SOME NOTES ON CANE MILLING

By PATRICK MURRAY.

In recent years, pronounced changes have taken place in the cane supply of mills in this country. The quantities of cane milled have very greatly increased without a corresponding increase in mill capacities, and the result is that the mills are now working at very high capacities. At the same time the old standard cane Uba has almost completely been replaced by new varieties. It is, therefore, of interest to see how the milling criteria have been influenced.

Graph No. 1 gives a picture of milling results for the last twenty years. The sucrose per cent. cane remains fairly steady, but shows no improvement with the new canes. We naturally expected sucrose per cent. cane to rise, due to the cleaner cane.

Fibre per cent. cane has fallen slightly, due possibly to cleaner cane (less trash), but this last season due, perhaps, to the low rainfall, it shows a rise. Sucrose lost in bagasse has steadily fallen.

Moisture per cent. bagasse rose steadily to 1936, but it is now steadily falling, reflecting a much better setting of the mills. It may also perhaps be due to more standardised drying and sampling of the bagasse.

Imbibition per cent. cane has risen perceptibly during the latter years, especially last season, due to the higher fibre in the cane and the greater amount of steam available for evaporation due to the greatly improved boiler furnaces.

Extraction of sucrose has risen steadily during the whole period.

Graph No. 2 shows the capacity of the various milling plants. The capacities per hour have increased since the last survey in 1939 by roughly 6 per cent., without the addition of practically any new plant. The average capacities are shown by the straight-line curve, which gives the capacity per hour in tons from the formula

$$\frac{D^2 \times L \times N}{10}$$

where D = diameter of roller in inches,

L = length of roller in inches,

N = number of rollers,

taking a shredder as equal to two rollers.

The capacity in 1939 was given by the formula

$$\frac{D^2 \times L \times N}{10.6}$$

I have adopted Mr. Mackesy's suggestion in 1939 of giving the percentage variation from the mean, and you will see capacities vary from 64 per cent. to 135 per cent. It is to be noted that Central Factory, with the largest percentage, still gets the highest extraction, and Entumeni is not far behind.

These graphs show that the mills are working at very high capacities, and with average extraction this last season of 93.15 per cent, we can conclude that milling in Natal and Zululand has reached a very high standard.

At the last survey in 1939, Mr. Macbeth and I intended taking tests on bagasse to see if we could get the resultant thrust on the top roller of a mill during crushing. This has been proceeded with, but it is difficult to get the actual thrust. Comparison tests were conducted on the final bagasse of Co.290, Co.281 and Uba cane in an hydraulic press. The 500 grams bagasse were compressed in a cylinder 4 inches diameter, 15 inches deep. The bagasse used had 52 per cent. moisture and the results were as follows :—

Tests on Wet Bagasse.

Number of tests	2	3	2
	Co.290	**Co.281**	**Uba**
Original depth of bale in inches	15	15	15
Load on Bagasse lbs. per sq. in.	Depth of Bale in inches.		
224	2.46	2.55	2.46
448	2.21	2.15	2.14
672	2.00	1.94	1.95
896	1.92	1.81	1.85
1,120	1.79	1.79	1.79
1,344	1.73	1.69	1.67
1,568	1.68	1.66	1.62
1,792	1.64	1.63	1.59
2,016	1.60	1.60	1.54
2,240	1.58	1.56	1.51
2,800	1.54	1.52	1.48
3,360	1.51	1.48	1.45
3,920	1.48	1.45	1.42
4,480	1.45	1.42	1.39
5,040	1.42	1.39	1.37
5,600	1.39	1.35	1.34
Weight of wet bagasse grams	500	500	500
Weight of pressed bagasse grams	376	374	373
Juice expressed grams	124	126	127
Moisture per cent. pressed bagasse	36.1	35.8	35.6

You will see that under these pressures the moisture left in bagasse was much the same for the three types of cane, indicating that they should give up their juices equally when milled, and that it is going to be very difficult to get low moistures in bagasse, as a pressure of 5,600 lbs. per square inch is much in excess of the pressure in a mill, which is not likely to be over one-tenth of this pressure.

I applied the above results to a last mill setting, and found that the pressures I was working to were too high.

Graph No. 3 shows the effect of these pressures and complies with the equation

$$PH^5 = 20500,$$

where P is pressure in lbs. per square inch and H the height of the bagasse. Deerr found that in his tests the formula varied as PH_5, confirming our figures.

I then tried to develop this curve for the lower pressure as shown in Graph 4, but it is not near enough and new tests will have to be done for these lower pressures.

The resultant force on the top roller is usually considered to be 15 degrees from the vertical to the cane side of the mill. From the work done, I am inclined to think it is more than this, and especially so in the old type cheek with wide waists.

In 36-inch mills we supplied here, the hydraulics were offset 1 inch from the centre line of the mill, which is equal to roughly 11.5 degrees. It might have been better to have offset them more and thus to get a better balance. This is important for lubrication. The position of the oil grooves, as now adopted, also indicates that the angle is greater than 15 degrees.

Some mills have redesigned and put in new cheeks with short top bolts, giving a narrower waist to the cheeks and trash turner and having the trash turner with outside adjustment. The juice

trays, being of the inverted diamond type, assisting cleaning of the bed and also helping the chokeless pumps by a steadier flow of juice and bagasse.

During the war years many roller shells have been cast here, but the indication is that, although these have done very well, there is room for improvement when compared with Scottish-made rollers.

The engineering shops here have done good work in making new parts for the mills, but we are greatly indebted to our friends in Glasgow for the plant they have made for us while turning out machinery to supply the Allies.

While on rollers, the zig-zag crusher continues to do good work and we have many records of 50 per cent. extraction with these rollers; they must be kept to shape and built up when worn or the extraction falls. Cast-iron or steel mixtures are not good for these rollers, which should be made of cast steel.

To me, it appears that mills fitted with zig-zag crusher rollers do not need further reducing of the bagasse by shredders; but shredders are necessary with splitter type crusher rollers, which leave long pieces of cane.

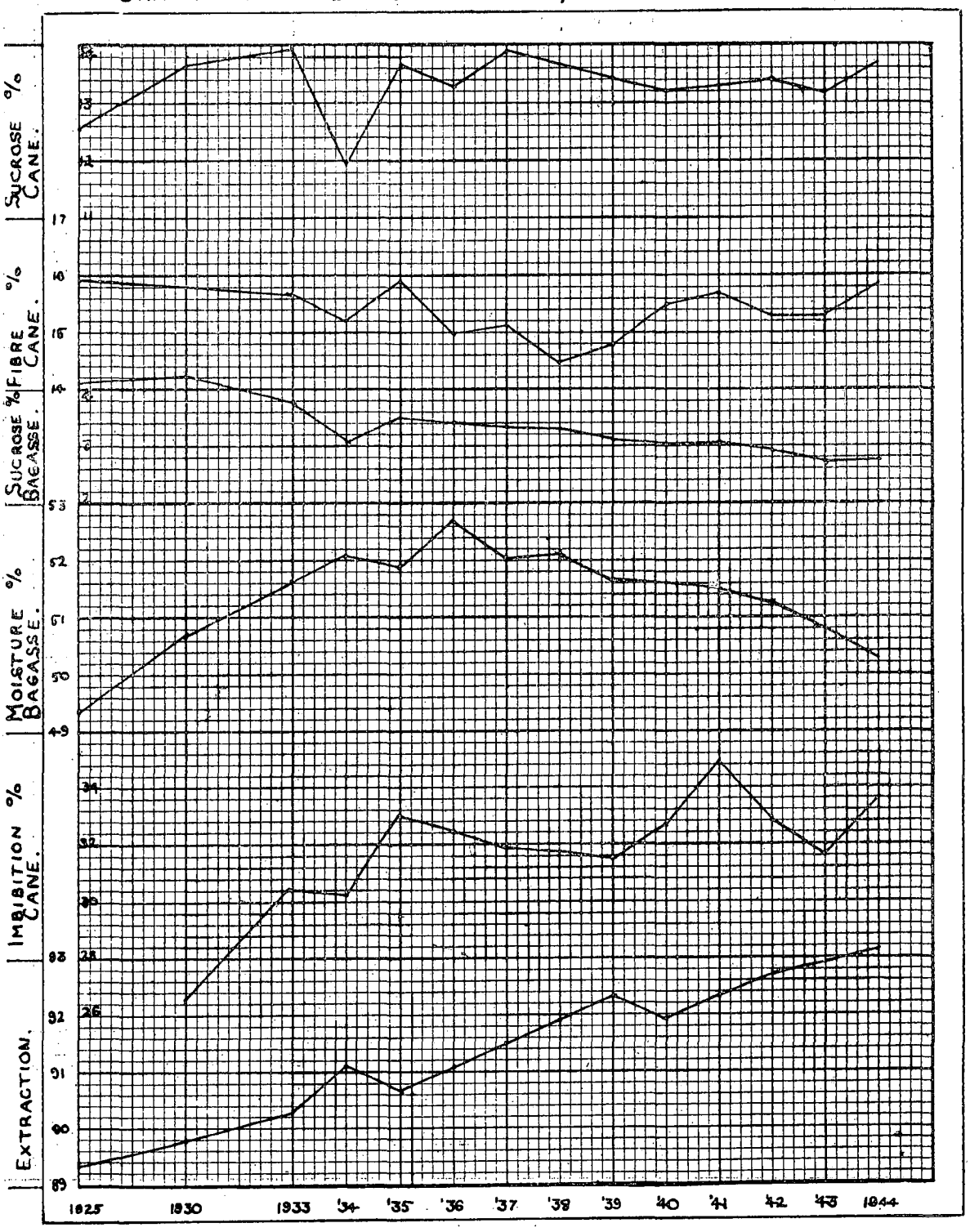
I have found that mills fitted with zig-zag crusher rollers give a higher extraction up to and including the first mill, than mills fitted with shredders, and it might have been better if the shredder had been placed after the first mill.

The feeding of mills has received a good deal of attention here, due to the greatly overloaded capacity of our plants. First we had various rammers, which did good work but were intermittent and clumsy. Then the intermediate carrier was made, sloping to the feed opening of the mill and the nose shaft positively driven. This, although doing good work, was rather drastic on chain wear. Then idle rollers were fitted to the top of the intermediate carriers to flatten the bagasse, but these did not appear to do much good. Then positive driven rollers were put on the top of the nose of the carrier, and this helped a great deal.

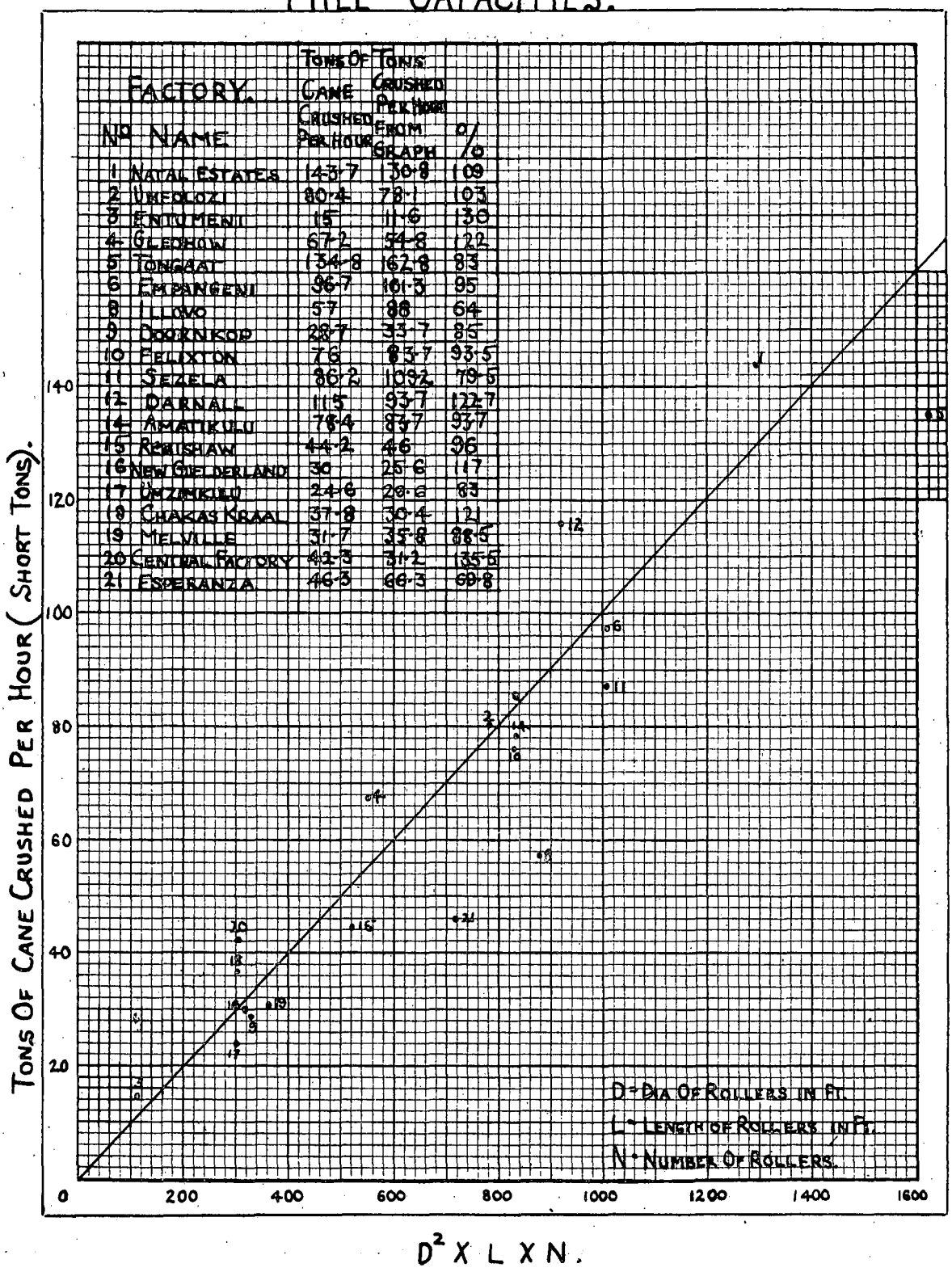
Latterly positive feed rollers have been placed under the top end of the intermediate carrier, squeezing the bagasse against the top roller, and I consider this the best arrangement of all, as it is very positive, continuous and clean.

We have not had an engineering paper for some time, and these views are put forward to create a discussion and in the hope that some of the young engineers will take up and carry forward the torch of engineering progress, which is the base rock of sugar economics. Costs are rising rapidly, and this can only be met by greatly improved methods and labour-saving machinery, otherwise the present economic structure will collapse. We must keep up a continuous advancement of progress and development.

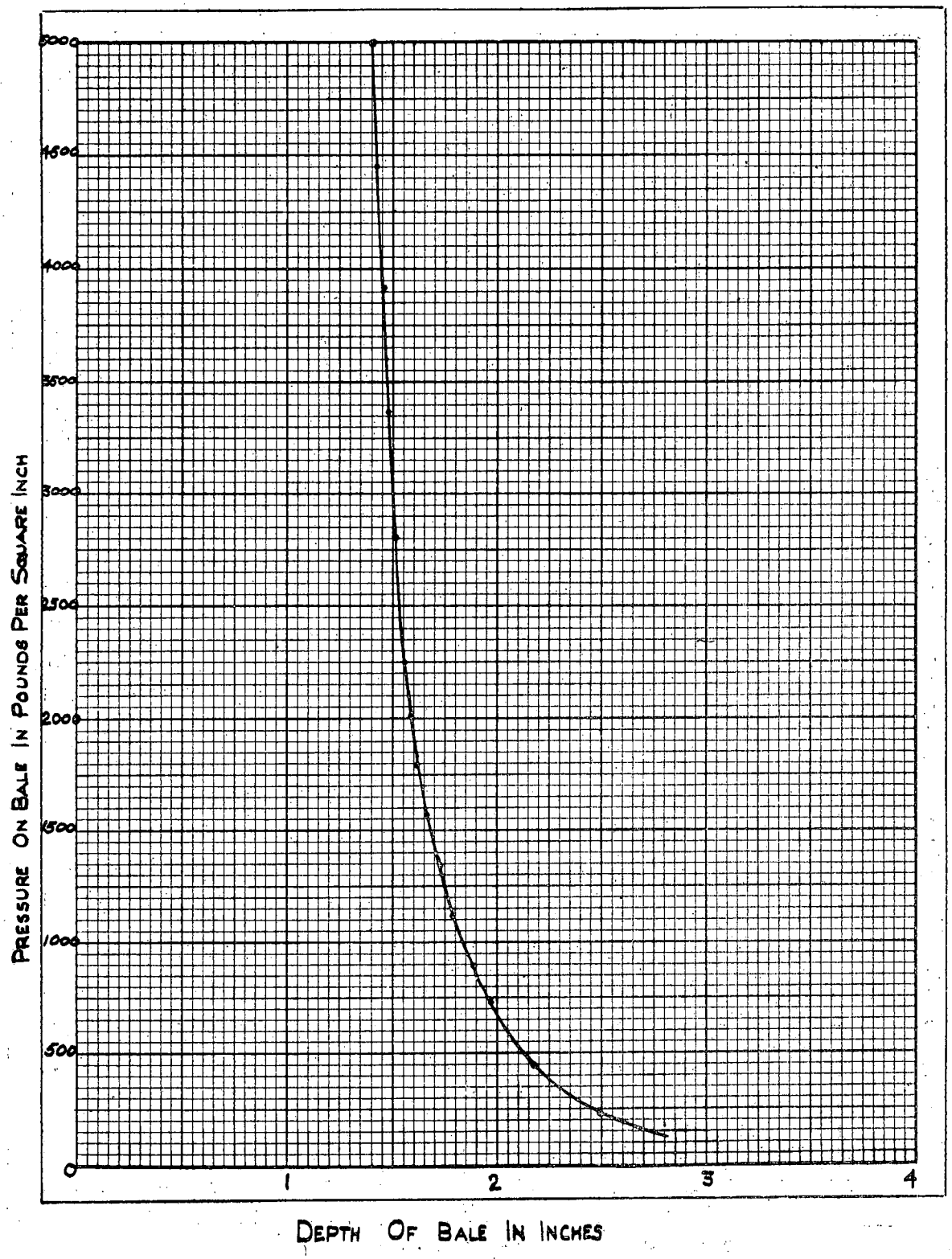
Graphs Of Mill Performance, 1925 - 1944.

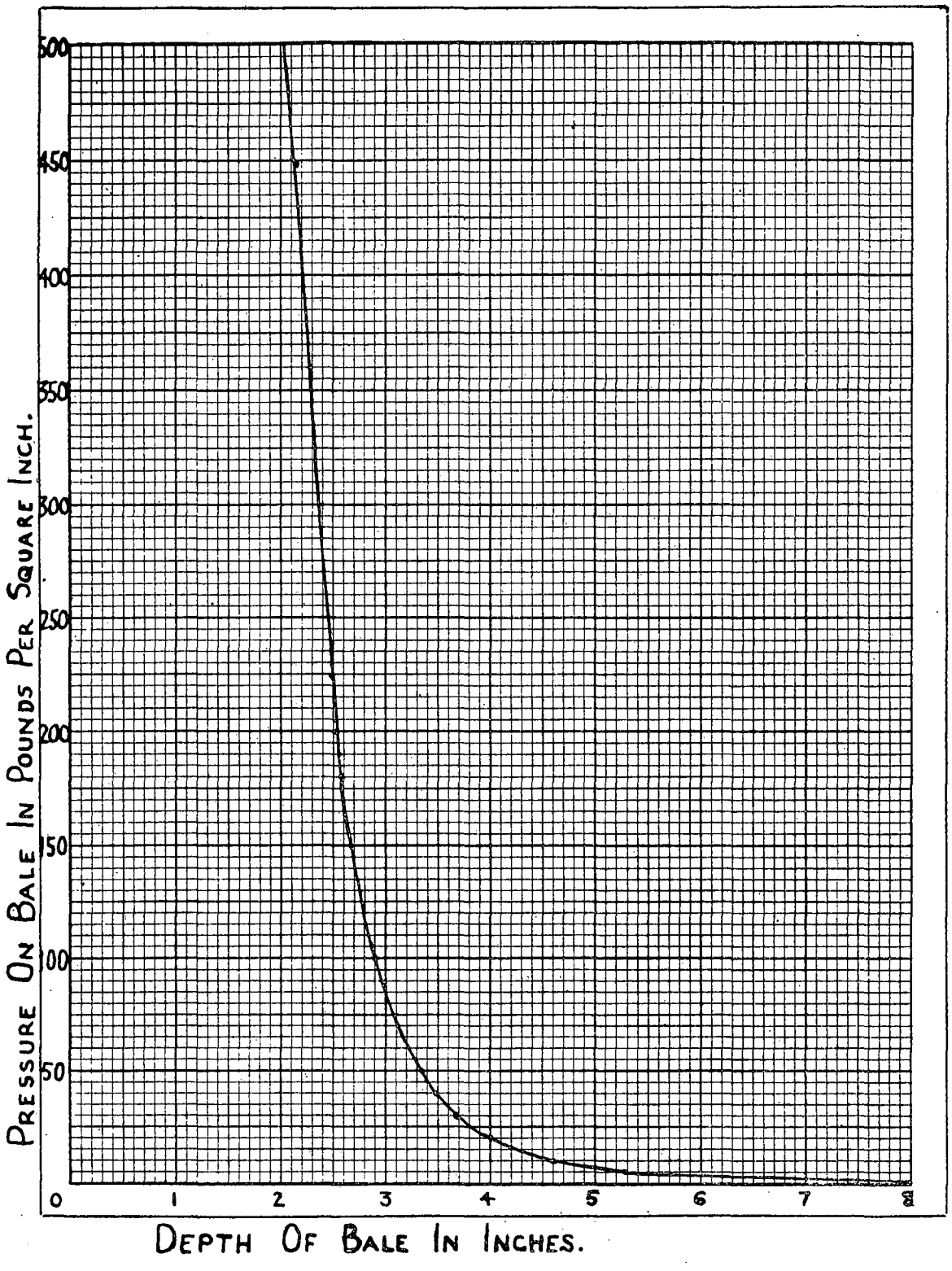


MILL CAPACITIES.



No.	Factory. Name	Tons Of Cane Crushed Per Hour	Tons Crushed Per Hour From Graph	%
1	Natal Estates	143·7	130·8	109
2	Umfolozi	80·4	78·1	103
3	Entumeni	15	11·6	130
4	Gledhow	67·2	54·8	122
5	Tongaat	134·8	162·8	83
6	Empangeni	96·7	101·3	95
7	Illovo	57	88	64
8	Doornkop	28·7	33·7	85
9	Felixton	76	83·7	93·5
10	Sezela	86·2	109·2	79·5
11	Darnall	111·5	93·7	122·7
12	Amatikulu	78·4	83·7	93·7
13	Renishaw	44·2	46	96
14	New Guelderland	30	25·6	117
15	Umzimkulu	24·6	20·6	83
16	Chakas Kraal	37·8	30·4	124
17	Melville	31·7	35·8	88·5
18	Central Factory	42·3	31·2	135·6
19	Esperanza	46·3	66·3	69·8


5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
1
2
3
4
PRESSURE ON BALE IN POUNDS PER SQUARE INCH
DEPTH OF BALE IN INCHES


500
450
400
350
300
250
200
150
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50
0
1
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5
6
7
8
Pressure On Bale In Pounds Per Square Inch.
Depth Of Bale In Inches.

Mr. SIMPSON said that their experience at Maidstone factory had been that we in South Africa could now make a very fine roller. They had installed three cast shells made in South Africa and had now run them for two seasons. The result had been that the average wear on the three rollers had been one-eighth of an inch less than the average wear on the imported rollers. The structure had also been very good, equalling average imported rollers. Steel castings made in South Africa were in his opinion not quite equal to the best that could be imported, but they were nevertheless very good, and they had carried them over the five war years. Industry in this country deserved a great deal of credit for the way it had helped us. Many things which five years ago would have been considered impossible to make in this country were to-day manufactured here, and although we might still have some way to go, we now made many things, if not quite as well, then very nearly as well as the best that could be imported.

The speaker found it rather difficult to understand some figures given by Mr. Murray. He thought the decrease in the depth of the bagasse bale was rather surprisingly small for the tremendous load applied. It was not clear to him either whether the underlying idea of the experiment was to see how tight rollers should be made or to find out what the effect of such a pressure would be on the moisture per cent. bagasse.

Mr. MURRAY agreed that South African-made rollers were very good, but he still preferred the imported article. He was surprised, however, to hear Mr. Simpson's remark as regards cast steel, because that, to his mind, was one thing they could make here. The cast steel produced in this country was as good as any that could be imported. Many other parts of machinery were now made locally but the big disadvantage was the high cost.

In applying various pressures to bagasse he was guided by Noël Deerr's book, but he found that the pressures used were too high. These tests would have to be repeated.

Mr. RAULT said the author worked out the capacity of the different mills and one would expect that if a mill were working at higher than the rated capacity that its extraction would fall, but such was not necessarily the case. The present milling plant at Natal Estates started by crushing 100 tons of cane per hour and having an extraction of 94.2 per cent. Gradually they had increased their throughput and last year they had been crushing about 144 tons of cane per hour with a higher fibre content, and their extraction was 94.8 to 95 per cent. Mr. Murray had mentioned 50 per cent. as the extraction of a crusher. The speaker wished that more extraction figures for individual units were available. It was their experience at Natal Estates that variations in the extraction of the crusher were not necessarily reflected in the final extraction.

Mr. MURRAY in reply said that he did not have the capacities of the different milling plants. He was only working on the average figures of South Africa. He too was very interested in the individual extraction of different units. His own experience was that a double crusher gave better results than a crusher and a shredder.