Mr. Ritchie replied that if anyone were to put in an application to his Department they would inspect the property and give what advice they could; the owner could then see whether he was in a position to go in for the scheme. Mr. Ritchie stated that his Department had already investigated and reported on a scheme for Mr. Warner at Chaka's Kraal, and he understood that this season Mr. Warner was going to start and put it into operation, which would irrigate about twenty acres of his cane. The furrow would run right through his cane lands, and a standard of comparison would be available; the scheme was a gravitation one, and it will be possible to compare the cane above the furrow with that below it.

The Chairman, on behalf of the Association, thanked Mr. Ritchie for his very interesting paper.

Cane By-Products and their Manurial Value.

(Paper by Mr. C. C. DYMOND, Head Chemist, Zululand Sugar Milling Co., Empangeni.)

The sugar cane, together with all forms of vegetable growth, require nine primary chemical bodies as plant food:—Water, carbon dioxide, nitrogen, sulphuric oxide, phosphoric oxide, magnesic oxide, calcic oxide, ferric oxide, and potassic oxide.

Of these, nitrogen, phosphoric oxide, potash and lime are not, as a rule, all present in sufficient quantities in the soil, and must therefore be supplied as manure. It is, in fact, the deficieney in one of these requisites of plant life which determines the crop yield, and not the superabundance of others.

The more important functions which these constituents perform in plant life are briefly the following:—

Phosphoric Oxide.—All plants, from the lowest to the highest, contain phosphoric oxide. It participates in the formation of albuminoids in the young leaf, and is hence always present in large quantities in the growing part of the plant. At a later stage it passes from the leaves to the stem and seeds of the plant, and is replaced in the leaves by silica. Further, it has a distinct ripening effect, besides stimulating the development of young plants.

Lime is a necessity for all plants in all stages of development. It plays a prominent part in the transformation of sugar and starch into cellulose, while giving a certain rigidity to the plant. The addition of lime to the soil accelerates the decomposition of the organic matter and assists in rendering all the constituents of the soil more available as plant food. It corrects the acidity of sour lands and acts on the physical properties of soils by altering stiff clays into loose loams, thereby enabling air and water to have freer access.

Nitrogen.—This element in combination is one of the important constituents of plant food. When applied to the soil in the combined state it has a direct and immediate action on the growth of the plant, besides acting as a stimulant during cold weather.

Potash.—This is a most essential constituent of all plants, especially those which store up large quantities of starch and sugar. It is associated in the formation of these carbohydrates in a similar manner in which phosphoric oxide is associated with the albuminoids. The richest potash soils are generally those which have been formed from the disintegration of granite, the success of viticulture in the Cape being largely due to the richness of their soils in this respect. In a plant, potash is the preponderating inorganic constituent wherever the formation of new cells is proceeding, thus, for example, cane tops always contain far more potash than does the trash.

Having thus outlined the properties of the four requisites of plant life with which the agriculturist has most to deal, we will see how these bodies occur in the by-products of the sugar cane, and the value of these residues as manures.

The principle of returning plant residues to the soil is one of the oldest principles of agriculture. To its observance is to be attributed the long-continued fertility of the soils of the older civilisations; while to its neglect is to be assigned the gradual exhaustion of our older cane lands.

In the sugar industry we have as residues:—Cane trash and cane tops which normally remain upon the land; bagasse ash, filter press cake and molasses—and, as a marketable commodity, white sugar. This ultimate product is composed of elements derived from the air, which are assimilated and elaborated by the chlorophyll of the leaf under the influence of the actinic rays of the sun. Nothing has been taken from the soil except a negligible amount of ash. The residues, on the other hand, contain the plant food

which the plant extracted and utilised in its growth, together with the lime and phosphoric oxide used in the defecation process of sugar manufacture.

Now the value of these by-products varies in the different sugar-producing countries in accordance with their varied soil conditions and deficiencies and it was with this in mind that some work has been done on the values of our own by-products, in conjunction with our local soil conditions. The collection of a large correlation of figures has not been possible as yet, but sufficient data was obtained to show the necessity of carrying out the oldest agricultural principle in order to maintain the present fertility of our soils.

Cane trash and tops.—Samples were taken from a field of 15 months old plant cane. The stalks showed an average sucrose content of 12.4 per cent. The soil was a black sandy loam, having total humus 6.9 per cent. and total organic matter 10.8 per cent.

In one acre of such cane running at 25 tons to the acre it was calculated that there would be 7070 lbs. of trash, and 22,670 lbs. of green tops, which in dry matter represents 5700 lbs. of dry trash and 3860 lbs. of dry tops.

Analysis of the dry substance showed the following:—

Nitrogen in trash.—.27 per cent. or (approximately) 15 lbs. per acre.

Nitrogen in tops.—.90 per cent. or (approximately) 34 lbs. per acre.

Total humus in trash.— 9.2 per cent. or (approximately) 526 lbs. per acre.

Total humus in tops.— 6.9 per cent. or (approximately) 267 lbs. per acre.

Ash in trash.— 7.3 per cent. or (approximately) 415 lbs. per acre.

Ash in tops.— 7.5 per cent or (approximately) 288 lbs. per acre.

The principal ash constituents were:—

Tricalcic ortho-phosphate in trash....trace.....

Tricalcic ortho-phosphate in tops 6 per cent or 17 lbs. per acre.

Potash in trash 3.2 per cent or 15 lbs. per acre.

Potash in tops 23.0 per cent. or 77 lbs. per acre.

Thus an acre of cane utilises 92 lbs. of potash in the trash and tops alone, which means that sugar cane is more exhaustive in this respect than wheat, tobacco, lucerne and potatoes, which take from one acre, 30, 60, 107, and 108 lbs. of potash respectively.

A study of the full analysis of the ash from the trash and tops shows how the cane, in common with all other plants, economises in its use of plant foods. In the growing part of the cane are to be found the maximum quantities of those compounds essential for its development, whereas in the dead portion (the trash) the sap has receded, taking with it most of the phosphates and potash, replacing them by the commonest of soil constituents—silica.

The ash of the tops actually showed 29 per cent. of total silica, while that from the trash contained 62 per cent.

Other compounds of comparative interest were:—

Magnesium oxide, 1.8 per cent. in trash and 6.17 per cent. in tops.

Sulphuric oxide, 3.5 per cent. in trash and 8 per cent. in tops.

Chlorine, .5 per cent. in trash and 9.4 per cent. in tops.

If we now take the values of nitrogen, potash and the lime and phosphoric oxide in combination as tricalcic orthophosphate as assigned to these substances in Hall's "Fertilisers" and "Manures," we find that the dry trash is worth 4s. 3d. per ton, or approximately 12s. per acre, while the dry tops are worth 19s. 9d. per ton, or £1 18s. per acre.

The value of the organic matter in the trash and tops is a distinct but variable one. In a sandy soil the need is far greater than in one which has 10 per cent. already present. In such soil there are 180 tons of organic matter or 114 tons of humus per acre 14 inches deep.

Some interesting deductions may now be made. On a crop of 100,000 tons of cane, assuming the above percentages of trash and tops to cane to hold good for the whole crop, there would be roughly 6,250 tons of dry tops having a manurial value of £6,170, and 7,300 tons of dry trash valued at £1,550. Assuming again that one-twentieth part of the crop, i.e., 5,000 tons, through inefficient topping reaches the mill as tops, then the loss to the land is roughly £1,082, the sugar value of the tops being nil.

We come now to actual mill by-products. Analyses of bagasse ash showed the following principal constituents:—

Silica 66.5 per cent.

Tri-calcic ortho-phosphate, 3.2 per cent.

Potash, 4.4 per cent.

Sulphates, 12.63 per cent.

Taking the same values as before for the potash and tricalcic ortho-phosphate, the value of this material per ton works out at £1 9s. 7d.

Much of the potash originally contained in the bagasse is lost in the furnaces, either becoming fused into an insoluble potash class, or being carried away while in a volatile state; so that no reliable figure can be arrived at as to the available quantity of this material during a crop. The best way of returning it to the soil after removing the clinkers is to mix it with the press cake.

Cane By-Products and their Manurial Value.

Filter press cake is the mill residue which is most used as a manure. Its value is due to the high percentage of nitrogen which it contains, ranging from .66 to 2.44 per cent., and also to its phosphoric oxide content. Its manurial value, however, appears to be disproportionate to the quantities of these bodies contained therein. This is due partly to its high wax content, and partly to the fact that here we have the most insoluble compounds occurring during the course of manufacture.

Analyses of the dry cake showed the following composition:—

Total organic matter, 63.3 per cent.
Ash, 36.7 per cent.
Nitrogen, 1.06 per cent.
Insoluble silica, 3.38 per cent.
Soluble silica, 4.7 per cent.
Tricalcic ortho-phosphate, 3.13 per cent.
Sulphates, sulphites and sulphides, 6.55 per cent.
Iron and aluminic oxides, 8.09 per cent.
Potash, nil.

On these figures the value of the dry cake works out at 18s. 7d. per ton.

Press cake is very suitable for light sandy soils, and is usually applied at the rate of six to eight tons per acre. This amount may, however, be increased in very sandy soils. Best results are obtained by spreading the press cake over the surface of the ground, and allowing it to dry out as much as possible before ploughing in.

In the final by-product of the industry molasses we would naturally expect to find the maximum percentage of those more soluble compounds, which originated in the cane. Analyses showed that the nitrogen, as in other countries is low, namely .14 per cent., while the ash averaged 9 per cent., of which:—

1.25 per cent. or .11 per cent. on molasses was tricalcic ortho-phosphate, and 23.4 per cent. or 2.1 per cent. on molasses was potash.

The manurial value of one ton is therefore 9s. 10d., which on a crop of 100,000 tons of cane would be roughly £1,536, of which £1,276 is due to its potash content.

Assuming the value of molasses for distillery purposes to be 1¼d. per gallon, the value for the crop would be £2,604.

On referring to Noel Deerr we find the following: "In Cuba a short ton of molasses will contain on an average 80 lbs. of potash, which at 5 cents per lb. exactly equals the price paid for molasses sold nominally on its contents of sugar. Our molasses only shows 40 lbs. of potash per short ton. This scarcity of potash was subsequently accounted for by the fact that in all samples of soils tested there was a deficiency in this compound.

The most rational method for the return of molases to the soil is undoubtedly to first obtain the sugar value in alcohol, and then utilise the lees. This may be done by first neutralising the acidity and then by pumping and irrigating, or by rotting the dry trash with it, or by the more elaborate methods of extracting the valuable ingredients.

In the older countries the industries have, long ago, had to look to their by-products, an almost classical example of which is shown by a French company, Messrs. Tilloy, Delaume & Co. This company utilises 90 tons of molasses per day, from which they obtain 5,500 gallons of 90 per cent. alcohol. The residual lees amounting to 40 tons after evaporation are treated, and yield 10 tons of potash salts, also 32 cwt. of ammonium sulphate, 2 cwt. of methyl alcohol, 4 tons of tar, 7¼ cwt. of oil, and a concentrated liquor containing trimethylamine salts.

The return of molasses to the soil has been studied by many competent authorities. Boname, in Mauritius, obtained good results by the application of 3 lbs. of molasses in each 3,000 holes dug in an acre of soil. Another authority, Peck, found that by the application of molasses there was first a decrease in the nitrogen content of the soil, due to denitrification, followed by an eventual increase over that which had primarily been present. He therefore recommends that applications should be made some time before planting.

The result of our investigation clearly shows that our soils are somewhat deficient in the necessities for long continued productivity, and that the oldest method of agricultural economy should be practised, under which conditions it follows that the sugar cane crop is not an exhaustive one, since so much of what has gone out of the soil is capable of being returned thereto.

DISCUSSION.

Mr. Jelley asked whether Mr. Dymond could say if the very small percentage of glycerine which exists in dunder would have any effect on the dunder as a fertiliser, and whether it would be possible to remove that glycerine. If the percentage was worked out, it would be found that they were dealing with thousands of pounds' worth of glycerine.

Mr. Dymond replied that he had not had any experience on that matter, but he believed in other countries they did extract the glycerine from the dunder.

Mr. Booth congratulated Mr. Dymond on the excellence of his paper, and said he was sure most of the technical people would agree that he had set a very high standard for future papers on the technical side. On the question of filter press cake,

Mr. Booth stated he had been speaking to a planter who had always been very keen on getting this cake, and was informed that he had been unable to obtain any from the mill he usually obtained his supplies from, owing to the cake being burnt. Mr. Booth wished to know whether Mr. Dymond considered the cake had been decreased in value by the burning.

Mr. Dymond replied that since the value of filter press cake is generally accepted on its nitrogenous content, he considered it would be decreased because by burning you naturally destroyed the nitrogen, which was the principal value of the filter press cake. The press cake contained a large percentage of water, and the longer it is dried out the better it is for spreading over the soil.

Mr. McAusland asked if it was possible to give the soil too much lime.

Mr. Dymond replied that all soils contained a good deal of lime, in some cases more than the safety mark. It was possible to increase the lime content of the soil above the safety mark, which would tend to destroy the organic matter.

Insect Pests of Cane.

(Paper by Mr. C. P. VAN DER MERWE, Government Entomologist, Durban.)

My intention in this paper is to say something not only about the insects attacking sugar-cane that we have got; but also something about those we have not got. This seems to be very necessary, as sufficient interest is not taken by people, even sugar-growers in the sugar-cane insects in other parts of the world, and which we are in danger of introducing with importations of cane. There are even some who think that there is no necessity for the restrictions on the introduction of sugar-cane which are now enforced, as we have already all the pests we are likely to get in sugar-cane. If there are any present who hold this opinion, I hope to convince them, before I am finished, that they are mistaken.

The Insects we have got.

There are certain locusts and grass-hoppers which are often found in cane-fields and feed upon the foliage; but the damage they do, except in the case of the Red-winged Plague Locust (Acridium purpuriferum), is so small that it hardly is worth mentioning. The plague locust for many years now has not been troublesome, and should it appear again in large numbers, cane-growers are not going to be unduly alarmed, as they know it can be controlled.

Then there is a small Frog-hopper or Sputtle Insect, the Red-winged Frog-hopper (Locris areata), which is sometimes found sucking the sap from sugar-cane in moist places; but the damage it does is of still less importance than that by the grass-hoppers. The insect only attracts attention on account of its conspicuous red colour as an adult, and the bunches of foam in which the nymphal stages are passed.

At times one finds on the leaves of cane an abundance of a small aphis or green-fly. They suck the sap from the plants, and the ground below them appears to be damp from the abundance of honey-dew they throw off. These insects could be a very serious pest; as even such a vigorous-growing plant as the sugar-cane could not long stand the serious drain of millions of insects sucking its sap; but fortunately the conditions never remain favourable for them for any length of time, and they soon disappear.

Of more importance is the Sugar-cane Mealy Bug (Pseudococcus sacchari). It infests the stalks of cane, and is usually found towards the top under the leaves, where the cane is still soft. The growth of the crop does not appear to suffer; but a black fungus grows on the honey-dew excreted by the insect, and causes the black appearance commonly seen on sugar-cane. This must increase the impurities in the juice, and cannot be otherwise than undesirable; but unless the mills pay a higher price for cane which is uninfected, growers cannot be expected to go to expense and trouble in order to control it.

The Black Beetle (Heteronychus lycas) has been reported to cause rather extensive damage at times to seed-cane, boring into the sets, and eating out the sprouting buds. The damage often, if not invariably, follows a flood. The insects are driven out of their hiding-places by the water, and seek refuge on the rubbish which is being carried along. When the rubbish is deposited near a cane-field, there is such an accumulation of beetles that they can be very destructive, and may necessitate the replanting of a field. Usually the beetles are not