subsoil Cultivation.

Fertilisers.	Value of Crop per Acre.	Cost of Crop per Acre.	Profit per Acre.
	£ s. d.	£ s. d.	£ s. d.
(1) Mixed Fertiliser	51 4 8	26 19 9	24 4 11
(2) No Fertiliser	47 4 0	23 2 6	24 1 6

(C) Irrigation, Deep, Subsoil Cultivation.

Fertilisers.	Value of Crop per Acre.	Cost of Crop per Acre.	Profit per Acre.
	£ s. d.	£ s. d.	£ s. d.
(1) Mixed Fertiliser	48 19 5	31 1 8	17 17 9
(2) No Fertiliser	39 14 6	26 1 3	13 13 3

VALUE AND COST OF THE CROP (Grown with Single Fertilising Elements).

I. Deep, Subsoil Cultivation, Non-Irrigated.

Fertilising Elements.	Value of Crop per Acre.	Cost of Crop per Acre.	Profit per Acre.
	£ s. d.	£ s. d.	£ s. d.
(1) Nitrogen	50 12 10	24 18 0	25 14 10
(2) Potash	50 12 10	24 16 0	25 16 10
(3) Lime	49 13 2	24 2 8	25 10 4
(4) Phosphoric Acid	48 1 9	23 5 6	24 16 3
(5) No Fertiliser	47 10 5	22 12 0	24 18 5

II. Irrigated, Deep, Subsoil Cultivation.

Fertilising Elements.	Value of Crop per Acre.	Cost of Crop per Acre.	Profit per Acre.
	£ s. d.	£ s. d.	£ s. d.
(1) Nitrogen	48 1 8	29 0 11	19 0 9
(2) Potash	48 13 6	29 1 3	19 12 3
(3) Lime	45 18 5	27 1 3	18 17 2
(4) Phosphoric Acid	42 9 8	26 3 3	16 6 5
(5) No Fertiliser	39 16 6	25 3 9	14 12 9

In the "non-irrigated" experiments it is seen that the elements "nitrogen," "potash," and "lime" gave small profits of 16s. 5d., 18s. 5d., and 11s. 11d. respectively, per acre, while the "phosphoric acid" made a loss of 2s. 2d. per acre.

In the "irrigated" series, nitrogen gave a profit of £4 8s.; potash, of £4 19s. 6d.; lime, of £4 4s. 5d.; and phosphoric acid, of £1 13s. 8d. Phosphoric acid, as phosphate, is associated with lime and often with small amounts of nitrogen, which elements also affect the results.

SUMMARY TABLE OF FINANCIAL RESULTS OF CROPS.

Methods of Cultivation.	Age of Cane.	Number of Experiments.	Value of Crop per Acre.	Cost of Crop per Acre.	Profit of Crop per Acre.
	Months.		£ s. d.	£ s. d.	£ s. d.
(1) Ordinary Cultivation	18	3	29 2 1	16 17 0	12 5 1
(2) Non-irrigated Deep Cultivation	18	21	49 6 2	23 18 10	25 7 4
(3) Irrigation, Deep Cultivation	13	18	44 19 11	27 6 1	17 13 10

This table of data summarises the practical results, with the commercial value, of the work of the year in experiments with sugar-cane.

SURPLUS SUGAR-CANE SOLD AND DELIVERED TO MEADOWLANDS SUGAR MILL.

Area of cane	3·11 acres.
Tonnage	147 1/2 1/6 tons.
Value	£144 7s. 6d.

CANE VARIETIES.

Experiments are being conducted in order to test the cane and sugar producing powers of different varieties of cane. There are sixty-eight varieties growing at the Mackay Station, and these are now in competition under uniform conditions of treatment. The results, which will indicate the commercial value of each variety as a sugar-producer, will come to hand next season.

The sixty-eight different varieties of cane include standard representatives from Demarara, Trinidad, South America, Mauritius, Louisiana, New Guinea, and Queensland.

Two series of tests are being made with forty-one of the varieties—

(1) *With Irrigation.*—All other conditions being equal.
(2) *Without Irrigation.*—All other conditions being equal.

It is known that varieties of cane, similar to other plants, vary in the proportions of water that they require to reach a maximum growth. These tests are intended to determine, in the first place, the varieties which are more adapted to locations of small rainfall; and, secondly, the varieties which promise the greatest returns for expensive irrigation in localities where the rainfall in all years is below the needs of the crop. Further consideration of this subject will stand over until next year.

GREEN FERTILISATION.

The Mackay Station has carried out a series of green fertilising tests, in order to ascertain, in the first place, the varieties that promise the greater value as crop-producers; and, second, to determine the manurial action upon the soil and the value of each kind of crop.

The kinds of crops experimented with are leguminous or nitrogen-gathering plants, and crops that are chiefly grown for their feed value—mangolds, rape, and white mustard being included in these tests.

The results which are now given are from crops grown under equal conditions of soil, cultivation, and other treatment. The land was ploughed 12 inches deep, and subsoiled to a depth of 6 to 8 inches, thus furnishing about 20 inches in depth of loose soil from which the crops could collect food and moisture.

YIELD PER ACRE OF GREEN MATERIAL.

Crops.	Total Weight per Acre.	Composition.		
		Solid Matters.		Water.
		Organic.	Ash.	
	Tons.	Lb.	Lb.	Lb.
Soja bean	3·34	2,868	190	5,436
Yellow lupine	7·06	3,244	237	12,343
White lupine	27·66	8,765	531	52,682
Cow pea	14·85	5,462	527	27,284
Winter tares	10·95	8,068	786	15,707
Velvet bean	18·67	8,012	773	33,049
Black Mauritius Bean	4·41	3,058	301	6,522
Rape	23·34	6,423	964	45,011
White mustard	30·93	9,690	1,412	58,289

The figures contained in the above table set forth the "weight per acre of green material," the proportions of "solid matter" and of "water," and the amount of "ash" contained in the solid

matter of each crop under trial. The action of these crops in maintaining the humus content is seen from the amount of organic matter that they give to the soil. The following table deals with the proportions of the four most vital elements that the crops have taken up during growth :—

AMOUNTS OF THE ELEMENTS USED PER ACRE IN MAKING THE CROPS.

Crops.	Pounds of Lime per Acre.	Pounds of Potash per Acre.	Pounds of Phosphoric Acid per Acre.	Pounds of Nitrogen per Acre.
Soja Bean	55	40	13	85
Yellow Lupine	41	59	8	99
White Lupine	59	166	32	303
Cow Pea	82	123	61	216
Winter Tares	140	162	24	298
Velvet Bean	294	97	51	272
Black Mauritius Bean	86	54	16	82
Rape	205	255	40	276
White Mustard	325	374	45	355

These data are laden with guiding instruction, covering the whole question of green fertilisation and the very special action that the different crops exercise upon the food elements of the soil. They require little comment. It is seen why the white lupine and the varieties of beans, peas, and tares are such fine precursors of the cane crop. The rape and white mustard are the most industrious preparers of all the four elements for the crop that is to follow them. It has to be remembered, however, that these crops are not amongst the active gatherers of nitrogen from the air; they are indebted to the nitrates in the soil for the nitrogen they have used in their composition. The results furnish one great warning, viz. :—That such green crops cannot be taken away from the land for other use without removing permanently from the soil large proportions of the elements most vital to the growth of crops, and particularly of the cane crop. The consumption of potash by the white mustard, were it possible to repeat annually the weight of crop, would remove every pound of potash from the Mackay Station soil to the depth of 1 foot in twelve years; while the present "available" amount of potash in that soil is barely enough for two such yields as the crop just recorded.

The Mackay Station, in addition to sugar-work, is carrying on certain experiments in general agriculture.

Trials are being made with some of the more important American varieties of sorghum. Each variety is being tested during stages of growth in respect of its content of prussic acid. The varieties, when they have reached the maximum measure of feed content, will be analysed, in order to determine their respective values for fodder purposes.

Cassava, turnips, mangolds, bulbs, and maize are being grown because of their relation, as supplementary crops, to the domestic situation of the cane-farmer and to indicate the kinds of crops that may be most successfully grown.

The tropical and sub-tropical fruit trees and vines are in a good state of growth, and are now almost wholly free from scale and other pests.

The general state and appearance of the Experimental Station is satisfactory. The care with which the Assistant Director, Mr. H. T. Easterby, has carried out instructions and discharged the duties of his position has received deserving approval and praise.

SUB-STATIONS: EXPERIMENTAL WORK.

The experimental work in operation at the Mackay Central Station is conducted exclusively by the Sugar Bureau. It appeared to the Director highly desirable that the actual work of the Central should be brought before the cane-growers of the several localities in the two other sugar districts. To this end small sub-stations were established, to be conducted in co-operation with the farmers in the several sub-districts. The Sugar Bureau has now in operation fourteen such sub-stations, which are located as follows :—

No.	Location of Sub-Stations.	Cane-grower in Charge.
1.	Mossman River	Exors., Pringle Estate
2.	Mulgrave, Cairns	Mulgrave Central Mill
3.	Sundown, Johnstone River ...	Mr. J. Hart
4.	Mundoo, Johnstone River... ...	Mr. R. Reid
5.	Ripple Crek, Herbert River ...	Messrs. Wood Bros. and Boyd
6.	Halifax, Herbert River	Messrs. Anderssen Bros.
7.	Proserpine River	Proserpine Central Mill
8.	Burdekin River	Messrs. Drysdale Bros.
9.	Woongarra, Bundaberg	Mr. Smith
10.	Gooburrum	Mr. J. Storrie
11.	Pialba	Mr. J. B. Stephens
12.	South Isis	Mr. T. H. Wells
13.	North Isis	Isis Central Mill
14.	Beenleigh, Logan	Mr. W. Lubach.

The conditions upon which these sub-stations have been begun, and according to which they are being carried on, are—

(1) That the Farmers' Association of a sub-district wishing to have such a sub-station shall appoint one of their number to carry out the proposed experiments.

(2) That the person appointed shall furnish the land and all labour, and that he shall carry out the experiments strictly according to instructions given by the Director of Experiment Stations.

(3) That the Sugar Bureau shall furnish any special implement required in cultivation, and all lime or manure that the Director may decide to use in the fertilisation tests.

(4) That the cane farmers or planters in charge of the sub-stations shall have the value of any increase in the crop as compensation for the undertaking.

As set forth in the report of last year, "by means of these sub-stations it is proposed to repeat, upon a small scale, such of the leading experiments that are being conducted at the Central Experiment Station as may apply to a given locality. In this way the technical and practical purposes of the Sugar Bureau will be brought into actual touch and union with the field, and the farmers themselves may become not only learners, but co-operators in the work."

Three of these sub-stations began operations two years ago, and the results of their first experiments have come to hand.

SUB-STATION, HALIFAX.

The land was furnished by Messrs. Anderssen Bros., and is a portion of a large area that is under cane. The soil of the experimental area is considered by the owners to be the poorest part of the field, which is indicated by the chemical analysis. The depth of the soil is less than 1 foot on the side where sections 6 and 7 are located, and increases towards the "Farmers' Test Plat," where there are about 15 inches of soil. The soil of the No. 1 Experiment may be considered as equal to the Farmers' Plat, and in all respects comparable. The ground had borne a light green crop previous to its being taken over for the experiments. The land had been under cane crops for eighteen years, and was considered exhausted. The mode of treatment of the land of the several experiments was as follows:—

Farmers' Test	Ordinary cultivation of the district; no manure.
No. 1 Experiment (Sections 1-2) ...	Deep, thorough, subsoil cultivation, Manures: Lime, potash, phosphoric acid, and nitrogen.
No. 2 Experiment (Sections 3-5) ...	Deep, thorough, subsoil cultivation; no manure.
No. 3 Experiment (Section 4) ...	Deep, thorough, subsoil cultivation; Manures: Potash, phosphoric acid, and nitrogen.

NOTES.—A fourth experiment, including sections 6 and 7, was ruled out of the competition in July, 1902, on account of a mob of cattle getting in and very largely damaging section 7, also doing notable injury to section 6. Those sections continued to grow, were well cultivated, and have been harvested, but they were excluded from the experiment five months after the cane was planted. The cane was planted in all the experiments and upon the Farmers' Plat, on 23rd March, 1902. All the plats were cut and harvested during the last week of September, 1903, they having been on the ground eighteen months.

The "weights of cane" and the "analyses of the juice" were furnished by the Colonial Sugar Refining Company's Victoria Mill, by courtesy of the manager, Mr. Forrest.

ANALYSES OF THE CANE.

Experiments.	Sugar in Cane.	Glucose in Cane.	Quotient of Purity.
	Per cent.	Per cent.	Per cent.
Farmers' Test	14·0	0·47	90·5
No. 1 Experiment	13·3	0·72	88·3
No. 2 Experiment	13·4	0·69	88·4
No. 3 Experiment	14·8	0·40	90·5

Separate checks, bearing the weight and analysis of each experimental block, was furnished by the mill to Anderssen Bros., who enclosed them with their report to the Director of the Sugar Bureau.

COST OF PRODUCTION PER ACRE.

Cost of Production.	No. 1 Experiment.	No. 2 Experiment.	No. 3 Experiment.
	£ s. d.	£ s. d.	£ s. d.
Carting and spreading lime	0 4 0	...	...
5 Ploughings, 12 inches deep	2 10 0	2 10 0	2 10 0
1 Subsoiling	0 12 0	0 12 0	0 12 0
5 Harrowings	0 7 6	0 7 6	0 7 6
Drilling and planting	1 8 0	1 8 0	1 8 0
Cane plants	2 12 0	2 12 0	2 12 0
Weeding, scarifying, supplying misses, and applying manures	2 11 0	2 11 0	2 9 0
Cost of lime	1 13 6	...	...
Cost of manure	3 12 0	3 12 0	...
Cutting, stripping, and loading	8 10 6	7 8 0	6 5 0
Rent of land and taxes	0 10 0	0 10 0	0 10 0
Totals	£24 10 6	£21 10 6	£16 13 6

The statement of cost is given, with the exception of two items, as furnished by Anderssen Brothers. It will be noted that in most items the cost is higher than was found by the Mackay Experiment Station in its experiments. The item "lime" is one-third of the cost, including freights, of the lime applied per acre. This manure in its action extends over five to seven years. The full cost of the other manures is charged against this crop. The cost of production of the Farmers' Test was not furnished.

The experiments were conducted with white labour after the date required by the Commonwealth Sugar Rebate Regulations, so that the growers were eligible for and have claimed rebate of excise, which in the Halifax district is 5s. per ton. The value of the cane at the mill is 14s. per ton, which, with the rebate of excise, amounts to 19s. per ton. The final outcome of the experiments is found to be as follows:—

VALUE AND COST OF THE CROP.

Experiments.	Weight of Cane per Acre. (English Tons.)	Value of the Crop per Acre.	Cost of the Crop per Acre.	Profit on the Crop per Acre.
		£ s. d.	£ s. d.	£ s. d.
Farmers' Test	25·0	23 15 0	...	...
No. 1 Experiment	42·5	40 0 0	24 10 6	15 9 6
No. 2 Experiment	35·7	33 17 7	21 10 6	12 7 1
No. 3 Experiment	31·2	29 13 4	16 13 6	12 19 8

(Signed) ANDERSSEN BROS., Halifax.

In the letter accompanying the report, Messrs. Anderssen Bros. say: "The cane of the experiment plats, like the cane of the district, was affected with gum, and a considerable quantity died from the cane rot which was prevalent on the Herbert River. The cane suffered severely by the exceptional drought of last year, which killed out some cane in the district. The experiments have been made upon the most exhausted soil, which has been cropped for over fifteen years—in fact, for nearly twenty years. The results are a lesson to many in the district, and are a happy surprise to us. We appreciate the share of credit that you give to us in carrying out the experiments."

The instructions given by the Director for conducting these trials were carried out faithfully by Messrs. Anderssen Brothers.

SUB-STATION, MOSSMAN RIVER.

This experimental plant is located upon the farm of the late Mr. Pringle, who undertook to carry out the work.

Mr. W. H. Buchanan, Executor of the Pringle Estate, states in his report, "The cane was planted on 16th, September 1902, and harvested 26th September, 1903, so that it is a *twelve-months' crop.*" Continuing, Mr. Buchanan remarks: "The experiment had anything but a fair season to contend with. It was planted fully three months before it received any rain, and then the rain was excessive."

The instructions given by the Director of the Sugar Bureau were the same as to Anderssen Bros., Halifax, and they were carried out, excepting in the matter of depth to which the ground was ploughed and sub-soiled. The instructions called for ploughing to a depth of 12 inches and sub-soiling to 6 to 8 nches, or 18 to 20 inches in all.

A measurement made by the Director just before the cane was planted showed a depth of loose soil of 15 inches. Apart from this defect in the depth, the cultivation was satisfactory.

The land selected for this experimental plat was declared to be below the average in depth and quality. The soil is irregular in depth, some spots being naturally more productive without, than others with, fertilisers. The chemical analysis showed that the soil is one of the poorest in the district in lime, potash, and nitrogen.

YIELD PER ACRE.

Experiments.	Mode of Cultivation.	Manures Applied.	Yield per Acre. (English Tons.)
			Tons cwt.
No. 1 Experiment	4 Ploughings 10 inches, Subsoiling 5 inches	Lime	23 15
No. 2 Experiment	,,	Potash, phosphates, and nitrogen	25 1
No. 3 Experiment	,,	Lime, potash, phosphates, nitrogen	29 15
Average	...	...	26 4
Estimated yield of the district, 14 to 15 tons, or average			14 10

(Signed) W. H. BUCHANAN.

It has to be borne in mind that the Mossman experimental crop was only of twelve months' growth, as compared with the Halifax experimental crop, which was eighteen months upon the ground. As a consequence, the Mossman crop has left much of the manures that were applied for the use of the next crop. As a short crop, in a season of exceptionally unfavourable climatic conditions at its beginning, and grown upon a soil which was selected on account of its quality being below and not better than the average of the land of the sub-district, the results of the experiments, in yield of cane, have to be considered a practical success.

SUB-STATION, RIPPLE CREEK.

Bearing upon the experiments made at Ripple Creek, Messrs. Wood Bros. and Boyd state: "Due to the very unsatisfactory weather—during part of the time we had no rain, and then came a deluge—and especially to the cyclone, the experiments have not been satisfactory. After the commencement of the wet season the cane made great growth, and just before the cyclone in March gave promise of a heavy crop. The cyclone and the cane rot which followed destroyed 25 per cent. of the cane." The Director saw the cane before cutting, and it was apparent that the statement of Messrs. Wood Bros. and Boyd was not an over-estimate of the damage done.

YIELD PER ACRE.

Experiments.	Mode of Cultivation.	Manures Applied.	Cane per Acre (English Tons).
No. 1	3 Ploughings, 12 inches deep ...	None	21·9
No. 2	Subsoiling, 6 inches deep	Lime	23·9
No. 3	All experiments	Potash, phosphoric acid, nitrogen ...	25·0
No. 4	...	Lime, potash, phosphoric acid, nitrogen	24·14

(Signed) WOOD BROS. AND BOYD.

The results from the action of the different fertilising elements can be only approximate indications, since the destruction by the cyclone may have been more in some than in other of the experiments. If the estimate of destruction, 25 per cent., is correct, then the average yield would have been 31½ tons per acre had the cyclone not have happened.

SUB-STATION, NORTH ISIS.

The experimental area of 5 acres, conducted by the Isis Central Mill, had for its primary purpose to make use of the waste waters from the mill, and to remove a local nuisance which was exposing the mill directors to litigation. The Director of the Sugar Bureau advised the mill to clear a piece of land near by, and to plant it with cane and irrigate it, and thus provide a means of removing the nuisance that would pay for the expenditure. The result of the experiment is given in a communication from the mill manager, Mr. W. E. Desplace, to the Director of the Sugar Bureau:—

"The following are the particulars of the 5 acres of land that you advised should be used for the water nuisance experiment, which undertaking has had the effect of getting rid of the waste-water nuisance for the past two crushing seasons.

"So far as the experiment is considered from the cane-growing standpoint, it may be explained that the 5 acres were put under plough, and 2½ acres planted with cane in July, 1901. In October, 1902, 50 poles of cane were cut for seed, the patch giving 3 tons 11 cwt. of plants. Immediately after cutting the plants clean water was applied, but only once, and this patch of 50 poles was cut again 11th September, 1903, and gave 12 tons 10 cwt., or a yield per acre of 38·6 tons of cane. The balance of the 2½ acres was cut for seed last March, and gave 33 tons 19 cwt. of fine plants. The next crop is growing and looking well. The effect of the water was very clearly demonstrated."

(Signed) W. E. DESPLACE, Manager.

The mill manager, Mr. Desplace, carried out the work very carefully, and it is expected that the waste-water nuisance has been gotten over. The excellent seed-cane furnished by the experimental area was eagerly sought after by the cane-growers, as plants were scarce, due to the drought.

In addition to the small sub-stations conducted by individual farmers under the instructions of the Sugar Bureau, enterprising planters and cane-growers are testing the value of special manures, the tests being based upon the requirements of their soils as shown by the analyses of the laboratories.

TESTS AT PALMYRA PLANTATION.

Mr. McCready, in speaking of tests made by him at Palmyra, says: "Consequent upon your repeated advice that soils in our locality required lime, potash, and nitrogen, according to your comprehensive examinations, I determined on testing by actual experiment a small area in one of my poorest fields, and I have now much pleasure in forwarding you the results. The plats were cultivated uniformly, and to a depth of about 15 inches. I append an analysis of the juice made by one of your officers at the laboratory at Mackay."

RESULTS OF THE EXPERIMENTS.

Palmyra Estate Experiments.	Weight of Cane per Acre.	Density (Brix.)	Sucrose in Juice.	Purity of Juice.
	Tons cwt.			
(1) Limed and Manured	22 6	20·1	18·92	94·1
(2) No Lime or Manure	14 8	21·7	19·96	92·0

(Signed) W. McCREADY.

Manuring tests were also made by Mr. Sorenson and Mr. Dimond, cane-growers at Sunnyside, Mackay, and with the following results:—

Mr. Sorenson ... ... 27 tons per acre.
Mr. Dimond ... ... 32·8 „ „

These cane-growers have expressed their intention to repeat the tests, and particularly as the weather conditions were very unfavourable during the early part of the past growing season.

The experimental tests made by individual plantations and cane-growers are practical and valuable object lessons for the localities where they are conducted.

Concerning the experiments carried out by the sub-stations, it has to be remembered that, although they are directed by the Sugar Bureau, the work is done by the farmers, and what those selected farmers are doing can be done by the cane-growers generally.

AGRICULTURAL.

The outside or sub-experimental stations, which have been discussed, are the connecting link between the work of the Central Experiment Station at Mackay and the work of the cane-growers on the farms.

In the report of last year it is said: "Bearing upon the new relation of the farmers to the technical and advisory function of the Sugar Bureau, it has to be said that in all the sub-districts where the soil examinations are advanced enough to have enabled the Director to speak, the cane-growers have shown an eager interest." This statement has also to be confirmed. The Director has finally made a first visit of inspection to all localities in the three districts, and the experience has demonstrated the readiness of large numbers of the farmers to be advised, and to adopt more improved methods in the field.

The work and results of the outside experimental stations is still further awakening a belief in what is possible where deep and good cultivation is practised.

On the other hand, there are factors operating which are having a deterring action upon the putting into practice, upon a general scale, of the more expensive modern methods which the Sugar Bureau is advising, and which its experiments are demonstrating to be necessary to greater production. These factors are of an economic and social nature, and are closely associated with questions of labour supply, which it is not proposed at this time to discuss. The situation is, however, that the adoption of those methods of cultivation has not followed as rapidly as the field conditions have required, and the purchase of fertilising elements for the purpose of restoring the producing power to the older and more exhausted soils has not in any commensurate sense proceeded. The whole situation, agriculturally and economically, will be exhaustively discussed in the next annual report.

IRRIGATION.

In the report of the Sugar Bureau of 1900, pages 13-19, the subject of irrigation, as it is found in practice in the several sugar districts of Queensland, is dealt with at some length. The "Sources of Water Supply" in the districts of the Burdekin, Mackay, and Bundaberg were discussed. A statement was also given, showing the *pumping power* installed and operating in the respective districts, an abstract of which, with additions made during the past year, is now reproduced, in order to present the proportions of the irrigation plants installed in the sugar districts at this time:—

Districts.	Pumping Power per Twenty-four Hours.
Burdekin...	... 100,750,000 gallons
Mackay	... 2,500,000 „
Bundaberg	... 27,000,000 „

These figures represent, approximately, the service, per day of twenty-four hours, of the pumping plants installed in the respective districts were they all in full operation.

In recurring to the question of "Sources of Water Supply," the Director made an examination of the present state of the *underground water* in the Burdekin delta district, in October of this year, in company with Mr. Douglas Brown, manager of the Pioneer Plantation. During the autumn and winter months of this year, heavy rains fell over the delta, and still heavier rainfalls are recorded as having occurred upon the higher back country where, and beyond where, the Burdekin River has its rise. The rainfall was sufficient to cause the great river to reach its fullest proportions, and the stream overflowed its banks and submerged areas of adjacent country. It might have been expected that such a precipitation and flood would in some measure and immediately have affected the underground water level. Two months ago, or four to five months after the rains had fallen, no rise in the level was observed. The overflow of the flood waters of the river had raised temporarily the visible level of some lagoons, which are maintained by the moving underground water; but with the abatement of the flood, when the river came down from its banks and became again a very ordinary stream, the water in those lagoons sank to the level at which it stood before the rains fell. One month ago, or towards the end of September, and nearly six months after the greater rains fell, a rise in the water levels of the lagoons became perceptible, which indicated that those rain waters were beginning to arrive. The movement is evidently slow, for up to the present time, November, the rise does not appear to be more than one-tenth of the drop of 8 to 10 feet from the normal level that had occurred during the several preceding years of great drought.

These observations indicate that the rate of movement of the underground waters through the strata underlying the Burdekin watershed is very slow. The catchment area, which extends several hundreds of miles back from the seaboard, covers a vast breadth of square miles, over which the rains fall that sustain the moving supplies of the underground. That proportion of the rainfall which finds access through outcropping or faulty strata to formations below moves at a rate which is governed by the dip and the structure of the strata, and the movement is essentially slow. Investigations have not been made covering the geological conditions of Queensland and the rate of movement of the underground, which is a subject of practical concern by reason of its relation to drought periods and to schemes of irrigation. In some other countries, and particularly in the United States of America, very careful observations and measurements have been made, and these indicate that the rate of flow of the water through the underground strata can vary from a few feet to the fourth of a mile per day. This is controlled by the nature of the rock strata which form the underground of the higher and vaster areas of catchment through which the water percolates to the valleys and waterways which lead it out to the ocean.

It is indicated that several wet seasons may be required before the underground waters will come up again to their normal level; since the constant wasting into the sea during the recent several years of drought has run the underground reserve down to a condition from which length of time, as much as volume of rainfall, will be required for it to recover.

The examination of these great natural matters compels it to be seen that in countries where there are no perpetual supplies of water from melting snows or from areas of constant rainfall, the underground waters and their slow rates of movement are means furnished by Nature whereby such countries, or at least large areas within them, can protect themselves from the recurring disasters that follow periods of drought. Surface or visible supplies are irregular, and fail at the time of acutest need. The great Burdekin River at once after the "Leonta" storm of this year swelled and overran its banks, and a stream was flowing a fourth of a mile in width and 30 to 40 feet in depth. Only a few weeks later the river was down to a simple course, which, when seen a month ago, was about 100 feet in width and some 2 feet in depth. That proportion of the rainfall which had not found its way to the underground rushed almost instantly away and wasted into the sea. Nature has put it very clearly that the standing source of supply in countries of irregular precipitation are the waters of the underground.

A table of data was also furnished in last year's report showing, approximately, the cost of fuel per 1,000,000 gallons of water incurred by the different systems and types of pumping plants in operation, which table, with advantage, can be re-presented, with the addition of an example:—

Estate.	Type of Pump.	Cost of Fuel per 1,000,000 Gallons.
		£ s. d.
Pioneer Plantation	15-inch centrifugal pump	0 13 0
Pioneer Plantation	12-inch centrifugal pump	0 16 0
Pioneer Plantation	8-inch centrifugal pump	1 17 0
Bingera Plantation	High-lift pumps	2 1 8
Qunaba Plantation	Duplex pumps	1 8 0
Fairymead Plantation	8-inch centrifugal pumps	0 12 0
Bell's Farm	...	2 1 8
Spring Hill	Worthington pumps	1 0 0

These figures are furnished by the several estates as approximations to the actual cost.

Efforts have also been made to establish the cost per acre of irrigation, and the results, as expressed in value of cane per acre. This has not been fully successful so far, and because most of the irrigation plants in operation, especially in the Bundaberg district, have only been installed in some instances two years, and in others only one year. Even at the Pioneer Plantation, on the Burdekin

delta, it has been found very difficult to work out a precise table of cost. Statements have been received from several persons and estates in reply to a series of inquiries sent out by the Director, and they are inserted at this place.

Messrs Drysdale Bros., Pioneer Plantation, could not furnish a precise written statement, but intimated that "the cost would be £3 per acre," and that "without irrigation cane could not be grown in the average of years in the Burdekin district."

In the Mackay district, Mr. Smart, Palms Plantation, states: "We have now cut the most of our crops which were irrigated, and find, from comparison, that the yield is about one-fourth over the non-irrigated; but in some instances it is more." Mr. Shannon reports paying results from the irrigation of a small area.

In the Bundaberg district, Messrs. Gibson and Howes, Bingera Plantation, in answer to the question covering the effects of irrigation, state: "The returns from several blocks of fields average 30 tons of cane per acre, twelve months old. The two experimental blocks, which, it must be said, did not receive water for a period of five months, gave as follows:—

Twelve months' old crop, 37 tons per acre;

Fifteen months' old crop, 42 tons per acre."

"As to your question of cost, we cannot at this time give reliable figures." Finally, in answer to the question of comparison between the results of irrigated and non-irrigated cane, Messrs. Gibson and Howes say, "Our answer is that we would not have had any cane fit to crush without irrigation because of the drought, while by irrigation we have grown from 15 tons to 42 tons per acre, and we have been able to plant 600 acres for the next crop."

Messrs. Young Bros., Fairymead Plantation, in reply to the same questions, have replied: "We irrigated 1,000 acres of cane. The estimated increase of yield due to irrigation was 20,000 tons of cane. Approximated cost of irrigation was £5 per acre, with an application of 6 inches of water per month. We hope to reduce the cost to £3 per acre."

Mr. J. J. Eastick, general manager, Millaquin Refinery, in answer to the questions submitted, states: "Upon Qunaba Estate the area under irrigation is 550 acres. The volume of water applied per acre, per month, was 89,000 gallons, and the total applied for the season was 480,000 per acre," which is about 21½ inches per acre.

Covering the qustions of cost and of results, Mr. Eastick states: "The cost of irrigation was £3 per acre. The average yield of the irrigated cane was 22 tons per acre, while the non-irrigated gave none fit to cut."

Upon the Waterview Estate, Mr. Eastick sums up the results as follows:—"The area under irrigation was 120 acres. The volume of water applied per acre, per month, was 80,000, and 320,000 gallons for the season, or 14 inches per acre. The cost of irrigation per acre was £1 10s., and the yield per acre of the irrigated cane was 12 tons, while the non-irrigated cane for the same period gave none fit to cut."

Mr. P. L. Elliot, Spring Hill Plantation, in reply to the questions, says: "The average application of irrigation to 100 acres of cane made fit to cut was somewhere about 50 inches, and the amount applied to 50 acres, which has been planted at different times, was about 20 inches." Mr. Elliot states: "The total cost for firewood, labour, &c., has been £410." It is thus seen that the 100 acres, which received about 50 inches of water, producing cane fit to cut, cost about £3 6s. per acre to irrigate. Mr. Elliot further adds: "The average yield of the 100 acres of irrigated cane was 25 tons per acre, while non-irrigated cane either died out or gave some 3 tons per acre of stunted cane." These figures are given as approximations only to the actual cost.

Messrs. F. and C. W. Buss, Bell's Farm, say: "22 acres of corn irrigated gave us 22 bushels an acre, non-irrigated corn near by being a complete failure." Applied to cane, Messrs. Buss state: "Irrigation applied to 20 acres of old, stunted, and almost dead cane gave us this season 17 tons an acre. Upon a small portion of the same block we were able to apply plenty of water, and this gave us 36 tons of cane per acre. Non-irrigated cane near by gave only 4 tons per acre. We cannot give the cost of irrigation per acre."

All these several examples indicate that irrigation has been seriously undertaken, and in districts where it had not been begun upon a practical scale three years ago. As stated by gentlemen representing several of the undertakings, this recent departure has been too short a time in practice to enable reliable statements of results and costs to be furnished.

The crop results which follow irrigation, and the cost of irrigating, other conditions being equal, are governed chiefly by the *method of irrigation;* and the method of irrigation, omitting at this place the labour factor, is controlled by the nature of the soil and by the abundance or scarcity of the water supply. There are two methods in practice in Queensland canefields: One, which is known as the *Hawaiian method*, provides for the application of the water in the furrow or trench where the cane is planted; the other, or more common method, consists in applying the water in shallow furrows between and parallel with the cane rows.

The Hawaiian method involves a more expensive mode of preparing the land, including the arrangement of the furrows more specifically according to the land contour, the cutting of the furrows into short sections to secure the even distribution of the water, and the drawing of tertiary, secondary, and primary ditches to convey the water to the furrows. This method combines the greatest economy of water with the highest expenditure of labour, and is applicable to light loam and volcanic soils, having porous subsoils, where the applications of water must be small and frequent, in order to avoid loss by seepage, and to maintain the crop in constant growth.

The more common method of irrigation involves a less expense in the preparation of the land and in the application of the water, and is specially adapted to soils having close and less pervious subsoils. This method uses a maximum of water with a minimum cost of labour. A modification of the "common method" is now being put in practice, in order to secure some advantages of the Hawaiian method without incurring its cost. This consists in drawing cross ditches to cut the field into sections, thus shortening the lengths of flow, yet retaining the application between the cane rows. This modification is intended to effect a more economic use of water and to secure a somewhat more even distribution, and thus avert the damage that happens to the land by the accumulation and stagnation of water in low places.

As one of these methods is more specially adapted to situations where water is scarce and labour is abundant, and the other method to conditions where labour is scarce and water is abundant, then it is clear that the labour factor has to exercise an increasing influence in Queensland in determining which method of irrigation shall be adopted, and where and when the adoption of irrigation is indispensable and can be made with a certainty of gain.

Bearing upon the question "where irrigation is indispensable and can be made with a certainty of gain," reference is again made to the report of the writer made to the Queensland Government in 1900, where it is said, "Excepting the districts of Bundaberg and the Burdekin, the volume of rainfall should be enough for the sugar crop." The reports of results from irrigation already given confirm that statement. The Pioneer Plantation stated that without irrigation cane could not, in the average of seasons, be grown in that district.

The statements made by the planters and cane-growers in the Bundaberg district indicate that by use of irrigation last year crops of cane were grown with yields running from 14 tons to 42 tons per acre, or an average of approximately 30 tons per acre, while without irrigation there was "nothing fit to cut."

In the Mackay district, the Palms Plantation gave the increase of yield due to irrigation as 25 per cent., showing that a moderate crop was grown without irrigation, and indicating the need of a careful examination in order to determine whether, and how far, the irrigation paid. Also, in the district of Mackay, the exactly recorded results of the Experiment Station show that while the eighteen months' crop, grown by "ordinary cultivation," gave a yield of 29½ tons of cane per acre, the crop of the same age, grown by "deep, thorough, and subsoil cultivation," yielded 49½ tons per acre, and *without irrigation*. The crop of twelve months' growth, *with irrigation*, all other conditions being the same, gave a yield of 45·5 tons per acre, the cost of the irrigation being 2s. 9d. per ton of cane. The "non-irrigated" crop of eighteen months' growth was grown with 65 inches of rain. The "irrigated" crop, twelve months' old, was grown with 56 inches of rain and 13 inches of irrigation water, or 69 inches in total. These results demonstrate that the question of irrigation is one for each district to determine upon the basis of its individual climatic conditions, having also in mind the proportion that irrigation bears in the cost of production, which the general examples already considered show to be very notable.

The results of the Mackay Station, of the sub-stations in the different sugar localities, and the operations upon a larger scale of some plantations and farmers, are demonstrating, most palpably, that the matter of deep and thorough cultivation demands the first attention, after which it can be determined in given districts if or if not irrigation is an economic necessity.

MANUFACTURE.

During the course of the first two years of the work of the Sugar Bureau, attention was very chiefly concentrated upon those matters which relate to the production of the crop in the field. That was essentially the division of the work that required, first in order, to be undertaken.

Having examined into the factors which control the production of the crop, the following business was to inquire into the character of the manufacture. It would be poor practice to advise methods for increasing the yield of cane in the field, and neglecting the means of recovering the sugar in the mill.

In August of this year, Mr. J. C. Penny was appointed Chemical Inspector of Sugar-mills. Mr. Penny was a student of chemistry, under the Director of the Sugar Bureau, during the period of the Director's control of the Sugar Experimental Laboratories in Honolulu. He has had a very sound and thorough experience in raw sugar manufacture during his engagement as control chemist in the mill of the Ewa Sugar Plantation Company, Hawaii, which is the largest cane sugar-making concern in operation.

The business of the Chemical Inspector is to examine into the actual work that is being done by the mills, and report to the Director. Special attention is being given to the Government Central Mills, and also to all private sugar-houses that ask for inspection.

A general survey of the work of inspection is afforded by the "Instructions to the Inspector" from the Director, specifying the matters to be inquired into—

(*A*) *Mill Equipment*—

(1) Type of boiler and steam power
(2) Type and power of crushing plant
(3) Type and capacities of clarifying vessels
(4) Type and capacity of evaporators
(5) Type and capacity of crystallisers
(6) Type and effectiveness of centrifugals
(7) Type and capacity of vessels for treating molasses and low grades of sugars
(8) Balance of relation of each part of the equipment to the whole and to the steam power.

(*B*) *Manufacture*—
(1) Method of feeding rollers
(2) Method and volume of maceration
(3) Determination of the extraction
(4) Determination of sucrose and glucose in juice, entering manufacture
(5) Method of clarifying juices and syrups, with determinations of alkalinity and acidity
(6) Survey of juices through all stages from rollers to centrifugals, determining sucrose, glucose, alkalinity, and acidity at each stage.
(7) Method of boiling and crystallising
(8) Method of working centrifugals
(9) Method of working the presses
(10) Method of treating molasses and lower grade sugars.

(*C*) *Economic*—
(1) Relation of cane supply to the mill power
(2) Consumption of fuel per sugar made
(3) Labour-saving devices.

This outline furnishes a survey of the inspector's duties without noting matters in special detail. The inspector is at this time engaged amongst the mills, and his observations will be given in the Director's next annual report.

Cane-cutting Machine.

The invention of a mechanical means of cutting cane, as a substitute for hand-cutting, has engaged the attention of several inventors, and for some time.

A cane-cutting apparatus has been made by Mr. Herbert Paul, and a public trial was made with the machine, on 17th October of this year, at the Mackay Sugar Experiment Station. It has to be said that a machine is now in the field which, mechanically, is a partial substitute for hand labour. The question of the relative economy of the device has yet to be determined. This will be done during the next season by comparative tests of cost of cutting by machine and by hand.

ECONOMIC.

This division of the subject includes factors which relate to the industry, to the State, and to the Commonwealth.

Condition of the Industry.

The sugar crop of 1902 was the smallest within several recent years, due to the unexampled drought which ravaged generally the producing industries of the State.

The weight of cane delivered at mills during the crushing season of 1902 was 641,126 tons, and the weight of sugar made, composed chiefly of raw but partly of refined, was 76,626 tons.

Production in the Three Sugar Districts.

Districts.	Weight of Cane Produced.	Weight of Sugar Made.
	Tons.	Tons.
(1) Southern, or Bundaberg district	69,920	7,140
(2) Central, or Mackay district	214,748	24,406
(3) Northern, or Cairns district	356,458	45,080
Totals	641,126	76,626

From these data it is seen that Mackay, and the district farther North, produced 69,486 tons, or 90·5 per cent. of the total sugar grown in Queensland in 1902. The significance of these facts will be considered at a later time.

During the season of 1902 the sugar provisions of the Commonwealth Tariff Act came into operation, which distinguished between cane and sugar produced by white and by coloured labour in respect of liability to excise duty. Sugar made from cane grown by white labour receives a rebate of two-thirds of the excise, or £2 per ton.

According to the Customs Returning Officers, rebates of excise upon sugar grown by white labour in 1902 amounted to £24,509 8s. 11d.

Rebates of Excise Paid in the Four Districts.

Rebate Districts.	Per Ton of Cane.	Weight of Cane Receiving Rebates.	Rebates Paid.
	s. d.	Tons.	£ s. d.
(1) Northern, or Cairns	5 0	17,094$\frac{17}{20}$	4,273 13 5
(2) Central, or Mackay	4 8	70,039$\frac{19}{20}$	16,345 3 7
(3) Southern, or Bundaberg	4 4	13,729$\frac{19}{20}$	2,973 18 1
(4) Sub-southern, or Logan	4 0	4,579	916 13 10
Totals		105,443$\frac{17}{20}$	24,509 8 11

The cane receiving rebates of excise was 16·5 per cent. of the total cane crushed in 1902.

The returns made to the Registrar-General of Queensland, showing "areas cultivated," indicate a reduction of area under cane in 1902. Those returns do not denote a permanent contraction, but rather some areas were killed out, and others could not be planted, during that year, due to the acute drought. The crop of 1903, which is at this time being delivered at the mills, will show a considerable increase upon the crop of 1902; while the weather conditions of this year, so far, are laying the basis of a notably larger crop in 1904 if the present indications should be maintained.

The Relation of the Sugar Industry to the State.

In order to assess the worth and significance of the industry to the State, it is necessary to estimate the aggregate value of the sugar crop, and to determine its place as an article of export compared with the exports of other agricultural crops and with the net exports of all articles of consumption.

Estimated Value of the Sugar Crop, 1902.

Exported sugar and molasses	£946,629
Home consumption...	338,870
Uncrushed cane	210,000
Cane feed, molasses, and distillery products	110,000
	£1,605,499

Reserve stocks of sugar are not included in these figures, and the "cane feed" and other secondary or waste products which constitute almost the exclusive feedstuffs on farms and plantations, are put at common values, and not on the basis of value current during drought conditions.

(1) Export value of the sugar crop in relation to the value of other exports of crops and produce, including dairy products:—

Crops—1902.	Imports.	Exports.	Balance of Imports.	Balance of Exports.
	£	£	£	£
Grain, fruit, vegetables, and sundry	1,865,313	147,694	1,717,619	...
Dairy products	205,510	28,358	177,152	...
Sugar and molasses	2,326	948,955	...	946,629

(2) Exports of sugar in relation to the net exports of meats, extracts, cattle, sheep, pigs, crops, and all edible produce:—

	Net Exports.
Meat and extracts	£1,482,999
Cattle, sheep, pigs	135,670
Crops and other edible produce...	97,960
Sugar and molasses	946,629
	£2,663,258

By means of the preceding brief review it is shown—

(1) That of all crops of the State, including dairy products, sugar commanded the whole net export value, or ... ... 100 per cent.

(2) That the exports of sugar, as part of the net exports of meats, extracts, cattle, sheep, pigs, and all other edible produce of the State, amount to 35·5 per cent.

These figures set forth the value of the sugar crop as an asset, and as one of the chief guarantees of the present credit and financial capacity of the State. Since the consideration of this matter a year ago, the proportion of burden has increased that the sugar industry is required to bear, and after a careful examination of the situation it is apparent that the burden will not be less within the next immediate years. The pastoral interests are beginning to recover from the state of disaster made known by the returns of cattle and sheep on 31st December of last year, yet some years must be necessary for the industry to recover its position, and to enable it to resume the measure of aid which it has formerly given to the national support. Concerning the several branches of the agricultural industry, it is very urgent that care shall be used in forming an estimate in average of the help which may reliably be expected from grain crops, from dairy produce, and from other products of the farm. The wheat crop of this year promises to be an actual providence following upon the failure of 1902. These extremes, found in two consecutive years, show, however, that only an average of years must be considered, and the returns of the six seasons from 1897 to 1902 stated that the production was 853,866 bushels, against a consumption of 2,905,216 bushels. The dairy industry has made a notable expansion during the course of recent years; yet when the production of the year 1902 is compared with that of the preceding year, it is seen that dairying is specially liable to disaster in seasons of drought. In 1901 there were *net exports* of butter from Queensland aggregating £88,283; and last year the State paid for a balance of imported butter the sum of £177,152. In the matter of fruit production, the imports in 1902, to meet the country's requirements, rose to £186,521. All of these several branches of agricultural production can be placed upon a surer basis, and are capable of a greater and more uniform expansion. It is the present condition, however, which determines their immediate and relative value to the State. When the sugar crop, in view of its direct export or cash value, is compared with other agricultural crops, its present significance is unquestionable and vast. At all times the sugar industry is the first consideration to the people and communities who depend upon it. At this time its maintenance and success are a vital necessity to the State.

FINANCIAL.

The statement following sets forth the mills at which cane was received for manufacture, the tons of cane crushed, and the assessments payable and received, which statement has been approved by an inspector from the Audit Department :—

CANE CRUSHED AND ASSESSMENTS PAYABLE THEREON, AT THE RATE OF ONE PENNY PER TON, FOR THE YEAR 1902.

Name of Mill.	Cane Crushed. Tons.	Assessment Payable. £ s. d.
Ashgrove ...	580 ...	2 8 4
Alberton ...	182 ...	0 15 2
Bellevue ...	96 ...	0 8 0
Bingera ...	17,616 ...	73 8 0
Bonna ...	1,474 ...	6 2 10
Fairymead ...	12,276 ...	51 3 0
Gin Gin Central ...	2,193 ...	9 2 9
Goodwood ...	520 ...	2 3 4
Goondi ...	62,451 ...	260 4 3
Hambledon ...	55,946 ...	233 2 2
Homebush ...	29,578 ...	123 4 10
Habana ...	11,593 ...	48 6 1
Invicta ...	1,180 ...	4 18 4
Isis Central ...	2,540 ...	10 11 8
Kalamia ...	18,963 ...	79 0 3
Knockroe ...	9,095 ...	37 17 11
Macknade ...	60,313 ...	251 6 1
Marian Central ...	15,184 ...	63 5 4
Meadowlands ...	5,197 ...	21 13 1
Miara ...	922 ...	3 16 10
Moreton Central ...	2,895 ...	12 1 3
Mossman Central ...	52,756 ...	219 16 4
Mount Bauple Central	1,335 ...	5 11 3
Mourilyan ...	14,716 ...	61 6 4
Mulgrave Central ...	44,851 ...	186 17 7
Nerang Central ...	236 ...	0 19 8
North Eton Central ...	10,858 ...	45 4 10
Palms ...	18,883 ...	78 13 7
Palmyra ...	3,846 ...	16 0 6
Pioneer ...	31,034 ...	129 6 2
Plane Creek Central ...	18,132 ...	75 11 0
Pleystowe Central ...	18,484 ...	77 0 4
Proserpine Central ...	17,850 ...	74 7 5
Qunaba ...	4,237 ...	17 13 1
Racecourse Central ...	15,350 ...	63 19 2
Ripple Creek ...	20,507 ...	85 8 11
Rocky ...	1,402 ...	5 16 9
Steiglitz ...	671 ...	2 15 11
Sunnyside ...	1,215 ...	5 1 3
Tegege ...	716 ...	2 19 8
Victoria ...	44,663 ...	186 1 11
Waterloo ...	192 ...	0 16 0
Waterview ...	5,464 ...	22 15 4
Windermere ...	2,934 ...	12 4 6
Totals ...	641,126 ...	£2,671 7 2
Arrears of 1901—		
Tegege Mill ...	529 ..	2 4 1
Bellevue Mill ...	744 ...	3 2 0
	642,399	£2,676 13 3

The total assessment due upon the crop of 1902, plus arrears for 1901, is £2,676 13s. 3d. The actual amount of assessments collected is £2,670 19s. 5d., leaving a balance of £5 13s. 10d. As there are some minor adjustments required, due to certain small over and under payments, upon the recommendation of the auditing inspector, the small balance is carried to next year's account. The income of the Sugar Bureau for the fiscal year ending 30th June, 1903, was as follows :—

	£	s.	d.
Assessments received on cane crushed	2,670	19	5
Endowment from Consolidated Revenue	2,670	19	5
Sugar-cane sold	15	4	0
Sale of pumpkins and turnips	5	10	6
Sale of old harrows	2	10	0
Sale of old timber	0	10	0
Fees for analysis of manures	4	4	0
	£5,369	17	4

STATEMENT OF EXPENDITURE FOR THE YEAR ENDING 30TH JUNE, 1903.

	£	s.	d.
Salaries	4,206	11	4
Wages	449	1	0
Travelling expenses—Dr. W. Maxwell	329	14	0
„ „ R. W. McCulloch	120	2	0
„ „ A. E. Anderssen...	56	5	0
„ „ Hy. Tryon	19	5	3
„ „ Others	9	1	7
Freights, passages, &c.	185	13	5
Horse and buggy hire, &c.	104	11	9
Chemicals, apparatus, &c.	390	10	11
Stamps, petty cash, and stationery	108	2	5
Heating gas	70	6	0
Manures	76	18	7
Printing and advertising	54	4	7
Tools, implements, &c.	33	12	0
Library	22	11	2
Repairs (carpenter, blacksmith, &c., and harness)	28	4	5
Expenses, Burdekin trip and irrigation meeting	26	16	9
Water service	19	15	0
Furniture	13	10	7
Fencing material	10	14	3
Washing and making towels, &c.	10	10	3
Exchange on cheques, &c.	10	8	11
Fuel	7	15	0
Cane plants and other seed	6	4	5
Irrigation, Mackay (Erection tank, £73 8s. 5d.; sundry, £31 18s. 11d.)	105	7	4
Sundries	65	14	5
	£6,541	12	4
Total expenditures, 1902-3	6,541	12	4
Total receipts, 1902-3	5,369	17	4
	£1,171	15	0

The excess of expenditures over receipts is due to drought and the small crop harvested.

The original estimate of expenditure of the Bureau of Experiment Stations was £8,000. The actual expenditure for 1902-3 was £6,541 12s. 4d., or £1,458 7s. 8d. less than the estimate.

The item for "manures" includes fertilisers used at the Mackay Experiment Station and upon nine sub-stations.

In the closing paragraph of last year's report it is stated that £115 is due and payable by the Commonwealth Government for extra expenditures incurred by the Director of the Sugar Bureau in connection with Federal sugar legislation. That amount was refunded by the Federal Treasurer to the Sugar Bureau in October of this year.

Price 10*d*.]

By Authority: GEORGE ARTHUR VAUGHAN, Government Printer, William street, Brisbane.