CLIMATIC CONDITIONS IN THE NATAL SUGAR BELT AS INDICATED BY RECORDS TAKEN AT MOUNT EDGECOMBE

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GENERAL REMARKS.

The Experiment Station is the only point on the coast of Natal and Zululand at which detailed records of weather conditions are taken. Since, however, the Experiment Station is situated in a central position, these records may be assumed to be fairly representative of the 250 miles of coast lands under sugar cane. Systematic records were commenced here in 1928, in which year apparatus specified by the Union Meteorological Office was obtained, and regularly since then monthly reports on weather conditions have been prepared and published.

A study of the prevailing climate does reveal many interesting facts, and though perhaps we ourselves may be inclined to give little attention to this subject at present it must be remembered that an accurate knowledge of our prevailing climatic conditions may be of interest in any future agricultural or industrial enterprise.

It will be observed from these records that the climate of the Natal sugar belt is on the whole very mild compared with the tropical cane growing countries. We do find fairly wide fluctuations in temperature, and our summer weather is often sultry, but rarely if ever intensely so.

It may be noted in passing that 1935 has been an exceptional year from a climatic point of view. The mean annual temperature was 1.6° F. below that of the previous seven years, and in the case of January, February, May, June, August, November and December the mean temperatures are the lowest on record for those months. During the year several severe hailstorms occurred. Of particular interest was the hailstorm which broke over Mount Edgecombe on the 31st October, as this approached from a north-easterly direction. Only on extremely rare occasions do storms approach from this direction. The so called rainy "quarter" extends from west to east via south, but practically all our rains come from a SSW point.

RAINFALL.

Owing to the co-operation of many planters it has been possible to obtain rainfall returns from some twenty nine centres. These figures summarised over twelve years show our annual rainfall to be 41.19 ins. *(see Table I.) This is below the average fall of most other cane growing countries and insufficient for the needs of a vigorous crop such as sugar cane. Furthermore, the distribution of our rainfall is so erratic that the successful planting of cane is often impeded. Drought conditions frequently prevail during the actively growing period (October to March), and cane planters often have to replant large spaces of their fields.

Table I. is appended below and shows the annual distribution of rainfall from Umzumbi to Umfolozi, near the southern and northern limits respectively of the sugar belt.

Of particular interest are the high rainfall returns of the Mtunzini—Umhlatuzi area in Zululand, where forest lands have been established.

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*Only 4-5 per cent. of the area of the Union of South Africa experiences a rainfall of 40 ins. and over.

TABLE I.*

A COMPARISON OF RAINFALL RETURNS FROM 29 DIFFERENT CENTRES THROUGHOUT THE SUGAR BELT OF NATAL AND ZULULAND.

	1924.	1925.	1926.	1927.	1928.	1929.	1930.	1931.	1932.	1933.	1934.	1935.	Average.
Umzumbi (30° 40′ Lat.) ..	26.37	40.54	34.99	37.31	25.18	56.28	34.95	40.31	42.04	36.35	37.50	43.66	37.96
Esperanza	30.09	43.81	28.34	43.11	27.58	57.47	42.10	36.13	38.36	32.81	46.13	43.70	39.14
Park Rynie	32.32	46.38	27.70	44.64	36.94	58.84	39.25	38.94	44.14	37.71	46.53	47.89	41.77
Renishaw	30.66	40.54	28.13	43.54	36.08	58.24	37.22	31.86	41.56	34.43	42.17	42.69	38.93
Illovo	28.92	47.41	27.70	32.94	27.85	49.22	38.12	31.54	36.89	26.94	41.00	39.03	35.63
Umbogintwini	36.13	50.18	31.73	34.65	33.41	47.88	42.10	32.42	39.67	36.43	45.59	52.87	40.26
Durban, Point	40.89	53.16	31.48	47.62	36.54	59.97	38.92	43.68	49.45	34.42	47.45	60.93	45.38
Durban, Berea..	34.82	44.93	26.16	37.52	34.62	46.87	38.93	31.51	44.74	31.61	42.28	58.08	49.34
Mt. Edgecombe (29° 40′ Lat.)	30.11	44.75	25.89	40.63	30.88	47.04	34.52	32.98	43.51	30.94	40.03	57.41	38.22
La Mercy	33.07	48.84	25.68	35.56	27.04	53.37	36.40	29.26	56.65	31.16	37.64	56.27	39.24
Tongaat	39.36	52.61	27.92	35.74	30.87	50.55	34.26	29.88	48.79	26.59	38.44	47.54	38.54
Sinembe	37.93	55.93	27.52	35.45	32.42	49.78	37.02	30.36	52.71	38.64	49.99	41.48	40.77
Umhlali	41.84	51.32	30.28	34.72	29.31	50.38	40.07	29.09	49.85	35.13	41.20	53.61	40.57
Chakas Kraal	32.38	45.33	26.99	31.89	29.88	42.78	33.06	22.25	43.05	30.14	35.09	43.38	34.69
Riet Valley	37.81	60.09	29.50	38.13	34.88	50.07	35.65	25.38	54.64	37.98	47.70	44.33	41.35
Tinley Manor	39.50	55.46	30.33	32.13	33.61	51.36	33.22	30.97	47.44	35.44	41.20	50.97	40.14
Kearsney..	44.72	63.32	37.79	45.25	33.55	49.20	43.36	26.31	55.49	37.45	53.57	38.42	44.04
Darnall	37.66	60.71	33.13	41.69	25.60	42.38	40.63	24.31	52.27	29.22	48.24	40.23	39.67
Sitebe Halt	38.60	63.18	32.42	39.10	25.66	42.05	40.41	24.40	51.27	28.10	53.33	42.57	40.09
Amatikulu	30.98	60.64	40.88	33.21	30.98	42.23	40.80	21.09	47.16	29.86	47.66	43.41	39.07
Gingindhlovu (29° 00′ Lat.) .	35.41	72.17	36.25	36.64	35.08	42.42	47.72	24.60	53.85	33.08	50.91	53.16	43.44
Eshowe	51.70	91.81	43.53	48.33	37.99	49.97	44.26	30.36	65.05	46.88	71.85	46.18	52.32
Mtunzini	53.87	79.15	44.23	40.93	39.01	52.57	48.99	32.92	61.97	40.03	59.28	53.02	50.50
Felixton	55.37	88.23	40.48	49.30	42.20	59.39	44.57	38.03	69.08	31.43	58.82	50.16	52.25
Empangeni	44.28	70.45	33.13	37.81	32.14	48.95	33.80	31.98	55.34	29.55	48.72	38.18	42.03
Kulu Halt (28° 40′ Lat.) ..	43.21	79.83	40.03	34.77	29.65	51.94	37.44	25.96	66.55	30.15	48.26	35.03	43.57
Mposa	37.46	75.42	35.56	32.12	28.91	45.80	37.83	24.29	59.33	25.43	46.45	29.59	39.85
Eteza	42.46	93.88	32.90	34.33	27.71	41.27	36.86	31.27	59.48	29.85	44.05	25.73	41.65
Umfolozi (28° 25′ Lat.) ..	29.91	84.44	22.55	26.82	24.90	34.53	27.99	22.38	51.19	25.04	37.34	21.44	34.04
	37.86	60.84	32.18	38.13	31.74	49.41	38.64	30.15	51.09	32.85	46.50	44.86	41.19

* Many of the monthly returns used in preparing this table were taken from the pages of the South African Sugar Journal.

The annual distribution of the rainfall is a further point to be considered, and Table II. was accordingly prepared to show this distribution.

From these records conditions would appear very favourable to growth, but if the figures were examined yearly it would be found that while some

TABLE II.

AVERAGE MONTHLY RAINFALL IN INCHES FROM 17 CENTRES.

	1924.	1925.	1926.	1927.	1928.	1929.	1930.	1931.	1932.	1933.	1934.	1935.	Average.
January.. ..	4.39	5.41	2.12	3.32	5.62	5.84	8.16	3.88	4.78	3.81	7.41	4.44	4.93
February ..	4.45	5.92	3.89	4.99	4.62	3.14	2.04	2.30	13.81	2.87	5.27	4.06	4.78
March	2.62	24.83	6.40	11.95	2.72	10.87	2.91	4.39	5.70	3.30	4.63	4.32	7.05
April	2.19	2.12	0.81	0.57	2.19	1.98	1.96	2.16	6.40	1.86	5.03	1.68	2.41
May	1.38	3.55	0.68	1.77	1.99	1.20	0.99	0.64	5.30	0.97	2.96	6.24	2.31
June	1.00	0.41	2.50	0.32	0.40	5.36	1.68	0.66	0.82	0.41	1.76	12.82	2.34
July	0.38	2.32	0.40	1.52	0.51	2.75	1.61	2.77	0.25	1.48	3.05	1.06	1.51
August	1.46	0.35	0.54	1.74	1.39	1.63	3.15	0.37	0.72	0.68	2.61	3.24	1.49
September ..	4.21	5.20	2.63	1.38	1.72	4.55	4.21	1.88	1.70	1.38	0.91	0.80	2.55
October.. ..	2.96	3.82	4.62	3.39	2.92	4.74	2.99	2.14	4.19	2.36	1.79	2.19	3.18
November ..	6.77	3.18	3.66	2.03	2.82	4.04	4.68	2.44	3.74	6.36	3.30	1.64	3.72
December ..	6.36	2.23	3.80	5.13	3.90	2.04	4.77	4.94	4.91	6.51	7.16	3.00	4.56

It is noticed from these figures, which are very representative and which extend over a period of twelve years, that on an average the heaviest rainfall occurs in March and the lowest in August. This is illustrated in Fig. 1.

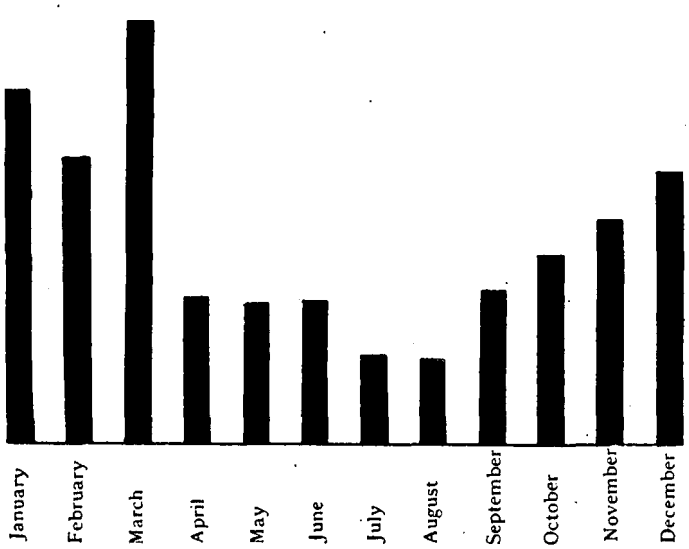


Fig. 1.

years had been more than favourable others had been very dry. Actually during the 1933 cutting season over 1½ per cent. of the cane received at the mills tested below the rejection points on the Fahey Conference Agreement scale, owing to the fact that during the first ten months of the year only 15.63 ins. of rain fell.

It has frequently been remarked that the calendar year's fall does not satisfactorily portray the whole rain cycle or correspond with our crop year. In view of this Table III. was drawn up for purposes of comparison.

In this table the climatic year 1925, to take an example, consists of the rainfall from July 1924—June 1925. This rearrangement, however, does not appear to be particularly instructive.

The highest rainfall on record for any one year is 93.88 ins. at Eteza in 1925, and the lowest 11.34 ins. at Hluhluwe in 1935, though this latter centre can barely be considered within the sugar belt. There have been several occasions on which no rain fell during the month. This was particularly the case in June 1927 and June 1928. The highest fall for

TABLE III.

	1925.	1926.	1927.	1928.	1929.	1930.	1931.	1932.	1933.	1934.	1935.
Calendar year (January—December)..	59.34	32.05	38.11	30.80	48.14	39.15	28.57	52.32	31.99	45.88	45.49
Climatic year (July—June)	64.38	33.50	38.57	32.73	41.65	37.49	35.44	51.35	28.73	45.83	52.38

any twenty four hours at the Experiment Station was 10.41 ins. on June 12th, 1935.

An apparatus for recording evaporation from an open air surface was installed at the Experiment Station in August, 1935. Records for the six months have now shown the evaporation to total 28.77 ins. We can from this compute that the annual evaporation will be in the neighbourhood of 60 ins., which is considerably in excess of the rainfall. It is considered by some authorities that if the evaporation from a free water surface is in excess of rainfall then drought conditions are indicated. Hence the degree of evaporation, which is influenced by such factors as atmospheric temperature, wind, relative humidity and sunshine, is a very important feature of the climate. Evaporation from a free water surface is described as being roughly equivalent to that from a continually wet soil surface. It would be of great benefit to this study if more evaporation tanks could be installed at one or two points along the coast and records sent to the Experiment Station each month.

TEMPERATURES.

Temperature is next to rainfall the most important factor in the climate of a country. The sugar industry of Natal and Zululand lying as it does outside the tropics is far less suitable for cane cultivation than most other sugar growing countries.

In Table IV. it will be observed that no other cane producing country excepting Louisiana (which is as far north of the tropics as we are south) experiences throughout such a low mean temperature as we do. In the tropics, furthermore, the monthly variations in mean temperatures are not excessive. In Natal the variation in mean temperature between the seasons is fairly considerable. The mean variation over eight years between the coldest month (July) and the warmest (February) was 12.3° F. The maximum difference between the warmest and the coolest month for any one year was 16.2° in 1931. The highest daily shade temperature on record was 104° on January 15th, 1932, and the lowest 41° on July 9th, 1934. Fig. 2 shows the mean monthly shade temperatures over eight years. The mean annual shade temperature over eight years was 68.2°.

The lowest grass temperature was 37.5° on May 27th, 1935. As this thermometer is located on a hillside the readings may be taken as fairly representative. Damage from frosts in the sugar belt is practically nil, though in some years it has been noticeable in low-lying areas.

Solar temperatures are recorded with a black bulb thermometer in vacuo. Though such thermometers are well known to be not concordant, it was nevertheless decided to take these records as the readings would be at least of comparative interest. The figures show that the mean annual temperature in the sun's rays was 129.8°, varying in monthly averages from 110.8° in June, to 133.2° in February. The highest temperature for any one day was 149° on January 19th, 1935. Like the shade temperature the solar radiation temperature falls in an even curve to mid-winter, rising again steadily to November.

Earth temperatures are taken at 1 foot, 2 foot and 4 foot depths, the thermometers being embedded in a clay-loam soil. Fig. 3 shows the relationship between the air temperature and the temperature of the ground. In this fig. the curves from top to bottom, as over the line of July, represent the 4 foot, 2 foot and 1 foot thermometers respectively. The continuous line represents the mean shade temperature. The abnormally cold spell of August 1935 was noticeable in all the thermometers.

Since several days are required for heat to move down four feet into the ground, a lagging effect, (which is observable in the graph) is to be expected. It is of passing interest to note that at a depth of 30-40 feet the temperature of the ground is said to be equal to that of the mean air temperature.

WINDS.

Two winds generally prevail along the coast of Natal and Zululand, namely the one blowing NNE by ENE and the other SSW by SW. These are referred to as north easterly and south westerly winds. Quite frequently SSE by ESE breezes blow from the sea during the day, but these never attain to any strength. The early morning land breezes which occur during the winter months from April to August, are very regular though they rarely

TABLE IV.

COMPARISON OF NATAL RAINFALL AND TEMPERATURE WITH THAT OF OTHER SUGAR GROWING COUNTRIES.

COUNTRY	Natal	Queensland.	Mauritius.	Peru.	British Guiana.	Java.	Philippine Islands.	Trinidad.
Latitude	28°–30½° S.	10°–28° S.	20° S.	5°–23° S.	2°–8° N.	6°–8° N.	5°–18° N.	10° N.
Annual rainfall in inches	41	40–150	79	10 (irrigated)	80	73–175	74	80
Mean annual temperature in °F. ..	68.2°	65°–85°	79°	52°–95°	80°	79°	77°–83°	70°–87°

COUNTRY	India.	Cuba.	Jamaica.	Puerto Rico.	Barbados.	Santo Domingo.	Hawaii.	Louisiana.
Latitude	10°–20° N.	10°–23° N.	10°–23° N.	10°–23° N.	13° N.	17°–20° N.	19°–23° N.	29°–31° N.
Annual rainfall in inches	20–150	54	70	65	60	120	12–300	67–95
Mean annual temperature in °F. ..	76°–80°	76°	71°–88°	79°	70°–86°	79°	72°–74°	68°

continue later than 10 a.m. These latter breezes blow from a direction almost due west and reach their maximum frequency in June. This is illustrated in Table V.

a barometer gently fluctuating at the mean level. It is only the north easterly and south westerly winds which appreciably affect the pressure of the atmosphere, the mercury showing only a very slight

TABLE V.

8.30 a.m. WIND STATISTICS OVER EIGHT YEARS.

1928—1935.	% winds blowing north-easterly.	% winds blowing south-westerly.	% winds blowing westerly.	Average number of windy mornings per month.
January	44.9	55.1	—	27.0
February	47.2	52.8	—	22.5
March	43.5	52.1	4.3	23.0
April	27.0	50.0	22.9	18.5
May	25.0	36.2	38.8	19.0
June	11.6	34.7	53.7	21.6
July	19.5	44.3	36.2	18.6
August	34.1	42.8	23.1	21.6
September	44.0	56.0	—	23.8
October	41.8	58.2	—	26.6
November	44.0	56.0	—	27.2
December	45.2	54.0	—	27.1
Mean	35.7	49.4	14.9	23.0

Very occasionally a wind will blow from a north westerly direction. Such winds, which are by no means limited to any month of the year, are usually very hot and dry. Temperatures rise rapidly and the relative humidity falls to some very low figure. The lowest percentage of relative humidity recorded at the Experiment Station was 15 per cent., as calculated from the wet and dry bulb thermometers, while the hair hygrograph showed 6 per cent. This occurred on the evening of October 12th, 1933, when a hot north westerly wind blew for five hours.

It is not usual for one of the two prevailing winds to blow continuously for more than two to three days. An exception to this occurred in July, 1932, when the south westerly wind blew strongly without a break for over five days.

The north easterly winds are almost invariably associated with a falling barometer, while the converse holds for the south westerly winds. The barometer falls steadily with a north easterly wind until a sudden change to south west occurs and it commences to rise rapidly. The total range it covers during such a cycle will amount, as on August 28th-31st, 1933, to as much as 1 inch of mercury or 33.86 millibars. The brief lull which occurs at the time of change is associated with a sharp upward rise of the barometer. A strong south westerly wind inevitably accompanies such a change and clouds are blown up. Rain does not always immediately accompany such changes, however, and even when it does so, rarely amounts to much. Most of our heavy rains have fallen with fall with the south easterly breezes, and no visible change at all with those from the west.

Table V. above summarises observations of winds made at 8.30 a.m. over a period of eight years. Strictly speaking such observations cannot be expected to give any idea of the velocity of the winds, such winds usually reaching their maximum velocity on the coast shortly after midday. For this reason it was decided to take wind records at 1 p.m. The figures in Table VI. summarise such observations taken over a period of three years.

Referring again to Table V. it will be noticed that the north easterly breezes diminish gradually at the expense of the westerly breezes in winter. Thus in June, 53.7 per cent. of the breezes recorded blew from the west. The effect of these characteristic winter land breezes is very clearly illustrated in Fig. 4, where the thick line shows the total windy days per month, and the dotted line represents the windy days per month had these westerly breezes not prevailed. It would seem thus, that if it were not for the influx of these winter land breezes the total frequency of the morning winds from the two cardinal points (north easterly and south westerly) would decrease in winter and increase in summer in the regular manner shown by the dotted line of the graph.

To continue, it is to be noted from Tables V. and VI. that the frequency of south westerly winds prevailing over north easterly winds is roughly about 15 per cent. In other words, if the wind blows seven days from north easterly points we

TABLE VI.

1 p.m. WIND STATISTICS OVER THREE YEARS.

1933-1935.	North-Easterly Winds.		South-Westerly Winds.		South-Easterly Winds.		Average number of windy days per month.	Monthly velocity in miles per hour of all winds.
	Average number of windy days.	Average velocity in miles per hour.	Average number of windy days.	Average velocity in miles per hour.	Average number of windy days.	Average velocity in miles per hour.		
January	11.7	6.4	14.3	6.0	3.0	0.7	29.0	13.1
February	10.7	6.9	12.0	6.7	2.3	0.9	25.0	14.5
March	9.7	4.2	13.0	5.7	4.3	1.3	27.0	11.2
April	10.3	5.2	15.0	6.4	3.0	0.8	28.3	12.4
May	8.0	2.4	11.4	4.7	4.3	1.4	23.7	8.5
June	5.3	2.1	14.3	4.5	4.0	0.9	23.6	7.5
July	7.7	3.3	13.0	4.9	5.3	1.1	26.0	9.3
August	10.7	5.7	13.7	7.2	4.0	0.8	28.3	13.7
September	12.0	6.9	13.7	6.2	4.3	1.5	30.0	14.6
October	10.3	6.0	14.7	7.5	3.7	1.1	28.7	14.6
November	10.0	6.2	15.3	6.8	3.0	1.0	28.3	14.0
December	9.3	5.4	16.0	7.9	2.3	0.8	27.6	14.1
Mean	9.6	5.1	13.9	6.2	3.6	1.0	27.1	12.3

can imagine it retaliating by blowing ten days from south westerly points.

Table VI. also shows the distribution of wind velocities over the year. September, October and February are the windiest months, while June is the calmest. In September we can expect most wind from the north easterly angle, while in December the south westerly winds preponderate. During July, 1933, we were able to record the daily average velocity of the wind with a cup anemometer. This amounted to 4.39 m.p.h., whereas the amount calculated (as in the preparation of Table VI.), from the daily Beaufort figures was 4.2 m.p.h. On such grounds as this we can tentatively assume that the 1 p.m. wind velocities approximately indicate the average daily velocity of the wind.

On the coastal belt, winds are usually mild, and only on rare occasions do they attain to strong gale force (50 m.p.h.), and then only briefly. Trees are sometimes blown down, but structural damage is not often reported.

SUNSHINE.

A glance at Appendix II. shows the variation in hours of sunshine which occurs month by month throughout the year. May experiences the greatest amount of sunshine, though indeed there is very little to choose between this month and April, June, July and August. During November the sun shines only 40.3 per cent. of the hours of daylight. In November, 1933, the total hours of sunshine amounted to only 31.6 per cent. of the hours of daylight and is the lowest on record. The highest was in July, 1928, when the hours of sunshine amounted to 81.7 per cent. of the hours of daylight.

Sunshine, in addition to light, is known to play an important role in plant growth, but the hours of sunshine on the coast are only 55.3 per cent. of the total hours of daylight, or 28 per cent. of the year. In other words, a cane plant which is left to grow twenty months would benefit by a period of sunshine equivalent only to five months. During its actively growing period which extends from October to March, the percentage of sunshine over the total is 9.4 lower than during the comparatively dormant winter months.

In view of the recognised effect of sunlight upon plant metabolism it occurred to the writer that some correlation might be found between the extent of annual sunshine and the sucrose content of the cane. The result of plotting hours of sunshine and sucrose per cent. cane for each year (Fig. 5), revealed a surprisingly close relationship. The upper line represents the average sucrose per cent. cane from all the factories, while the lower represents the total hours of sunshine at Mount Edgecombe. The abnormal drop in sucrose per cent. cane during the 1934 season is largely attributable to locust infestation.

This paper is the first step towards a systematic study of our coastal climate. The importance of such a study and the role it plays in helping us to understand the natural forces around us need not be emphasised. Even though as some may remark

we shall not be in any better position to alter these conditions, we shall at least be in a position to define them better.

The present study, however, is not very comprehensive, there being many other factors which would still require observation. Our study of the winds for example is limited only to the surface currents, and furthermore we work in complete ignorance of the large scale weather cycles which are responsible for the disturbances of our atmosphere. But climatology as a complete science is beyond both our scope and our means, and we shall have to be content at this stage with only the limited survey this paper is able to present.

Experiment Station,
South African Sugar Association,
Mount Edgecombe,
Natal.
March, 1936.

FIG. II.

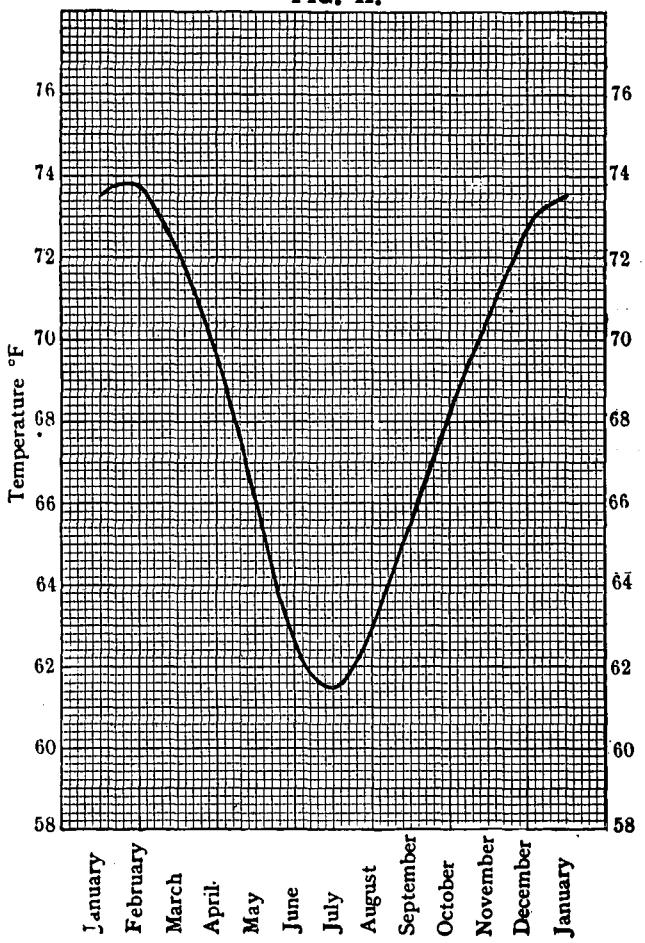


FIG. III.

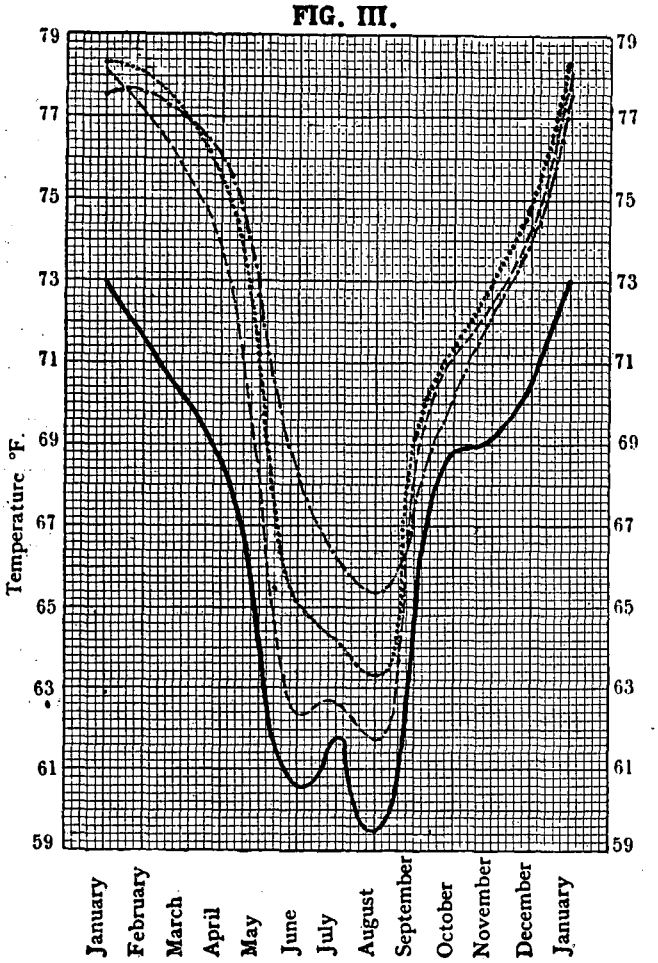


FIG. IV.

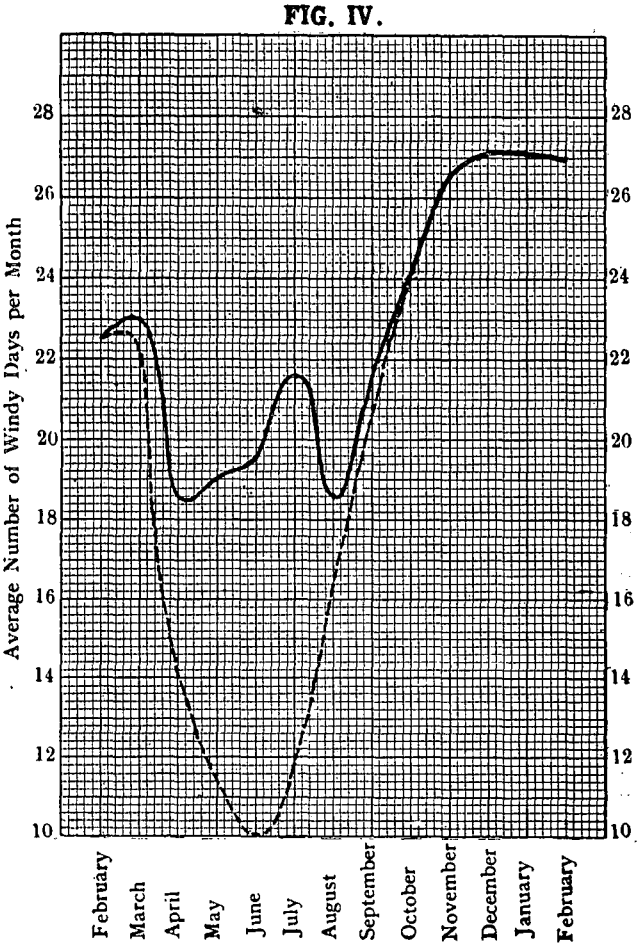
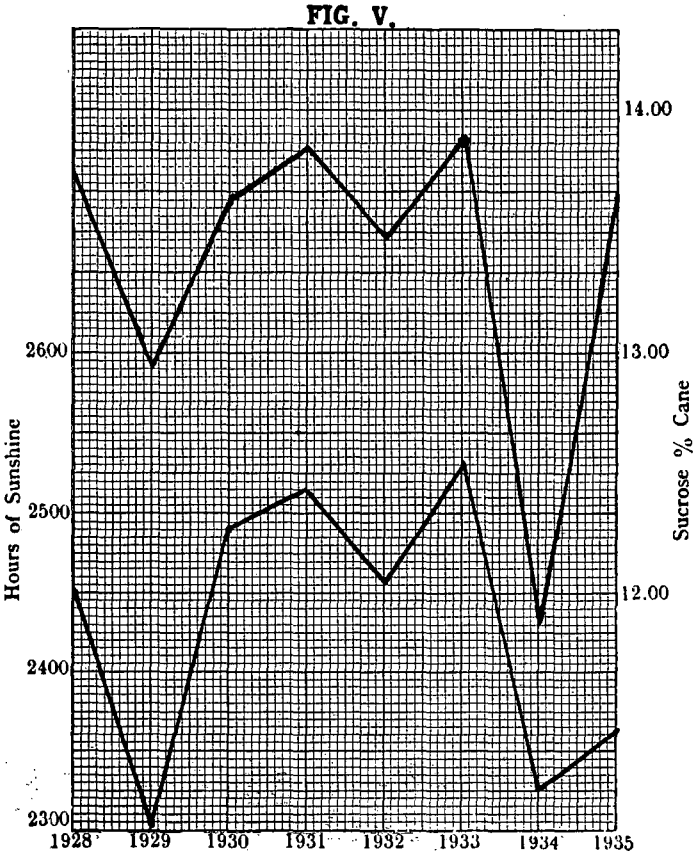


FIG. V.



APPENDIX I.

SUMMARY OF WEATHER CONDITIONS 1928-1935.

YEAR	1928.	1929.	1930.	1931.	1932.	1933.	1934.	1935.	Averages.
Rainfall in inches	27.56	43.83	30.03	28.01	41.36	27.14	39.42	53.25	36.32
Number of rain days	114	129	123	112	126	109	127	111	118.9
Highest fall in 24 hours in inches	2.25	3.24	2.18	2.05	3.87	2.00	2.83	10.41	10.41
Date	Nov. 22	July 9	Mar. 7	July 14	Feb. 21	Nov. 23	Dec. 6	June 12	June 12, '35
Per cent. of normal (37.03")*	69.5	110.3	75.4	74.6	110.7	72.4	107.6	145.1	98.1
% Relative humidity at 8.30 a.m.	75.0	74.2	71.7	71.7	74.2	71.6	75.5	73.1	73.4
% Relative humidity at 1 p.m.	—	67.2	62.1	61.3	63.2	61.3	63.4	62.7	63.0
Total hours sunshine	2,453.0	2,304.3	2,492.3	2,513.2	2,458.1	2,478.9	2,325.1	2,359.8	2,423.1
Per cent. of daylight	56.0	52.6	56.9	57.3	56.1	56.6	53.0	53.8	55.3
% of sky covered by clouds at 8.30 a.m.	42	47	47	47	47	43	47	45	45.6
Mean true atmospheric pressure in inches at 295 feet	29.76	29.76	29.78	29.77	29.76	29.75	29.77	29.78	29.77
Highest	30.34	30.37	30.31	30.26	30.23	30.28	30.34	30.39	30.39
Lowest	29.20	29.14	29.13	29.24	29.20	29.12	29.20	29.20	29.12
Mean earth temperature at 1 foot	—	—	—	—	—	—	—	70.4	—
Mean earth temperature at 2 feet	—	—	—	—	—	—	—	71.6	—
Mean earth temperature at 4 feet	—	—	—	—	—	—	—	72.6	—
Mean solar maximum temperature	—	—	—	—	—	—	—	124.1	—
Highest	—	—	—	—	—	—	—	149.0	—
Mean grass minimum temperature	—	—	—	—	—	—	—	53.5	—
Lowest	—	—	—	—	—	—	—	37.5	—
Mean screen maximum temperature	76.2	75.1	76.5	77.5	77.8	77.4	77.0	75.0	76.6
Highest	95.0	100.5	98.0	95.0	104.0	99.5	91.0	96.0	104.0
Lowest	60.0	60.0	59.0	60.5	60.0	62.0	60.0	58.0	58.0
Mean screen minimum temperature	59.3	59.9	59.1	60.1	60.4	60.4	60.8	58.7	59.8
Highest	73.5	72.5	75.0	75.5	73.5	74.0	72.5	72.0	75.5
Lowest	43.0	46.5	43.5	42.0	43.5	45.5	41.0	44.0	41.0
Mean screen temperature	67.8	67.5	67.8	68.8	69.2	68.9	68.9	66.8	68.2

* The normal rainfall is derived from figures taken at Natal Estates, Ltd., Mount Edgecombe, over the past 44 years.

APPENDIX II.

SUMMARY OF WEATHER CONDITIONS 1928-1935.

MONTH	JAN.	FEB.	MARCH.	APRIL.	MAY.	JUNE.	JULY.	AUG.	SEPT.	OCT.	NOV.	DEC.
Rainfall in inches	4.59	3.67	4.47	2.30	2.35	3.09	2.00	1.47	2.16	2.63	3.09	4.50
Number of rain days	14.6	12.8	12.0	9.0	5.6	5.0	5.4	5.5	8.2	12.4	13.6	14.8
Highest fall in inches	2.56	3.87	2.18	2.25	3.75	10.41	3.24	2.11	2.06	1.26	2.25	2.83
Date	14th,'35	21st,'32	7th,'30	4th,'34	12th,'35	12th,'35	9th,'29	5th,'30	15th,'29	28th,'32	22nd,'28	6th,'34
Total from January 1st in inches	4.59	8.26	12.73	15.03	17.38	20.47	22.47	23.94	26.10	28.73	31.82	36.32
Per cent. of normal	108.3	96.9	93.5	92.4	96.4	105.8	109.9	110.6	106.5	100.5	97.9	98.1
% Relative humidity at 8.30 a.m.	75.2	75.4	78.7	77.6	75.0	70.0	70.2	72.5	70.6	71.2	71.6	72.7
% Relative humidity at 1 p.m.	66.9	66.2	67.7	64.8	61.7	54.6	56.1	60.2	61.6	63.6	67.1	66.4
Total hours sunshine	186.8	181.7	200.8	225.4	231.5	218.1	223.6	227.1	200.2	183.7	164.0	180.2
% of daylight	43.8	48.0	54.7	66.4	73.0	71.1	69.3	66.3	57.0	46.2	40.3	42.3
% Sky covered by clouds at 8.30 a.m.	61	57	51	35	31	29	27	33	46	55	63	60
Mean true atmospheric pressure in inches at 295 feet	29.64	29.67	29.70	29.77	29.83	29.90	29.91	29.89	29.79	29.74	29.70	29.65
Highest	29.98	30.06	39.08	30.25	30.30	30.31	30.33	30.39	30.34	30.23	30.03	30.06
Lowest	29.17	29.12	29.35	29.28	29.30	29.34	29.35	29.12	29.13	29.19	29.20	29.14
Mean earth temperature at 1 foot*	78.1	77.1	75.7	73.8	68.0	62.4	62.6	61.8	67.0	71.2	72.4	74.3
Mean earth temperature at 2 feet*	78.3	78.1	77.0	75.5	70.5	65.1	64.2	63.4	67.4	71.3	73.0	74.8
Mean earth temperature at 4 feet*	77.5	77.6	77.0	76.0	72.8	68.3	66.2	65.4	67.2	70.0	72.3	73.8
Mean solar maximum temperature*	131.9	133.2	130.0	126.2	117.5	110.8	112.8	116.1	122.7	127.2	131.0	129.8
Highest	149.0	142.5	143.0	135.0	133.0	119.0	122.5	122.0	136.0	144.5	141.0	142.0
Mean grass minimum temperature*	62.1	60.2	60.1	55.5	51.1	45.5	46.3	45.8	50.4	56.0	54.0	55.5
Lowest	53.0	52.5	51.5	46.0	37.5	39.0	40.0	38.5	40.0	45.0	42.0	45.5
Mean screen maximum temperature	80.6	80.9	79.7	78.0	75.6	72.3	71.3	72.2	74.3	76.1	77.8	80.2
Highest	104.0	95.0	99.5	92.0	90.0	88.0	92.0	95.0	101.0	102.5	96.5	100.5
Lowest	68.0	68.0	65.0	66.5	61.0	58.0	60.0	58.0	59.0	63.5	61.5	69.0
Mean screen minimum temperature	66.4	66.6	64.8	61.3	56.5	52.6	51.6	53.0	56.4	60.3	63.0	65.5
Highest	75.0	75.5	75.0	72.0	68.5	62.5	61.5	61.5	67.0	71.5	73.0	73.5
Lowest	57.5	57.0	54.0	50.0	44.0	42.5	41.0	43.5	42.0	47.0	51.0	54.0
Mean screen temperature	73.5	73.8	72.3	69.6	66.1	62.5	61.5	62.6	65.3	68.2	70.4	72.8

* Observations commenced only in 1935.

The CHAIRMAN: I greatly welcome this paper, since it deals with phenomena which have been of special interest to me for a good many years. But I think besides being of scientific interest it is of great potential value to the Industry to have complete records for a number of years, as we have here, and as we are steadily building up. We cannot say precisely what value these records will have, but I have no doubt they will be found to be of inestimable value in the future in the study of the general conditions governing our Industry as well as in the study of special problems that we cannot yet foresee. The paper is now open for discussion.

There is an appeal for co-operation made in the paper. We already have very valuable co-operation in the supply of rainfall returns from many districts, but we should like to have a little more, particularly with regard to the evaporation of water, which is, as you will appreciate, of fundamental importance in our industry, and we should much appreciate records of evaporation from different localities. The type of apparatus is a very simple one, consisting of an open iron tank, six feet square, with a measuring device. The whole thing costs, as far as I remember, about £6 for the tank. I think there will be a good opportunity for some of the factories to instal these plants, which would give valuable information to themselves as well as to the industry as a whole.

Mr. HAYES: Mr. Chairman, I don't think it is perfectly correct to say that the damage due to frost in the sugar belt is practically nil. For some years it has been noticeable in certain areas. In 1934 the damage due to frost was considerable. The estimated loss to Kwambonambi and Nkwaleni planters was 45,000 tons of cane. A very large amount was sent to the mill and, not actually rejected, but the damage was difficult to compute, because this cane was crushed while in an immature condition, or at any rate earlier than it would have been cut in the usual course. I think the damage due to frost in some years must be very considerable.

Mr. BEATER: I appreciate what Mr. Hayes says. I did not realise that that was the case. I still, however, wish to emphasise the fact that frost damage in this country has never become a really serious proposition.

The CHAIRMAN: During the past few years we have been very fortunate at Mount dgecombe, at least, as regards frost damage. Even last year, when we had the coldest winter and the coldest month on record, we had little or no frost damage. It is a question not merely of temperature, but of other conditions, particularly, I think, the association with drought, because we find that drought-stricken canes are more liable to suffer from frost; the lack of wind also has a good deal to do with it. Frost occurs on still nights in low-lying valleys, where are formed what we call "frost pockets." Even a gentle breeze would prevent the same conditions from arising, not withstanding a possibly lower atmospheric temperature.

Mr. BEATER: You will notice on table 4 that all the countries mentioned except Peru, with its large irrigation scheme, have a total rainfall far in excess of ours, and I think it is very much to our credit that we can grow cane as successfdlly as we do under these quite adverse conditions.

The CHAIRMAN: If there is no further discussion, I will ask you to accord a hearty vote of thanks to Mr. Beater for his paper.