SOME RECENT ADVANCES IN SOIL SCIENCE (WITH ESPECIAL REFERENCE TO SOIL FERTILITY)

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In attending this meeting my memory goes back to some twenty years ago when I was acting as Chemist at Beneva Estates at Esperanza when Mr. E. W. Hawksworth was living. At that time I urged that we should exchange factory laboratory reports and the matter was taken up by the Millers' Association, and just eighteen years ago we met at the offices of, I think, Messrs. C. G. Smith & Co., and arranged to co-operate as far as possible in the interchange of control sheets. There were at that meeting Mr. Rault who is here to-day, the late Mr. King of Empangeni and representatives from Tongaat and from Hulett's Mills and Illovo. I have kept copies of these sheets and I have one or two here with me. Comparison of the figures of these early days with those published in your proceedings last year show the great improvement in recovery which has taken place in about twenty years. The improved efficiency in the milling and in the curing, on the last year's total crop gave, as I estimated, a rough increase of no less than at least twenty-five thousand tons of recovered sugar of 99.6% purity (a jump from 71 to 77.59% recovery).

Things have indeed changed since those days, but I look back on that period as one of the happiest in a comparatively very happy life for I feel sure that those of you who knew Mr. Hawksworth and his family will agree that I was indeed associated with one of the most genuine and kindest and most sympathetic characters in the Industry.

A visit to the Experiment Station last year gave me food for thought. The enormous increase anticipated in the new canes established there, both in tonnage and in sucrose content certainly appeared to promise to revolutionise the Industry. But to maintain the maximum in both directions the fertility of the fields will have to be kept up. A chance remark of Mr. Rault at Mount Edgecombe gave me further food for thought. He said that the mill control revealed that little improvement could be anticipated in the milling process as compared with practice in the larger mills overseas, and improvement, therefore, must take place before the cane reached the factory.

I cannot come to you with any concrete suggestions as to the improvement of your soil, for it is impossible to translate experiences in soil and plant investigations under other climatic and soil conditions to suit these circumstances under which you work with cane as a specific crop. But I feel that in giving you a short résumé of the recent trend in some of the more important phases of soil study these may give food for thought and some sense of direction in approach to investigation of your soil problems. In the present status of soil science we have:—

(1) The soil-plant relationships, the fertility and its method of determination in laboratory, in pot study and in field experiment.

(2) The biological activity of the soil—the problem of the organic matter and the relationship between the organic matter and the plant growth; the function of manure and its replacement by artificial composts of vegetable debris; the bacteriological activity and its effect on the nutrients and their liberation.

(3) The physical properties of the soil—especially in regard to moisture; the study of the water in the soil—its penetration, its retention and its loss by evaporation and by percolation, run off. erosion; storage and underground water.

(4) The soil profile and its study, soil classification, soil survey and the mapping and field study of the soil.

I can only say a few words on each of these points and throughout the trend of my remarks will bear on the question of fertility.

Dealing firstly with the soil plant relationships—the fertility and its study.

The need for the three major elements has been recognised for three-quarters of a century. The mode of determination in the early days was by attack of the soil body—the soil complex as I shall term it—by acids. Disintegration with strong acids gave the investigator a mental picture of the soil condition in the amount of inert silica left unattacked and the amount of iron, aluminium, calcium, magnesium, potash, and phosphate dissolved and recovered in the analysis. Thus the eventual potentialities were arrived at.

The immediate reserves were got at by treating the soil with weak acids. I feel it is unnecessary to survey the work of Dyer which led to his use of citric acid over a period of time, this giving a solubility under equilibrium due to the time factor. Variation of the time factor and concentration factor have led to various empirical methods devised by one or other workers—we have numerous methods involving the use of concentrated mineral acid and several methods using citric acid—Lemmerman's, Hasenbaumer"s, Dirk's and Scheffer's and others.

The biological methods—those dependent on growth response under empiric conditions have latterly increased. One of these is the germination plant method of Neubauer in which the soil is exhausted of its root available plant food by means of a large number of rye seedlings grown for a limited period and the phosphate and potash content determined in their ash.

The microbiological processes mainly based on the use of pure cultures (aspergillus method) have taken their place among the more readily recognised methods. The pot method has had applied to it a mathematical bias in the Mitscherlich equation.

Latterly, by reason of its great value in soil morphology the fusion method (the ultimate disintegration of the complex) has found more usage.

We are all or nearly all of us acquainted with the term hydrogen ion concentration. It has permeated the biological sciences and has filtered through most industries. It has, I believe, an important place in clarification and recovery in sugar processes. From the usage of various degrees pH to denominate the soil acidity, the investigation of the optimum pH for various crops and common plants rapidly followed. The degree of saturation of soil complex—its lack or sufficiency in bases materially affects the relative activation or fixation of phosphates. Determination of the exchangeable bases—the calcium, magnesium, and potassium has led to some interesting work on soil plant relationships.

In the exchangeable bases we have the methods of Gedroiz, of Kelley and of Hissink, Williams, Puri and others, and in the determination of phosphorus by attack of weak mineral acids in a period before equilibrium has taken place, the methods of Forbes and Truog.

A further step in another direction was taken when Mattson found that by electrodialysis—the passage through the soil suspension between diaphragms of suitable material (Parchment) of a current of suitable E.M.F. the bases could be removed to an extent equivalent to those displaced in the base exchange methods already mentioned, the cations, Ca, Mg, K and Na going to the cathode and the anions—the P, Cl, SO_4, NO_3 going to the anode. The method has been adapted to fertility studies by McGeorge and others, and the cell has been improved by Loddesol and the process also adapted to routine electro-filtration. I spent a year on its investigation and found that the curve of outgo of the K, Ca and P ions was relative to their root availability. Cooper has noted the relation between the intake of the ions and their place in the electromotive series.

Lundegardh and co-workers have adapted the spectograph to the estimation of the elements in the plant and in the soil. The intensity of the bands is determined by a photoelectric cell and in this way the relative presence or absence of the element is determined.

The determination of the less prevalent elements has not been a matter of sufficient general importance in advisory work to place their determination on the same basis as that of the three major elements.

Thus we must consider the mode of approach in the determination of soil fertility to be by two ways; one by the empiric measurement of the plant or the organism either in relative growth increase or removal of nutrients, the other by the degree, greater or lesser, of displacement and attack on the soil complex. But in both cases the soil sample is removed from its natural condition, disintegration of the structure has taken place, the relationship to the underlying soil or subsoil has been broken and we are dealing with an entirely different condition to that prevailing in the natural medium for plant root and sustenance. The variation in root habit and exhaustive power between different plants varies on the same soil type and in the same plant varies between the different soil types. No method outside the field takes full cognisance of these facts, nor of the essentially variable climatic factor, or the effect of moisture relationships arising out of the climate or of the artificial use of water. Comparison has been made between the results of the different methods and between these and the field results, since agricultural science developed the earliest investigation in this way nearly a century ago, with disappointing results. Only last year Mitscherlich reported on the international investigation of the 2% and 1% citric acid methods, the aspergillus method, the Neubauer germinating plant method, and the displacement method of Truog and of Krauss, and the Mitscherlich Pot method. His findings were that while some soils gave results compatible in all cases, a number furnished returns which differed materially in a few or several cases.

Obviously a method of laboratory investigation is essential to answer questions of fertility, but in view of this conflicting opinion and incompatibility, we are forced to assume that we can only adopt a compromise at the best, with the certainty that we have no knowledge as to where it will fail and that its failure will be likely to occur in borderline cases which are the most important.

Thus we are driven to the use of the actual field plots, at least until we have a fair acquaintance with the properties of the soil type we are working upon and can correlate these with our laboratory or pot house results.

A good deal of attention has been paid to field plot technique, especially of late. Most of the early work was confined to comparison between individual treatments in single plots. Replication was not considered as of such importance as later when the practice was to frequently replicate in sequence with a goodly sprinkling of untreated blanks. Thus some allowance was made for error but no offset to the interplay of soil heterogeneity, which was made by randomisation or the chance scattering of replicates. Again later the introduction of statistical method gave a definite basis of probable error inside of which we had no significance and outside of which the results would be significant.

The more recent work of Fisher and his co-workers gave us a vastly improved technique for sufficient replication and of absolute randomisation; of the standard error and the value of "Z." Soil irregularities are so taken care of and we are able to say of our results that they are either not significant although they may appear to be so, or again that the chances are twenty to one or a hundred to one that such a result will be obtained under the circumstances of the experiment. I would draw your attention to an interesting paper by Fisher given at the Oxford Conference last year and to the paper by Fisher and Wishart and that by Hoblyn, also to a very helpful paper by Saunders obtainable from the Department of Agriculture.

Replication if adequate is such that a large variety of treatments is impossible in a reasonably sized experiment, but the technique has so far been developed that it is possible to reduce replication and increase the treatments by lay out so that there is little sacrifice of accuracy in the experiment.

In the general run of crops, the need would arise for consideration of the question of annual experiments carried out afresh on new ground versus that of the prolonged experiment over a decade or more. Here in the sugar belt the need would be apparent not only for one year trials but also over a cycle of time to include the first cutting and adequate ratooning. But I would call your attention to the climatic factor in the effect on the yield. I append the monthly figures for Empangeni, Mount Edgecombe, and Umzinto over the last few years. I may inform you that in the statistical treatment of some plot work by van den Berg of the Division of Plant Industry at Kroonstad, the seasonal influence was such that results in extreme drought years completely offset those in years of normal rainfall. In your case you do not alone deal with the crop weight but also the complex material in the juice and in the fibre and here the effect of the elements and the seasonal difference may assume great significance.

We may here conveniently turn to the second phase of soil study—that of the biological activity and the problem of the organic matter. I feel that in this phase the interest of the sugar planter should be focussed to a marked degree for in the leached soils of the coastal belt the organic material assumes several roles.

The earlier investigation was concerned with the nitrogen question. Some of us will have some vague recollection of the search of Warrington for the actual cause of nitrification and of his failure and Winogradsky's success in the isolation of the organisms. Several lines of attack have followed the early work. They may be roughly divided into:—

(a) The study of the organic material in its progress from the complex of cellulose, sugars. starches, pentosans, etc., to humus, by study of the bacterial activity and (separately) by the study of the intermediate stages by isolation of the intermediate products.

(b) The study of the nitrogen activity—ammonification, nitrification and denitrification in the soil.

(c) The study of the numbers of the bacteria and higher bacteria in relation to each other and to depth and to climate and their isolation and activities.

(d) The study of the nitrogen fixation by symbiosis in the legumes. In the short time I can give to this phase I would refer to the work by Waksman and Starkey and by Conn and Fred on the bacterial population and their isolation and functions and to the work of Russell on the partial sterilization of the soil.

So far as the soils of the Union are concerned, we realise that the rate of decomposition of the organic material is enormous. Our soil population is apparently normally in keeping with that of the rest of the subtropical zone and subject to the same fluctuation. It is essential to maintain both the organic matter and the bacterial activity at a consistently normal level. In general, soils are low or deficient in organic matter and we usually try to maintain this as high as possible. It has been the consistent policy until recently to preach the doctrine of phosphate fertilization and rotation. Theron recently put forward a paper in which some doubt was thrown on the supposed necessity for rotation and organic material thus introduced, and at Potchefstroom after eight years of rotation of maize with legume no actual superiority of the rotation could be seen and the rotation was turned into straight maize. Examination of the results of the rotation experiments at Kroonstad led to the conclusion that some increase of the maize crop follows the first two years after the use of the legume but the effect is lost, if not entirely, then almost completely after the second year. But there is little advantage in the ploughing in of the whole plant including the top since little or no effect is shown in the succeeding crop yields. If the soil conditions at the time of turning in the cover crop be not propitious then the effect may not be seen until the following year.

The question of organic material and bacterial activity has another important aspect of special interest in the cane belt. We have noted that in general there appears to be a marked effect of the organic matter on the activation of the phosphorus added to the soil, especially in soils of low saturation. Whether the organic material in certain forms of organic phosphate acts as a form of buffer in the interaction between the soil complex and the phosphates, whether the amounts of organic nitrogen play any part; or whether the probable aid to bacterial activity is the reason we are not prepared to say, but the organic material does play a role in phosphorus utilisation, particularly so it seems, in the leached soils of the heavier summer rainfall area.

Of further interest are the efforts being made to compost the vegetable debris and so return the decomposed material to the soil, thus replacing manure.

The idea is by no means new, but methods suitable for this country, which are both simple and cheap, have yet to be evolved. I would suggest that here, in view of the large quantities of trash left after cutting, is a matter of interest, and the biological section of this Division would gladly co-operate in this direction.

Dealing next with the physical properties and especially with water relationships, I would point out that over a hundred years ago, Sir Humphrey Davy, called attention to the absorptive power of the soil complex—the hygroscopicity. He remarked: "The ability of the body of the earth to withdraw moisture from the air is intimately linked with its fertility; if this ability is great the plants in dry years are well supplied with moisture."

We are all acquainted with the so-called three forms of soil moisture—that combined and inaccessible to the plant, the available water, and the excess of free water which drains downwards to the water table. Although work was carried out previous to this century, it might justly be said that soil moisture relationships have been only fully established during the last thirty years. The hygroscopicity—the hygrocopic coefficient—or Mitscherlich's hygroscopizitaet are all arbitrary relationships established by maintaining the soil for definite periods, varying according to the method, in atmospheres at various degrees of vapour saturation. Briggs and Schantz in their work on the wilting co-efficient correlated this to the hygroscopic co-efficient, and later to the moisture equivalent, and these relationships were correlated to the mechanical analysis by Alway and his co-workers. All of these relationships have been subsequently criticised in various directions and as in the case of the determination of the fertility no one of these is strictly applicable under all soil conditions but each one serves a useful purpose to a greater or lesser degree. A later and different division was suggested by Bouyoucos, who on the basis of the freezing point depression discriminated between free and unfree water by means of the freezing point and the dilatometer methods. Studies on the heat of wetting have been made by numerous workers—Janert especially has put out several papers on this phase. Again Bouyoucos has attempted to correlate the heat of wetting with the composition of the soil.

Hardy, Coutts and Keen have evolved the sticky point method for the measurement of the water held by the soil in the condition in which the soil ceases to adhere to external objects or as Coutts has put it—the colloid status of the soil. It has been shown that the water capacity and the sticky point water are practically proportional to each other and in some cases almost equal. Marchand has pointed out that from the amount of sticky point water, other data such as the pore space and clay content may be deduced.

At the Oxford Conference, Schofield, in a most interesting paper, gave an account of the pF of the water in the soil and he has diagrammatically illustrated through a logarithmic scale the variation in suction on which the pF is based from the oven dry condition to the 40 cm. water suction and to that at 50% relative humidity over 10% and 30% sulphuric acid. to the hygroscopicity, and the permanent wilting point, the field capacity, the moisture equivalent and Hilgard's maximum moisture. This paper also gives considerable food for thought.

The moisture adsorption was studied by Mattson, who regarded the phenomenon solely as a surface one. Against this we have the argument of Vageler and Alten who regard it as intimately related to the hydration of the ions on the surface and not as a surface phenomenon. The theme was developed in the study of the soils of the Nile in Egypt, and was expounded in a publication by Vageler. There does not seem to be an intense display of interest in this now, although there is a considerable amount of thought in its concept.

In this section a few words should be said in regard to run-off and erosion and to the loss directly and indirectly of the water in the soil body, since water is not only essentially the limiting factor in this land but its relative presence or absence has marked effect in the relative absorption of the ions by the plant. Thompson has given in a review of the run-off experiments at the Pretoria University, the following figures obtained from the plots (90ft. long with a slope of 3.75 ft. in 100).

TREATMENT.	Run-off per cent.	Tons Soil Eroded per morgen
Bare Fallow	39.41	36.49
Cultivated	24.6	17.44
Maize	15.6	11.87
Teff	13.9	2.61
Grazed Veld	4.1	0.21
Natural Veld	0.5	0.05

The figures cover the years 1931-32, 32-33, 33-34, 34-35, four seasons in all, in which the rainfall varied from 22.19 to 28.55 inches of which 11.73% fell in showers of less than one quarter of an inch, 21% from a quarter to half inch, 26% from half to one inch, 31% from one to two inches and 9.5% in more than two inch showers.

Of the rain falling on to the soil over the four seasons, only in one case did this penetrate to a depth of four feet. This is most highly significant and gives rise to disturbing thoughts in regard to our sub-soil water, for in this case the soil was disturbed at some time previous. What of the water falling on undisturbed soil?

Of the water entering the soil, roughly two-thirds is evaporated by the crop—in this case maize—and one-third is lost in evaporation from the soil surface.

I may mention here that we have two forms of lysimeters in this country. One is the copper funnel, and the other a form of a column of original undisturbed soil surrounded in situ by concrete. This latter form is peculiarly suited to all forms of experiment and has the additional advantage of being fairly cheap.

The phases of moisture study quoted, are by no means purely theoretical. Alway and others adapted the hygroscopic coefficient to very practical field studies. The moisture equivalent has been adapted in field studies in irrigation practice, to advantage in this country and the same determination has been suggested as the basis of soil texture determination. It is a pity that, apart from the valuable work of Coutts so far, so little has been done in general soil mouisture relationships in this country, where moisture is so important a factor and where irrigation has been so widely fostered and has need for direction in its practice.

This brings us to our final section—the soil profile, its classification and morphology, its field study and soil mapping survey.

I feel that it is impossible to leave out of this talk a brief resume of soil classification. As you are no doubt aware,tremendous strides have been made in study of soil morphology, and the world is now busy resolving itself into the more or less broad lines of classification evolved from the Russian School initiated by Glinka and his successors. Briefly the relationship between the soil and its evolutionary factors may be summarised in the words of technical communication No. 29, of the Imperial Bureau of Soil Science.

Of the environmental factors affecting soil development, the following four groups are most important:—

Intrinsic—the nature of the parent rock.
Extrinsic—the climate.
Intrinsic and Extrinsic—(dependent on geology and climate).
- (a) Physico-chemical, the movement of precipitation.
- (b) Biotic, the whole flora and fauna, macroscopic and microscopic — particularly the vegetation.

Thus we have a basis for soil study in the intrinsic factor—the parent material, the petrogenetical basis; the extrinsic factor—the climate—the active agent on the parent material—the climatogenetical basis, and lastly the utilisation and productivity of the soil, the agrological system.

The Russian School has brought the classification to an advanced degree and its terminology has been accepted in general use.

The American system, based on soil zones and mainly agrological, has been followed largely.

A skeleton outline copied from technical communication No. 29 is appended. There is I think, a general understanding of the influence in soil formation in the moisture and temperature factors, with the corresponding ecological factors and the general structure and zonal limits in the soil.

We, in the Division of Chemical Services, have approached the survey of the soil from the utilitarian point of view and have studied the profile in its morphological characteristics mainly from the point of view of its potentialities. We study the pH, the brak, the whole profile and the plough depth and the present soil utilisation. From this we determine the ability of the soil to support plant life and to retain and furnish water. I commend this system to you, it having had ten years of continuous usage without any material alteration. I might add that it was built up in a tent in the veld over several weeks of evening deliberations lasting to the small hours of the morning after hard days of field work.

In this paper I have traversed, in a very hapzazard fashion, practically the whole sphere of modern soil science and I feel that I must now finish by giving the gist of a very valuable paper by de Vries, before the International Soil Congress last year. This remarkable work is of special interest to you, for it covers essentially the tropical crop production of the Netherlands Indies and of this, a fair proportion was under sugar. I would be glad if I may give this remarkable activity a proportionally large amount of time.

The area under investigation was about eight million hectares of which one million was under European crops and the remainder under Native crops. Sugar occupied 190,000 hectares, Rubber 600,000, Rice 3,000,000, Maize 1,900,000, Tea and Coffee 185,000. In this were 15 experiment stations —one for Native crops and the others for European crops and latterly 150 fully qualified assistants were employed, with the corresponding number of field assistants, analysts and other helpers (amounting apparently to some hundreds). In the beginning, much was expected from chemical plant analysis and from soil analysis. The former never acquired practical importance and the latter gave little satisfaction. Few experiments were taken up, but they numbered in 1930, 3,230; in 1931, 4,351; in 1932, 3,575, and there was roughly one experiment to every 50 hectares. The number of treatments ran from 2 - 6, or more and the replications were not less than 10 and generally 12. At first the experiments were 200 a year, latterly about 3 - 4,000 a year, and in all over 40,000 experiments were tried and the results of the experiments were also compiled statistically and summarised in regularly appearing publications. Special methods were developed, increase or decrease yield was for comparisons always expressed in terms of the standard error of the difference between the two treatments in question. The subjects investigated were amount of manure, type of manure, influence of the principal plant nutrients on the amount necessary of each, local manures, new types of manures, tillage and cultivation, water supply, time and distance of planting, etc.

All experiments on sugar and tobacco, and many on rice, were annual and not run over a sequence of years. As the Author remarks, the tendency in Europe to investigate manuring problems only on the basis of static experiments, is subject to criticism. One often sees unwarranted or unallowable conclusions drawn from them. The whole system of experiment was so planned that the effects of all casual factors—the weather conditions of the year, local climate, local soil conditions, etc., were removed, and well founded general results obtained which could then, by systematic calculation and study, be brought into relation with different factors—chemical composition of soil, lime or base status, phosphoric acid or potassium status and so on. Pot cultures were adopted, and even the Neubauer method was subjected to experimental adaptation to the climate. Pot work is still carried on.

Apparently considerable work was done on mapping, especially in later years, the work being based on the Russian (climatogenetical), the German (petrogenetical) and the American (agrological) systems.

In dealing with soil analysis it is shown that the divisions in provisional limits gave difficulty, and in 1916, at the local Soil Congress, soil analysis was rejected as a basis for advice on manurial problems, being only deemed useful when limited to soils of one type and on the basis of practical yield figures. The Author adds "It may be asked, by the way, what the results would be when the analysis figures, which at present take a prominent place in some European countries, were put to the test by such a large number of elaborate field experiments. It would not be astonishing if the confidence now put in the analytical data by many workers was found as unwarranted as in Java."

All the methods were standardised between the various stations.

I would like to close the summary of this paper by quoting the Author's words:—

"Of the four chief expedients discussed, plant analysis, for various reasons, played only a minor role in the Netherlands Indies. Soil analysis, favoured at first, lost importance and was replaced by large scale field experiment work and this, for some crops, more or less exhausts the possibilities. Modern soil type mapping combined with soil analysis on modern lines is providing a better base for the layout of field experiments and the interpretation of their results."

In thanking you for your courtesy and attention, I would say that while I have taken much of your time to traverse considerable ground without adding anything new, I would remind you that I promised only to give you food for thought on soil problems. I would like to call your attention to the statement I made that by constant, steady effort over a period of years, in co-operation through your Experiment Station, your chemists and your engineers have added a further 25,000 tons to the sugar recovery of 20 years ago, based on last year's total cane tonnage. Is it not possible that by application of investigation on the lines I have covered, the agronomist and plant breeder and chemist, aided by the engineer, may yet, in field practice and cultivation, add further to those figures? I am not an economist, but I feel somehow that enhanced productivity and fertility mean increased return on the capital locked up in the soil. We agricultural chemists, of the Department of Agriculture, do not care to advertise ourselves, as our field of work is very broad and the calls on our resources are so numerous that we cannot respond to them as well as we would like. Our knowledge and experience are also limited, but we are willing at all times so far as we are able to aid and assist those who have their problems and care to bring them to us. We hope that co-operation may take place between us to our mutual benefit.

March, 1936.

MOUNT EDGECOMBE.

YEAR.	JANUARY.		FEBRUARY.		MARCH.		APRIL.		MAY.		JUNE.		JULY.		AUGUST.		SEPTEMBER.		OCTOBER.		NOVEMBER.		DECEMBER.		TOTAL.		AVERAGE.	
	Inch.	Day.	Inch.	Day.	Inch.	Day.	Inch.	Day.	Inch.	Day.	Inch.	Day.	Inch.	Day.	Inch.	Day.	Inch.	Day.	Inch.	Day.	Inch.	Day.	Inch.	Day.	Inch.	Day.	Inch.	Day.
1926	0.99	8	4.12	11	4.48	12	0.27	2	0.55	8	2.41	7	0.13	2	0.28	3	2.07	7	5.44	13	2.49	9	2.30	10	**25.55**	**92**	2.13	8
1927	2.45	13	5.28	13	18.23	20	0.46	4	0.75	5	0.21	1	0.67	5	2.20	3	0.83	6	2.25	12	2.80	7	4.59	12	**40.63**	**101**	3.39	9
1928	4.96	9	4.89	9	2.49	5	0.94	7	0.80	4	0.11	1	0.13	3	1.34	5	2.40	8	—	—	4.67	11	5.57	15	**28.30**	**77**	2.36	6
1929	3.67	14	3.56	13	9.68	16	1.75	4	0.54	3	6.15	10	3.97	2	1.01	4	6.04	10	5.51	12	3.94	17	2.48	9	**48.30**	**114**	4.02	10
1930	4.37	8	0.88	9	4.83	8	2.28	8	0.94	5	0.57	4	1.45	3	3.68	4	4.13	11	3.08	7	3.19	11	5.12	10	**34.52**	**89**	2.88	7
1931	6.25	11	1.13	9	4.56	13	1.65	13	0.20	2	0.54	3	4.21	6	0.36	7	1.30	7	1.63	11	1.54	13	4.37	21	**28.01**	**116**	2.32	10
1932	4.87	15	10.23	18	5.13	14	2.50	10	3.80	6	0.24	4	0.43	4	0.60	4	1.83	8	4.21	15	2.66	11	4.85	17	**41.35**	**126**	3.45	11
1933	2.09	10	1.84	16	2.80	11	1.51	7	1.84	5	0.53	5	1.54	6	0.12	4	1.50	8	1.86	9	5.30	15	6.21	13	**27.14**	**109**	2.26	9
1934	5.95	19	3.50	11	4.35	14	6.61	13	2.09	7	0.41	4	3.75	12	2.22	6	0.68	5	0.99	8	2.60	13	6.09	15	**39.42**	**121**	3.29	10
1935	5.45	14	4.93	10	4.10	13	1.24	7	8.72	8	16.93	4	0.94	5	2.88	10	0.63	6	2.41	16	2.39	7	2.63	11	**53.25**	**111**	4.44	9
Totals	41.05	121	40.36	119	60.65	126	19.21	75	20.23	53	28.10	43	17.22	48	14.69	50	21.41	76	27.38	103	31.58	114	44.21	133	**366.47**	**1,056**	30.54	88
Averages	4.105	12.1	4.036	11.9	6.06	12.6	1.92	7.5	2.023	5.3	2.810	4.3	1.722	4.8	1.469	5.0	2.141	7.6	2.738	10.3	3.158	11.4	4.421	13.3	**36.647**	**105.6**	—	—

EMPANGENI.

YEAR.	JANUARY.		FEBRUARY.		MARCH.		APRIL.		MAY.		JUNE.		JULY.		AUGUST.		SEPTEMBER.		OCTOBER.		NOVEMBER.		DECEMBER.		TOTAL.		AVERAGE.	
	Inch.	Day.	Inch.	Day.	Inch.	Day.	Inch.	Day.	Inch.	Day.	Inch.	Day.	Inch.	Day.	Inch.	Day.	Inch.	Day.	Inch.	Day.	Inch.	Day.	Inch.	Day.	Inch.	Day.	Inch.	Day.
1926	3.70	11	2.01	11	3.28	16	1.84	6	0.70	8	2.90	9	0.76	5	0.67	6	3.16	3	4.31	12	5.47	15	4.31	10	**38.21**	**112**	3.18	9
1927	5.78	13	3.61	12	6.89	16	1.23	6	4.11	8	1.47	4	2.60	7	1.54	5	2.01	8	5.44	14	1.87	6	4.11	12	**40.66**	**111**	3.39	9
1928	5.80	12	3.79	15	3.08	7	3.58	8	5.02	5	1.40	5	1.25	5	0.98	9	1.44	14	1.34	11	0.80	11	2.05	15	**30.53**	**117**	2.54	10
1929	9.46	14	1.16	12	11.48	17	2.95	7	1.31	3	2.53	7	1.34	10	3.18	8	3.11	12	2.54	19	2.99	16	1.03	12	**43.08**	**137**	3.59	11
1930	5.85	16	2.17	10	2.32	13	0.98	10	0.86	8	2.88	11	1.98	7	1.26	7	2.70	11	1.17	9	2.71	13	2.75	13	**27.63**	**128**	2.30	11
1931	1.40	10	1.69	9	2.45	11	2.26	10	0.64	3	1.08	8	1.89	9	0.08	2	1.59	9	2.93	13	4.70	13	3.75	15	**24.46**	**112**	2.08	9
1932	2.39	17	13.75	5	3.40	16	7.42	7	5.21	8	0.31	3	0.52	3	0.89	4	0.92	4	1.85	8	3.30	9	4.15	8	**44.11**	**91**	3.68	8
1933	2.57	5	2.31	7	1.26	6	0.51	3	0.77	3	0.20	2	0.28	4	1.17	7	0.88	6	1.74	11	3.89	13	5.02	15	**20.60**	**82**	1.72	7
1934	5.46	10	4.78	8	2.17	3	2.73	6	1.17	4	3.00	4	4.19	7	1.71	4	0.87	3	2.71	8	2.50	6	8.40	13	**39.69**	**76**	3.31	6
1935	1.93	3	2.63	5	¶		¶		¶		¶		¶		4.03	9	0.72	7	1.55	15	2.03	12	1.49	13	**14.38**	**64**	2.05	9
Totals	44.34	111	37.90	95	36.33	105	23.50	63	14.79	50	15.77	53	14.81	57	15.51	61	17.40	77	25.58	120	30.26	114	37.06	126	**323.35**	**1,030**	26.94	85
Averages	4.434	11.1	3.790	9.5	4.04	12	2.61	7	1.75	5	1.86	6	1.66	6	1.551	6.1	1.740	7.7	2.558	12	3.026	11.4	3.706	12.6	**32.40**	**103**	—	—

¶ No records.

MID ILLOVO.

YEAR.	JANUARY.		FEBRUARY.		MARCH.		APRIL.		MAY.		JUNE.		JULY.		AUGUST.		SEPTEMBER.		OCTOBER.		NOVEMBER.		DECEMBER.		TOTAL.		AVERAGE.	
	Inch.	Day.	Inch.	Day.	Inch.	Day.	Inch.	Day.	Inch.	Day.	Inch.	Day.	Inch.	Day.	Inch.	Day.	Inch.	Day.	Inch.	Day.	Inch.	Day.	Inch.	Day.	Inch.	Day.	Inch.	Day.
1926	2.47	15	6.99	18	5.24	20	0.30	3	0.79	6	1.73	6	0.02	1	0.84	7	3.82	11	3.64	15	4.73	15	6.36	21	**36.93**	**138**	3.08	11
1927	2.50	16	4.13	17	11.99	18	0.54	5	0.87	3	—	—	0.73	6	2.77	6	1.05	8	3.20	19	2.86	13	9.59	20	**40.23**	**131**	3.35	11
1928	7.04	19	5.07	15	2.74	9	0.72	7	0.77	4	0.06	1	0.01	1	1.63	7	2.49	9	2.62	14	3.83	15	4.18	21	**31.16**	**122**	2.59	10
1929	7.16	19	2.71	13	7.04	17	1.68	5	1.33	4	5.94	11	3.47	3	0.42	4	4.46	16	5.71	21	3.91	20	4.08	13	**47.91**	**146**	3.99	12
1930	8.31	15	2.05	14	5.61	12	0.94	7	0.50	4	1.08	5	0.75	4	1.24	7	2.69	14	4.32	13	5.06	16	6.09	18	**38.64**	**129**	3.22	11
1931	6.48	16	3.02	12	5.76	16	1.90	12	0.07	2	—	—	9.41	7	0.90	9	1.36	5	2.54	10	3.69	15	4.78	18	**39.91**	**122**	3.34	10
1932	3.80	14	6.34	19	7.03	17	0.94	7	3.01	5	0.89	3	0.37	4	0.54	3	1.25	7	5.13	17	5.36	15	6.61	21	**41.27**	**132**	3.44	11
1933	3.02	12	3.39	15	4.10	18	2.61	7	0.52	3	0.31	3	2.97	6	0.33	4	1.56	9	1.89	11	8.33	19	8.06	19	**37.09**	**126**	3.09	11
1934	10.24	18	3.48	14	6.30	16	3.01	13	2.77	9	0.08	4	2.96	8	0.60	5	0.42	4	1.39	12	4.78	19	7.12	18	**43.45**	**140**	3.59	12
1935	3.66	18	4.85	12	3.99	12	3.08	11	3.43	9	12.42	5	0.16	3	0.58	9	1.00	6	2.58	18	0.77	11	2.01	8	**38.53**	**122**	3.21	10
Totals	54.68	162	42.03	148	59.53	155	15.72	77	14.06	48	22.51	38	20.89	43	9.85	61	20.10	99	33.02	150	43.32	158	58.88	177	**294.82**	**1,308**	24.57	109
Averages	5.468	16.2	4.203	14.8	5.953	15.5	1.572	7.7	1.406	4.8	2.251	3.8	2.089	4.3	0.985	6.1	2.010	9.9	3.302	15.0	4.332	15.8	5.888	17.7	**29.48**	**130.8**	—	—

After reading the paper the author expanded it as follows:—

At the end of the eleventh paragraph on page 131. We know very well what has happened in the past. We know that the attack on the soil body was by means of disintegration by acids. We started with the soil particle and in the early days we simply smashed right into the soil particle and broke it up by strong acids, by one acid or another, and the thing resolved itself into a measurement of the proportions gone into solution of the elements mainly required by the plant and these were taken as the total reserves in the soil. When Dyer started with citric acid extract determination, he simply took the juice of his plant, determined the relative acidity, and by that fact worked with the nearest solution he could get to that relative acidity, using that and the time factor to attack the soil. But in those days there was no idea of pH, nor was there any idea of any balance between your time factor and the degree of attack. That had not then entered into the question.

Expanding the last paragraph on page 131. In case you are not acquainted with this method, I might say that you mix your soil and sand, 400 grammes of each, put them in the bottom of a small vessel, put on the top of that a layer of sand, and in that layer of sand you plant exactly 100 rye seedlings of a known origin, of a known weight, and a certain length of time after reaping, which must also be taken into consideration. Another sand layer is then put on top, or the sand closed over the seedlings, as the case may be. A lead or similar disc is put on top of the vessel and the seedlings allowed to grow for 18 days. At the end of the time, you take the whole thing, collect your plants in one hand, wash them under the tap until completely free from sand and soil, take every seed, germinated or ungerminated, and determine your phosphate and potash. By means of figures given by Neubauer, you can translate that down to P_2O_5 and K_2O per acre or morgen, and relatively you can reckon according to the plant you are going to grow what you have to add to the soil. I must warn you it is a very tricky method.

Referring to fifth paragraph, page 132: With regard to that, I think this is a field which offers a very good line in investigation, and I can say that with regard to this electrofiltration, or electro-dialysis, the material that you have got when you have finished is very nice to handle. You have got your ions. They are all collected together, and are very easy to manipulate. They are nice to work, and if you carefully control your current and regulate your temperature, the method does offer a very good approach in various directions. But the great advantage is that you can stop at any point you want to, and if you use the antimony electrode in the determination of your soil suspension, you can measure that also. The method which I use, and one which I can recommend, as it is an improvement on Mattson's, consists of an arrangement like this. (Demonstrated on blackboard).

Paragraph six, page 132: This apparatus is expensive, but I was given to understand that a demonstration was given at Oxford last year in regard to this spectograph, and it does give a method of soil research that opens up an entirely new field. You can run through the whole spectrum and get everything in that spectrum. You not only get the relationship of the more common elements, but you get the rare ones at the same time. It does afford a very good basis for work.

Second col., page 132: I may mention that this was really putting your soil determination, or fertility determination on trial before a pretty good jury. These methods were carried out by experts in every case. What I call an expert is a man who either evolved the process or was closely associated with its evolution. Therefore these methods have the best chance in the trial. In a number of cases they fitted in; there were a number of cases where they did not. But I would point out to you that with a complex substance like soil, it is rather too much to expect to get all these methods to fit in in all cases.

Referring to paragraph 1, page 133: Dr. Saunders, of Potchefstroom, has just put forward a very useful paper on field pot technique. This is obtainable from the Department of Agriculture, and I would commend it to all of you. Dr. Saunders will at all times be willing to solve any points that arise in connection with his paper, or to give you any points that arise in connection with his paper, or to give you any advice on statistical methods or layout of field work in any direction. We have worked a good deal in Pretoria in this matter lately, and I must say frankly it is a very fine feeling that one has in dealing with pot work, where you can turn round and say "This is so," or "This is not." It is nice to be able to say what a result looks like, but it is a very much finer feeling to say definitely "That is so," and that the chances are 100 to 1 that if you repeat that under the same circumstances, you will get the same result. Of course, down here, with your broken soil types, it is perhaps a little more difficult, but in the parts of the Union where we have large stretches of land all of one type or another, and very slight variation in climate, you are able consequently to interpret results at one point and apply them for that area, and say either "We think," or "We know definitely that the 20 to 1 chance is we will get that result here, or here, or here." It is much better to be able to do that instead of saying "Well, there is a possibility, or there is a probability."

After paragraph 2, page 133: In regard to that, Fisher has developed this method so far that a series of experiments have been put through in Britain where there is only one replication and numerous treatments, and by a suitable arrangement and compounding of the experiment itself. you actually can get statistically interpretable results. I don't know how far that would be applicable out here since that type of experiment has not even been tried, but it has been worked out, or evolved in England, and indicates the possibility of at least a reduction in the number of your plots and the increase of your treatments.

Referring to paragraph 10, page 133: I want to point out that I am by no means condemning the rotation system, but at the present moment our positive knowledge in that respect I think is somewhat in a state of flux. That is my own personal opinion. I don't know that it is the opinion of the Department. Our present knowledge is to some extent in a state of flux, and there is no doubt whatever that unless one does rotate to some extent, you are bound to suffer. But I cannot tell you anything more than that.

Referring to paragraph 2, page 134: There is no doubt whatever that this method of composing has a good future in front of it if it can only be adapted and made cheap. It simply means that you turn your debris into something at least approaching the equivalent of your animal manure, which you can put back on your land. You are getting something which you cannot get if you merely incorporate that same material direct into the soil by ploughing in. It is an important line of work, and I do think it is worth a good deal of attention.

Mr. GOLDING: What is this pF?

Mr. CUTLER: I simply take it that the pF is the logarithmetic ratio of your water to soil, from very dry conditions until you get down to the utmost extreme of moisture a soil can hold, in the same way that you have your pH scale in your acidity determination for all possible ranges of hydrogenion concentration.

At the end of paragraph 6, page 7: At this point I would like to call your attention to something which I think you must take up in the cane belt, and that is the lysimeter study of the soil. You have here ordinary rainfall, and you have irrigation both affecting profoundly the soil and the availability of elements to the plant, and I would direct your attention very strongly to lysimeter studies. We have at Grootfontein School of Agriculture some lysimeters built out of a solid mass of soil. They have simply taken the soil in situ. They have cut round it until they got a square block, still based on the soil down below, and they have cemented round that, so that you have your undisturbed soil body in situ. Now two things have been done. They suspended this whole mass, by means of a crane, and they cut underneath it, and put in a complete concrete layer. Or they have let it remain undisturbed in contact with the soil down below. These lysimeters I may tell you—I may be wrong—they work out at a cost of £12 or £13, or even less than that. Now here is a very useful method of getting at the soil, by lysimeter study. You don't have to dig your soil out and put it back and wait for it to settle. You don't have to disturb it. You merely put your concrete round it and study the water draining from the soil. There again is a line of work which I would commend to you because of its absolute relative importance to your water conservation.

After the penultimate paragraph on page 7: With regard to our concrete funnel, that has been used on the ground as this might be. A trench has been cut and the soil cut away at the depth required, and a small copper funnel—I think 17 inches or 15—has been pushed in. The funnel had previously filled up with rubble. That also gives you a form of study which is not as effective in every direction as in this, but you can in this way get your soil solution at any point from the top, or three or four inches down, or as far as you want to go. This was the method that was used by Thompson to get the figures with regard to the depth of penetration.

At the end of paragraph 7, page 8: I may say I have a series of maps here with me, and to you who are interested I shall be pleased to show them later on during the morning. What we do is to send out a party of men. They put down a series of holes all over the area. These holes are usually about a thousand feet apart, perhaps a little more, or perhaps less, as circumstances dictate. These are dug to a depth of 8 feet. We don't use an auger, we have given that up. We actually study the soil profile in situ and we remove samples—examine it and record its texture and structure, and classify it. We remove samples and determine the brak and the pH and other determinations in the field, and on the results of that we make a map. One map shows the profile, or what is in the soil; the second one the brak, the amount of salts that are present, determined by the resistance; a third one giving the pH, and a fourth one giving you what the soil is used for at the time of examination. And from all these data we compile one full final map which gives you what we call its irrigability value, that is, its value from the agricultural point of view, its present value. And from that also one can judge its future potentialities. We have done that for the last ten years. It has served a good purpose, and it has not been materially changed.

The CHAIRMAN: Gentlemen, I am sure we are all very much indebted to Mr. Cutler for giving us this excellent exposition of soil investigation. I have long felt that we were very backward in this Industry in our soil investigation. Other lines of technical work have been developed within the last few years, but we have not made a commensurate advance in soil work. There are many reasons, perhaps, that have led to that state of affairs. Soil study is a highly specialised business, as you can well imagine, and we have no one here who has yet sufficient experience in this work. Undoubtedly there is vast scope for improvement here. As Mr. Cutler told us, this has been realised for many years, and was mentioned to him long ago by Mr. Rault. In the factory we get recovery of sugar on cane now of about 78%. I suppose the best we can hope to do under present conditions of manufacture is to get round about 88, which is attained in some highly efficient industries in other countries. But that, after all, is a relatively small increase, whereas many countries have succeeded in doubling the yield of sugar per acre from their soil within recent years, and I believe we can do that here. It indicates in any case a much greater scope for improvement and increased economy and efficiency in the Industry on the agricultural side than in manufacture.

There are many interesting points that were mentioned in Mr. Cutler's paper that I would like to refer to in detail, but there will not be time to discuss them all; we are already very late. Mr. Cutler's intention was, as he told us, to give us food for thought. I think he has certainly succeeded. The paper is full of all kinds of suggestions for soil study, and these recommendations will be carefully considered. We very much welcome the promise of the co-operation of the Department of Agriculture in soil studies. What we need probably more than anything for a beginning is a soil survey. Our soils are exceedingly broken, and there are many types of soil, each of which have their own problems. To begin with, we must know how to identify these different types of soils, and know where they are.

These two papers are now open for discussion.

Mr. COIGNET: I would like to ask Mr. Cutler about the manner in which the top soil and the subsoil may be defined.

Mr. CUTLER: As a matter of fact I don't think that we can draw any line of demarkation. I suppose if one took it on a zonal basis, one could, but unfortunately biotic activity and bacterial activity do not stop at any particular point. It tapers off, so to speak. What we, in the Division of Chemical Services do when we make our soil surveys is (unless we can see a very definitely demarkated survey) to take in general either the top six inches and the second six inches, or the top foot. Of course the top foot is below the depth of your plough sole and the top six inches is above that depth, but that is for our purposes the way we examine our soil. I would suggest nine inches to 12 inches for the top soil, according to the general depth of your soil treatment and collateral operations.

Mr. BEATER: If Mr. Coignet refers to Bulletin No. 2 published last year by the S.A. Sugar Technologists Association, he will find our definition of the two layers. The first eight inches we designate "surface soil" and the second twelve inches of available soil, irrespective of colour or texture, we designate as "subsurface soil." From an agricultural point of view the strict division of a soil into its horizons appears to be of little practical importance in sampling.

Mr. CUTLER: I would like to add for general information that when we dig these holes over the land, we almost invariably (unless we are stopped by something which we cannot get through), go down eight feet. We do not regard two or three or four or five feet as being sufficient. We go down to as far as we can get in each case. It is pretty hard earth that is capable of stopping us. It must be hard enough to break a pick before we stop, but we go right down to a depth of eight feet. That is what we consider a fair depth.

Mr. COIGNET: I would like the opinion of Dr. McMartin as to the depth to which cane roots go.

Dr. McMARTIN: In Natal we have seen cane roots to the depth of 11 feet. I don't know if they go any farther than that, because the job of excavation was given up at that depth, but I believe they go down very much farther.

Dr. VAN ZYL: In connection with soil survey operations, it is quite true that we usually go to eight feet, but I would like to point out to you that our surveys in the past have all been conducted with regard to irrigation schemes, and as most of these irrigation schemes are developed in the dry areas. where we can anticipate trouble with the soluble salts in the soil, we are forced to go so far. I do not think that when once we initiate a systematic soil survey that we can attempt to go so far. It will take too long. To dig an eight foot hole is a very difficult matter. I don't know if you have had that demonstrated to you, but eight feet is, in my opinion, too deep for general practice. On the other hand, when you are dealing with cane nowadays, we are also forced to take into consideration the question of irrigation. I understand it is becoming an increasingly popular practice to irrigate, when you are liable to trouble from salts, so it might be necessary to go to eight feet under irrigation conditions. We are forced to limit the depth of the hole by practical considerations. Of course, a cane root might conceivably go down to 20 feet or more, just like a lucerne root, but it is impracticable to study soil to that depth. Naturally we try to amplify our knowledge, which we get from digging holes, by studying also existing sluits and dongas, where very often you get additional information about soil layers. From a practical point of view I think you will all feel that eight feet is rather too much, and if we should in future assist you in soil matters in the sugar area, I personally feel that we should limit that to six. But that is for the future to decide.

In connection with the remarks made by Mr. Cutler in his paper, and also Mr. Beater's paper, I feel that I might as well make a statement here. I have already told you, Mr. Chairman, that I will definitely undertake to assist the Experiment Station, and through the Experiment Station the Industry, in getting soil survey operations started. I remember that at least seven or eight years ago Mr. Dodds alrady asked us whether we could assist. We had hoped that it might be possible. He has got a promise dating back at least seven or eight years that we would offer him assistance. I think I can see a little daylight now, and I will make a very serious effort to give you some assistance. It might not be very much, but I think that with the large number of chemists working in the Sugar Industry, it might be possible if a soil survey expert comes down here and spends a few months in the area, that he might show the methods that we use and assist in getting some definite work started. I think it is of great value to undertake a systematic study of the cane soils, because new ideeas definitely show that it is no use to lay down one or two fertiliser experiments in the whole of a complicated area where you have such conditions as you have in the cane belt, with its great variation in soils. Therefore it will be necessary, if you want to lay down your future experiments on the best sites, and get the most value from them, first to attempt to classify the soils and see to it that you lay down experiments on soil which stands for something definite. In that way I think that a soil survey ought to be very helpful.

The CHAIRMAN: I am very glad, and I am sure we all are, to have Dr. van Zyl's assurance that we are likely to have a soil survey in the near future. I can assure him that we will be very glad to have the opportunity of giving whatever help we can with our somewhat slender resources at the Experiment Station. I am sure that he will find some co-operation also from the chemical laboratories at the different factories. Mr. Cutler made some reference to work done in Java on these lines, and I had the opportunity of seeing the results of some of that a few months ago. I can fully endorse what he says concerning the vast amount of valuable work that has been put into the soil in that country through the Experiment Stations, not only of the sugar industry, but of all the agricultural industries of which they have a great number in Java, and the results may be seen in the wonderful yields that they are capable of getting—for example, an average over-all yield of over six tons of sugar per acre per annum, nearly six times our present yield of sugar per acre per annum in this country.

I feel that this is an unusual opportunity of discussing these soil matters while we have visiting experts here, and I think that you should take advantage of this by making enquiries, either on the subject of the paper or any other aspects of soil investigation.

Mr. BECHARD: One thing that struck me most in Mr. Cutler's paper was the amount of erosion and rainfall as quoted by him. We had the idea that even on a small slope certain erosion was taking place, but do not think that many people realised the extent of this erosion. I would like to know from Mr. Cutler, if possible, what lines of attack have been recognised, or if anything has been suggested to try and re-establish this top soil that is going away. Considering the rivers in this country, and the millions of tons of soil taken yearly out by the coastal rivers, one would realise how greatly we are depleting our supply of top soil, and the outlook for the future is very serious unless something is done to remedy this state of affairs.

Mr. CUTLER: In answer to that question, in the Department of Agriculture, there is a section devoted to soil erosion, and it is combating erosion and rehabilitating the soil wherever it can do so. There are erosion engineers stationed at Cedara, and information can be obtained from Mr. Taylor in that connection. Mr. Taylor, who is Acting Principal at Cedara, I am sure will be willing to afford you all the information and help which is possible, and at the various Schools of Agriculture there are these engineers stationed, whose duty it is to assist in running counters, devising schemes for prevention, giving help and assistance; while in Pretoria in the Division of Chemistry, we now have a man who is engaged on the non-chemical side, on the more theoretical and physical side of this study.

Mr. TAYLOR: With regard to the references to Cedara, if any of the people interested write to us, we can give them details of the various schemes in existence for assisting farmers in controlling erosion. Unfortunately we have so many of these applications on hand at the moment that our two soil erosion engineers are absolutely up to the neck in work, so it may be some time before anything definite can be done. Two or three little points about controlling soil erosion I might mention. Many farmers do not plant along the contour, they plant up and down the hill. The maintaining of the organic matter in your soil is of great importance; that is, of course, where the more modern practice of non-burning has big results. In the wattle industry, though conditions are different, there is a strong movement in the direction of stopping burning their trash, but instead running it along the contours, and that has done a tremendous lot to stop erosion. Then maintaining strips of some perennial grass, Napier fodder sometimes, or just ordinary grass, we find extremely useful in checking washdowns. One could speak a long time on that, but this is not the time to expand the matter.

Mr. BOOTH: I would like to mention in regard to the last speaker speaking of the planting of grass, I happened last year to be at Rietendale Experimental Farm at Pretoria. There I saw good work being done towards the preventing of erosion, and chiefly by the planting of some types of grass. Less than one season's growth over what seemed to be entirely barren ground was producing effects years, provided there was no grazing, the erosion factor would be well under control. I would like to pay my tribute to the hospitality which I received at the hands of the Department of Agriculture at Pretoria.

The CHAIRMAN: Are there any further remarks? If not, I will ask you to accord a very hearty vote of thanks to Mr. Cutler and Mr. Beater for the excellent papers they have given us.

The CHAIRMAN: Gentlemen, our first Agricultural Sectional session does not seem too promising from the point of view of attendance. Perhaps we can blame the last two days' rain a little bit for that, but at the same time I should have thought more people would have made an attempt to attend this very interesting session in view of the interesting programme of papers that is being offered this morning and this afternoon. However, even with the few people who have thought it worth while to turn up, I am sure that these papers will give rise to a lot of interesting discussion. The first paper is a paper on Experiments at Umfolozi, a further Progress Report by Mr. P. Fowlie.