MUTUAL MILLING CONTROL PROJECT

PROGRESS REPORT No. 2

By E. J. BUCHANAN, K. DOUWES DEKKER and A. VAN HENGEL

Summary

The technologists in charge of milling tandems in Natal are to be congratulated on the remarkable increase in milling efficiency over the last few years. This paper presents the averages and means for the milling data tabulated in connection with the M.M.C.P. during the 1962-63 crushing season. The average figures have been tabulated in such a manner that it is possible to detect reasons for tandems falling into high or low performance groups. In this manner several interesting trends have been established in the relationship between performance and process variables. A notable example is that all milling trains in Natal equipped with shredders preceding the first mill are placed at the top of the high relative performance group. A number of other interesting trends are discussed. It is hoped that during the coming season, data will be sufficiently comprehensive to warrant a thorough multiple regression analysis.

Introduction

The first progress report was read at the 1962 Congress. At that stage only five factories had submitted data over a limited period and it was possible only to point out a few preliminary observations. The response during the 1962-63 season has improved considerably, however, and it is apparent that a more tolerant attitude is being adopted towards the tedium of submitting weekly figures. Still more encouraging is the increasing interest shown by technologists in milling performance and the acceptance of specific performance figures such as lost absolute juice % fibre. It is possible that this renewed interest in judging milling performance on the more specific figures of the M.M.C.P., thereby facilitating a more reliable exchange of information between factories, is connected with the appreciable improvement in performance of South African milling tandems during the past few years as shown on the graph below. However, we do not wish to be too presumptuous in this respect and would rather offer our congratulations to the technologists directly associated with this achievement.

This paper presents a summary of the average milling data for the season 1962-63 and discusses some apparent trends in the relationship between milling variables.

Frequency of Reporting Data

The response from the factories during the last season was encouraging. All except two factories, viz. Umfolozi and Sezela, equipped with lift integrators, were able to submit at least some data as shown in Table 1. However, in several cases some of the figures were omitted and the reporting was intermittent. This detracts considerably from the value of the data. In some cases, several figures were of questionable accuracy.

The frequency of reporting data from each tandem shown in Table 1 should be borne in mind when considering the average values shown in subsequent tables.

Accuracy of Data

In general, with a few obvious exceptions, the process data are reliable. The exceptions appear to fall in the first mill data. Several of the residual absolute juice figures of Table 2 appear to be higher or lower than expected, e.g. those for Pongola and Illovo.

The mechanical data are less accurate. These include data 11 to 18 and 29 to 30 on Table 2. In many cases the fibre index is higher than the reasonable maximum. This is borne out by considering the apparent density of bagasse calculated from

$$\frac{100 \times \text{lb. fibre/cu. ft. escribed volume}}{\text{fibre \% bagasse}}$$

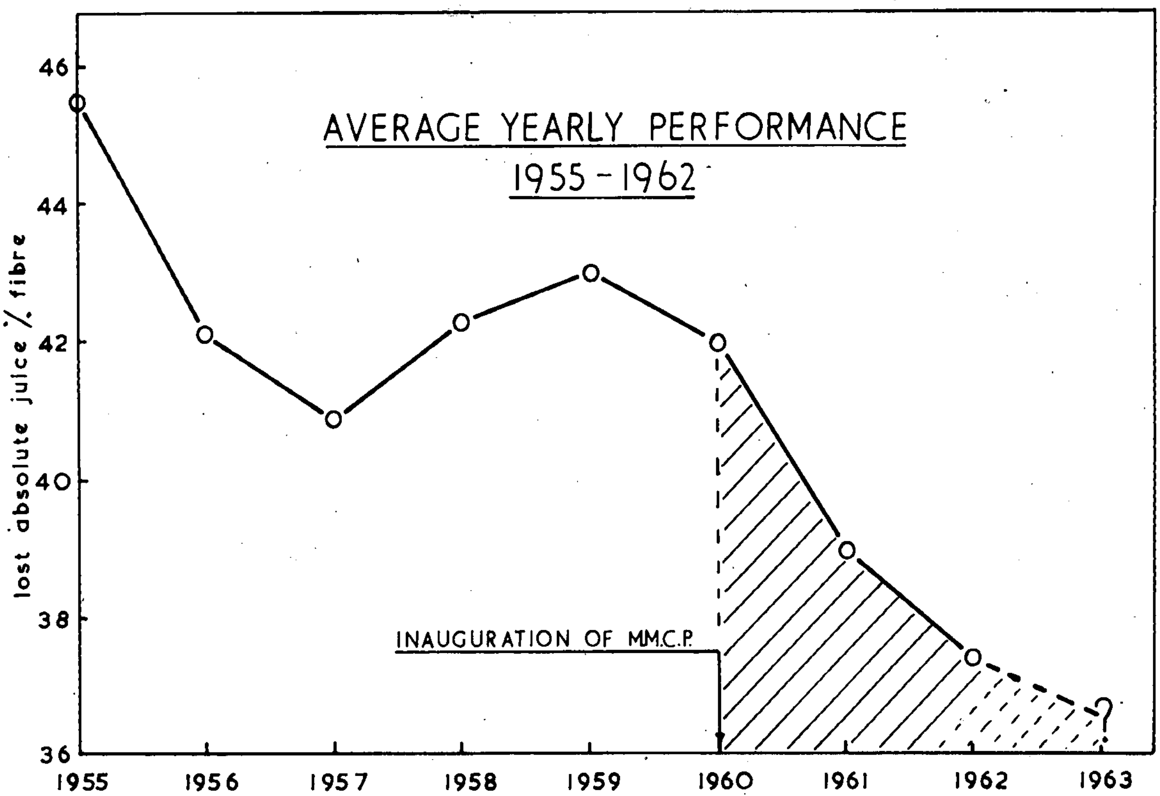
From overseas data, a normal value for this figure is about 110 lb./cu. ft. and values falling in the range 95 to 115 are reasonable. Data 32 and 33 in Table 2 indicate that only about 50 per cent of the fibre indices are reliable. This is unfortunate since the apparent bagasse density calculated by the above formula is a useful guide to the amount of "reabsorption" which occurs as the bagasse passes through a mill. The density of bagasse is about 75 lb./cu. ft. so that any excess over 75 lb. bagasse/cu. ft. escribed roller volume may be attributed to reabsorption.

We hope therefore that particular attention will be paid to increasing the accuracy of assessing the first mill fibre % bagasse and also the measurement of discharge work openings, speeds and diameters of both first and last units.

Trends Noted from 1962-63 Data

Unfortunately, the data submitted during the last season was not sufficiently comprehensive or accurate to warrant a detailed analysis. A survey of the figures rearranged in Tables 3, 4 and 5 in order of performance has indicated several trends but it is now clear that due to interactions between the independent variables a multiple regression analysis is unavoidable if the various relationships are to be accurately determined. This is an extremely tedious process and would best be carried out by a specialist in statistics as was the case in a similar analysis on a single tandem conducted by Haines and Hughes discussed at the 11th Congress of the I.S.S.C.T. in Mauritius last year[3].

A simple method of determining trends in the dependence of milling performance on the variables



was adopted. Three dependent variables, viz. relative performance, lost juice and residual first mill juice were chosen and arranged in order of decreasing merit as in Tables 3 to 5. Tandems above the mean performance were arbitrarily termed high performance and those below, low performance. The applicable process data were arranged in columns corresponding to each tandem. The figures were then examined in order to detect obvious differences in magnitude between the upper and lower groups, i.e. above and below the mean line. The disadvantage of this type of analysis is that relationship may be obscured by interactions. For example, in Table 5 there is no clear evidence that a high top roller pressure decreases the residual juice but this may be obscured by the existence of a high peripheral speed which could increase reabsorption and hence nullify the advantage of the high pressure. For this reason an additional figure, viz.

$$\frac{\text{specific pressure}}{\text{surface speed}}$$

has been added in Table 5. This is a more enlightening figure and clearly shows that a high value of this ratio corresponds to good first mill performance and the reason for exceptions becomes clear. This is elaborated below.

Having explained the method of analysis, some trends are discussed in the following sections.

Variables Related to Relative Performance

Few technologists are able to concentrate on the economic aspect of milling, their attention being fully occupied with the efficient manufacture of the primary product, viz., sugar. It is quite normal, therefore, that a healthy spirit of competition exists between technologists in charge of milling tandems in attaining the lowest lost absolute juice % fibre. This is of course, to be commended. However, we are ultimately concerned with the annual return per unit installation. Hence, in order to compare the overall performance of tandems of different sizes, it is necessary to consider both efficiency and throughput. On this basis, the relative performance of a milling tandem is proportional to the specific feed rate and inversely proportional to the lost absolute juice % fibre. Thus:

Specific feed rate = lb. fibre/cu. ft. T.R.V.

$$\text{Relative performance} = \frac{100 \times \text{lb. fibre/cu. ft. T.R.V.}}{\text{lost absolute juice \% fibre}}$$

The term, relative performance, therefore expresses the efficiency modified to account for the ratio of fibre rate to installed roller volume.

The various tandems are tabulated in order of decreasing relative performance in Table 3. We now have a true picture of which mills are performing the best work and this provides a useful basis for considering which preparatory devices are capable of rendering the best support to a milling train. Referring to the column headed "Units" in Table 3, it is interesting to notice that the high performance group comprises tandems equipped with shredders and those without shredders, viz. PG, UK, FX_1 and $UF_1/_2$, fall at the end of the low performance group. A notable exception is FX_2 which is unique in having only *one* set of knives. The value of shredders has long been realized in Natal and there are very few remaining sceptics in this respect. But this is probably the first clear distinction which has been shown in figures.

Even more startling are the first four tandems of the high performance group, viz. DL, ZM, TS_1 and $SZ_1/_2$ for these comprise all the tandems with the IIS preparatory arrangement, i.e. two knives followed directly by a shredder. This is not a thorough statistical analysis but it would appear highly significant that the top performance tandems in Natal with respect to throughput and efficiency have shredders directly following the knives. The arrangement has been recommended by the S.M.R.I.[2,4], and the reverse arrangement of two knives, a three roller unit, followed by the shredder was favoured in a discussion published in the S.A.S.J. in 1958.[1] However, this is the first clear distinction on a statistical basis. The advantage of the IIS arrangement over that of the II1S would appear to be that the former feeds a more constant bulk density material to the milling train thereby maintaining weight and volumetric feed rates closer to the optimum values necessary for maintaining constant imbibition/fibre and fibre/escribed volume ratios. This is in addition to the usual improved preparation attained by a shredder.

In this connection it is appropriate to note the improved performance of ZSM tandem after installing a shredder:

Factory	ZSM	ZSM
Period	1961-62	1962-63
Units	II6	IIS6
Tons fibre/hr.	26.1	28.6
Lost ab. juice % fibre ..	41.2	34.0

Continuing the discussion of factors affecting relative performance, Table 3 indicates that the larger tandems appear in the high performance group. Extreme imbibition rates, both low and high, appear in both performance groups so that the imbibition rate is unlikely to have a major effect on performance (within a reasonable range). Likewise, the absolute juice % cane is not of major importance. Several tandems with abnormally high mill ratios and feeder ratios appear in the low performance group. There is no obvious trend in the roller pressure and speed figures, but this is very likely due to interactions. It is significant that the tandems with abnormally high residual absolute juice % first mill begasse all fall into the low performance group. No definite trend is shown in the fibre index figures but these are incomplete and some are obviously inaccurate.

Summarizing the above trends, it appears that a good relative performance is associated with tandems fitted with shredders particularly when the shredder precedes the first mill, with the larger installations, with mill ratios in the region of 2, feeder ratios in the region of 6 and a good first mill performance.

Variables Related to Residual First Mill Juice

As pointed out in the previous section, a good first mill performance is conducive to high overall performance. In Table 4, the tandems are tabulated in order of decreasing first mill efficiency expressed in terms of residual absolute juice % first mill bagasse. Again, the milling trains headed by shredders appear in the upper performance group. However TS_1 appears rather low in this group, but this may be due to the low specific pressure on the top roller of only 16 lb./sq. ft. projected roller area. In fact it appears that the low pressure mills all tend towards the low efficiency group. No clear effect of pressure and speed is apparent, however, due probably to interactions. For this reason, the effects have been combined in the ratio:

$$\frac{100 \times \text{specific pressure in lb/sq. ft. projected roller area}}{\text{peripheral speed in ft./min.}}$$

the values of which appear in the last column of Table 4. The highest values appear in the high efficiency group indicating that high specific pressures and low peripheral speeds are conducive to efficient milling. In this connection, it is interesting to note that though the tandems FX_1, TS_2 and UK (particularly the latter) are not preceded by shredders, the high pressure/speed ratios probably raise their first mill efficiency to the upper group. It would appear that FX_2, in spite of having an average pressure and a low speed, is unable to compete with other first mills due in all likelihood to the presence of only *one* set of knives.

In this analysis, the fibre index shows a more definite trend, the high values falling in the high performance group.

Summarizing these trends, it appears that good first mill efficiency is associated with mills preceded by two knives and a shredder, high pressures and low speeds and high fibre indices indicating good feeding.

Variables Related to Lost Absolute Juice

Having discussed the variables associated with high milling efficiency at high throughput and first mill efficiency, the discussion is now limited to the variables affecting high overall efficiency regardless of throughput. In Table 5, the tandems are tabulated in order of decreasing efficiency expressed in terms of lost absolute juice % fibre in last mill bagasse. Again the tandems equipped with shredders preceding the first mills fall in the higher efficiency group, as do the larger tandems. There is some indication that the low specific fibre rate tandems tend to the high efficiency group and vice versa. There is no clear trend with respect to imbibition rates. Dilution ratios appear to be closely related to lost absolute juice and this indicates that efficient imbibition (not necessarily high rates) is an important factor. Low final bagasse moistures all fall in the high efficiency group. Finally, the tandems having an abnormally high residual absolute juice % fibre in first mill bagasse all fall in low efficiency group.

Summarizing the above trends, high milling efficiency is associated with milling trains preceded by shredders, the larger installations, good first mill efficiency and low final moistures. Efficient imbibition is important.

Conclusions

The average data in Table 2 should provide a useful means for checking abnormalities in low performance milling tandems. The data have proved extremely useful to the S.M.R.I. in advising factories on adjustments and new installations. The trends discussed in the latter sections, though based on a superficial analysis, nevertheless warrant serious consideration. Particularly worthy of note is the fact that high efficiency at high throughput is best attained by milling trains preceded by two knives and a shredder. In general, there is no evidence to show that high imbibition rates are necessary in order to attain high performance. However, efficient imbibition is important. Attention should be focussed on mill and feeder settings and also on pressures and roller speeds. High first mill performances and low final bagasse moistures should be a target.

The S.M.R.I. invite the wholehearted participation of technologists concerned with milling in the M.M.C.P. during the 1963-64 season. Particular attention should be paid to the accuracy of data. It is hoped that the data will be sufficiently comprehensive to warrant a detailed regression analysis by which definite relationships in milling variables will be established.

Finally it should be pointed out that technologists whose mills fall in the low efficiency group may derive some consolation in the fact that the average lost absolute juice % fibre in this country is now close to being the lowest in the world.

Acknowledgments

The authors wish to extend their sincere thanks to the chemists and engineers who have devoted so much of their valuable time during the 1962-63 season to measurements, analyses and calculations in order to submit the data presented in this paper. We are particularly grateful to the factory managers who have shown so much interest in this project.

We should also mention that Mr. D. J. Collingwood assisted with the calculations.

References

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[2]Buchanan, E. J., S.A. Sugar Jnl., 1961, **45**, (10), 895.

[3]Haines, W. S., and Hughes, R. H., Proc. XIth Congress I.S.S.C.T., 1962. (To be published.)

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Table 1

FREQUENCY OF REPORTING MILLING DATA

Week	PG	UF_1	UF_2	ZM	FX_1	FX_2	AK	DK	DL	MV	TS_1	TS_2	NE	IL	RN	SZ_1	SZ_2	UK	Total
0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	X	—	—	—	1
1	—	O	O	—	O	O	X	—	X	—	—	—	—	O	O	—	—	—	2
2	—	O	O	—	O	O	X	—	X	O	—	—	X	O	X	—	—	—	4
3	—	O	O	O	O	O	X	—	X	O	—	—	X	O	X	O	O	—	4
4	—	O	O	O	O	X	X	—	X	O	—	—	X	O	X	O	O	—	5
5	O	O	O	O	O	X	X	O	X	X	O	O	X	O	X	O	O	—	6
6	O	O	O	O	O	X	X	O	—	X	O	O	X	O	X	O	O	O	5
7	O	O	O	O	O	X	X	O	X	X	O	O	X	O	X	O	O	O	6
8	O	O	O	O	O	X	X	O	X	X	O	O	X	O	X	O	O	O	6
9	O	O	O	O	O	X	X	O	X	X	O	O	X	O	X	O	O	O	6
10	O	O	O	O	X	X	X	O	X	X	O	O	X	O	X	O	O	O	7
11	X	O	O	O	X	O	X	O	X	X	O	O	X	X	X	O	O	O	8
12	X	O	O	O	X	X	X	O	X	X	O	O	X	X	X	O	O	O	9
13	X	O	O	X	O	X	X	O	X	X	O	O	X	X	X	O	O	O	9
14	X	O	O	X	O	X	X	O	X	X	O	O	X	X	X	O	O	O	9
15	X	O	O	O	O	X	X	O	X	X	O	X	X	X	X	O	O	O	9
16	X	O	O	O	O	X	X	O	X	X	O	X	X	X	X	O	O	O	9
17	X	O	O	O	X	O	X	O	X	X	O	X	X	O	O	O	O	O	7
18	X	O	O	X	O	O	X	O	—	X	O	X	X	X	X	O	O	O	8
19	X	O	O	X	O	O	X	O	X	X	O	X	X	X	X	O	O	O	9
20	X	O	O	O	O	O	X	O	X	X	O	X	X	X	X	O	O	O	8
21	X	O	O	X	O	X	X	O	X	X	O	X	X	X	X	O	O	O	10
22	X	O	O	O	O	X	X	O	X	X	O	X	X	X	X	O	O	O	9
23	X	O	O	X	O	X	X	O	X	X	O	X	X	X	X	O	O	O	10
24	X	O	O	X	O	O	X	O	X	X	O	X	X	X	X	O	O	O	9
25	X	O	O	O	O	O	X	X	X	X	O	X	X	X	X	O	O	O	9
26	X	O	O	X	O	O	X	X	X	X	O	X	X	X	X	O	O	O	10
27	X	O	O	O	O	O	X	X	X	X	O	X	X	X	X	O	O	O	9
28	X	O	O	O	O	O	X	X	X	X	O	X	X	O	X	O	O	O	8
29	X	O	O	O	O	O	X	X	X	X	X	X	X	X	X	O	O	O	10
30	X	O	O	O	O	O	O	X	X	X	X	X	X	X	X	O	O	X	10
31	X	O	O	O	O	O	O	X	X	X	X	X	X	O	X	O	O	X	9
32	X	O	O	O	O	O	X	O	X	X	X	X	X	X	X	O	O	X	10
33	X	O	O	O	O	O	X	O	O	X	X	X	X	X	X	O	O	X	9
34	X	O	O	O	O	O	X	O	X	X	X	X	X	X	X	O	O	O	9
35	X	O	O	X	O	O	O	O	X	X	X	X	X	X	O	O	O	O	8
36	X	O	O	O	O	O	X	—	X	X	X	X	X	X	X	O	O	—	9
37	X	O	O	O	O	O	X	—	X	O	X	X	X	O	—	O	O	—	6
38	X	O	O	X	O	O	X	—	X	O	X	X	X	O	—	O	O	—	7
39	X	O	O	O	O	O	X	—	X	O	X	X	X	X	—	O	O	—	7
40	O	O	O	O	O	O	X	—	X	O	X	X	X	X	—	O	O	—	6
Total	29	0	0	10	4	15	37	7	37	32	12	26	39	25	34	0	0	4	311

Week 0: 30 April — 5 May, 1962

Week 40: 2 Feb. — 9 Feb., 1963

O=No data submitted, X=Data submitted, —=Not crushing.

TABLE 2

AVERAGES OF WEEKLY MILLING DATA 1962/63

Crushing Period: 30th April, 1962 to 9th February, 1963	PG IIG5 588	UF_1 II6P 1045	UF_2 IIC6 777	ZM IIS6 986	FX_1 IICC6 886	FX_2 I1S5 549	AK II2S4 745	DK II1S5 541	DL IIS6 1212	MV IICS5 304	TS_1 IIS6P 1176	TS_2 IIS6P 653	NE II1S5P 1212	IL IICS5 625	RN IICC5 379	SZ_1 IIS5 520	SZ_2 IIS5 520	UK II5 378	**Mean Average** 728
FEED RATES																			
1. Tons cane crushed/week	15,093			23,473	13,017	8,881	14,296	8,982	25,585	6,907	20,397	9,072	21,081	18,568	7,053			8.670	14,363
2. Tons cane/crushing hour	114.7			170.3	90.3	62.9	104.9	70.8	189.1	53.9	146 9	67.0	158.8	86.6	52.5			63.1	102.3
3. Tons fibre/crushing hour	15.8			28.7	13.5	10.0	17.1	11.7	30.8	8.4	24.8	10.9	24.8	14.2	8.1			9.9	16.3
4. Lbs. fibre/(hour) (T.R.V.)	53.7	(22)		58.2	30.5	36.4	45.9	43.3	50.8	55.3	42.2	33.4	40.9	45.4	42.7	(43)		52.5	45.1
5. Imbibition % fibre	227	(294)		367	305	280	251	216	383	217	179	203	228	244	204	(249)		258	254
QUALITY OF PROCESS MATERIALS																			
6. Fibre % cane	13.80			16.86	14.93	15.98	16.33	16.50	16.22	15.70	16.90	16.29	15.50	14.70	15.27			15.63	15.76
7. Absolute juice % fibre in cane	626			494	570	533	514	508	517	540	492	515	543	575	553			538	537
8. Fibre % bagasse ex Unit 1	21 59			29.12	30.19	20.30	24.47	20.81	31.84	28.58	26.32	27.38	25.64	31.99	—			26.27	26.53
9. Fibre % bagasse ex Unit Z	39.25			43.91	40 46	45.13	44.23	43.67	46.23	43.28	47.73	47.83	46.17	45.42	46.73			41.95	44.43
10. Moisture % bagasse ex Unit Z	56 51			53.10	53.75	52.01	52.81	52.49	51.38	52.87	49.47	49.49	51.41	51.17	50.40			54.17	52.22
11. Average top roller lift unit 1, in.	0 41			0.16	0.06	0.13	0.36	0.15	0.20	0.13	0.18	0.36	0.50	0.18	0.15			0.20	0.23
12. Average top roller lift unit Z, in.	0 17			0.18	0.28	0.14	0.18	0.19	0 26	0.24	0.17	0.18	0.23	0.10	0.14			0.14	0.19
13. Discharge work opening unit 1, in.	1 59			1.28	1.74	1.68	1.30	1.14	1.63	0.78	1.90	1.19	1.77	1.85	1.41			1.26	1.47
14. Discharge work opening unit Z, in.	0 82			0.85	0.58	0.45	1.15	0.53	1 00	0.59	1.08	0.87	0.68	0.98	0.67			0.57	0.77
15. Mill ratio (between work opening) unit 1	2.19			2.15	1.67	1.90	2.05	2.27	2.05	3.08	1.66	2.91	2.18	1.89	2.05			2.04	2.15
16. Mill ratio (between work opening) unit Z	2.35			2.13	2.00	1.92	1.96	2.46	2.77	2.43	1.64	2.88	2.18	1.97	2.56			1.91	2.23
17. Feeder ratio (on discharge work opening) unit 1	8.49*			6.21	5.65	7.27	—	—	5.31	10.96	6.16	—	—	6.20	—			7.68	7.10
18. Feeder ratio (on discharge work opening) unit Z	8 94			6.39	7.92	10.68	—	11.93	5.31	5.50	—	8.71	1.71*	5.33	8.48			6.12	7.25
19. Total hydraulic load, unit 1, ton	398			400	250	255	342	283	615	186	327	314	366	415	229			363	339
20. Total hydraulic load, unit Z, ton	372			438	401	301	384	339	621	189	341	365	465	475	288			268	375
21. Specific hydraulic load unit 1, ton/ft.	72			57	49	50	53	51	88	41	47	57	52	69	51			73	58
22. Specific hydraulic load unit Z, ton/ft.	68			63	73	60	69	62	89	42	49	66	66	79	57			54	64
23. Specific hydraulic pressure unit 1, ton/sq. ft.	26.4			19.1	18.5	20.8	17.5	19.5	25.4	19.7	16.0	20.9	15.2	25.8	24.5			31.7	21.5
24. Specific hydraulic pressure unit Z, ton/sq. ft.	24 6			20.3	25.1	22.5	24.5	23.3	25.2	18.6	15.9	22.7	20.0	27.6	23.2			22.0	22.5
25. Top-roller surface speed unit 1, ft./min.	27.0			48.4	18.5	16.4	31.5	23.3	33.7	23.9	21.8	15.6	35.1	26.4	16.5			22.5	25.8
26. Top-roller surface speed unit Z, ft./min.	34 9			45.1	23.1	22 9	24.9	26.3	28.9	26.1	—	22.2	34.1	21.7	18.5			32.8	27.8
SPECIFIC PERFORMANCE DATA																			
27. Residual absolute juice % fibre in bagasse, unit 1	374			232	218	392	307	377	208	245	273	254	281	205	—			271	280
28. Lost absolute juice % fibre in bagasse, unit Z	50.1	(38)		33.3	39.3	38.7	36.2	46.4	27.1	46.0	31.2	30.8	31.3	40.2	32.4	(33)		50.9	38.1
29. Fibre index unit 1, 1b fibre/cu. ft. escr. vol.	27.1			26.7	30.7	29.4	25.7	33.6	32.8	40.8	41.7	46.2	23.0	19.3	30.7			26.6	31.0
30. Fibre index, unit Z, lb. fibre/cu. ft. escr. vol.	40.6			44.1	74.4	78 9	43.1	62.8	59.5	49.7	—	43.0	62.1	44.5	53.8			44.3	53.9
31. Dilution ratio	73			82	75	72	77	67	83	68	76	77	79	70	75			67	74
32. Apparent density of bagasse, unit 1	126			92	102	145	105	161	103	143	—	169	90	60	—			100	117
33. Apparent density of bagasse, unit Z	103			100	184	195	97	144	129	115	158	90	135	98	115			106	121

KEY:
- P = Unit with Pressure Feeder
- G = Unit with Gravity Feed Chute
- I = Set of knives
- C = Two-roller crusher
- S = Shredder
- 1–6 = 3-roller mill units
- T.R.V. = Total roller volume

Unit 1 = first 3-roller unit

Unit Z = last 3-roller unit

*Pressure feeder setting ratio or gravity chute opening ratio.

Figures shown in (brackets) are averaged from general weekly returns.

TABLE 3

MILLING DATA IN ORDER OF RELATIVE PERFORMANCE

Data:	Relative Performance*	Tandem	Units	T.R.V.	Imbibition % fibre	Absolute juice % fibre in cane	Moisture % bagasse ex Unit Z	Mill ratio (between work-opening) unit 1	Mill ratio (between work-opening) unit Z	Feeder ratio (on discharge work-opening) unit 1	Feeder ratio (on discharge work-opening) unit Z	Specific hydraulic pressure unit 1, ton/sq. ft.	Specific hydraulic pressure unit Z, ton/sq. ft.	Top-roller surface speed unit 1, ft./min.	Top-roller surface speed unit Z, ft./min.	Residual absolute juice % fibre in bagasse, unit 1	Fibre index unit 1, lb fibre/cu. ft. escr. vol.	Fibre index, unit Z, lb fibre/cu. ft. escr. vol.
High Performance Tandems	187	DL	**IIS6**	**1212**	383	517	51.38	2.1	2.8	5.3	5.3	25.4	25.2	33.7	28.9	208	32.8	59.5
	175	ZM	**IIS6**	**986**	367	494	53.75	2.2	2.1	6.2	6.4	19.1	20.3	48.4	45.1	232	26.7	44.1
	135	TS	**IIS6P**	**1176**	179	492	49.47	1.7	1.6	6.2	—	16.0	15.9	21.8	—	273	41.7	—
	(133)	$SZ_{1/2}$	**IIS5**	520	(249)	—	(50.54)	—	—	—	—	—	—	—	—	—	—	—
	132	RN	IICC5	379	204	553	50.40	2.1	2.6	—	8.5	24.5	23.2	16.5	18.5	—	—	—
	131	NE	II1S5P	**1212**	228	543	51.41	2.2	2.2	—	—	15.2	20.0	35.1	34.1	281	30.7	53.8
	127	AK	II2S4	745	251	514	52.81	2.1	2.0	—	—	17.5	24.5	31.5	24.9	307	25.7	43.1
Mean:	124	**Mean**	—	728	254	537	52.22	2.2	2.2	7.1	7.3	21.5	22.5	25.8	27.8	280	31.0	53.9
Low Performance Tandems	120	DK	II1S5	541	216	508	52.49	2.3	**2.5**	—	**11.9**	19.5	23.3	23.3	26.3	**377**	33.6	62.8
	120	MV	IICS5	304	217	540	52.87	**3.1**	**2.4**	**11.0**	5.5	19.7	18.6	23.9	26.1	245	40.8	49.7
	113	IL	IICS5	625	244	575	51.17	1.9	2.0	6.2	5.3	25.8	27.6	26.4	21.7	205	19.3	44.5
	107	TS_2	IICS5	653	203	515	49.49	**2.9**	**2.9**	—	**8.7**	20.9	22.7	15.6	22.2	254	46.2	43.0
	107	PG	IIG5	588	227	626	56.51	2.2	**2.4**	**8.5**	**8.9**	26.4	24.6	27.0	34.9	**374**	27.1	40.6
	103	UK	II5	378	258	538	54.17	2.0	1.9	**7.7**	6.1	31.7	22.0	22.5	32.8	271	26.6	44.3
	94	FX_2	I1S5	549	280	533	52.01	1.9	1.9	**7.3**	**10.7**	20.8	22.5	16.4	22.9	**392**	29.4	78.9
	78	FX_1	IICC6	886	305	570	53.75	1.7	2.0	5.7	**7.9**	18.5	25.1	18.5	23.1	218	30.7	74.4
	(58)	$UF_{1/2}$	II6P	1045	—	—	—	—	—	—	—	—	—	—	—	—	—	—
			IIC6	777	(294)	—	(52.88)	—	—	—	—	—	—	—	—	—	—	—

$$^*\frac{100 \text{ lb. fibre/(hr.) (T.R.V.)}}{\text{lost abs. juice \% fibre}}$$

N.B.—The bold figures show significant trends.

TABLE 4

MILLING DATA IN ORDER OF RESIDUAL FIRST MILL JUICE

Data:	Residual absolute juice % fibre in bagasse, unit 1	Tandem	Units	Absolute juice % fibre in cane	Mill ratio (between work-openings), unit Z	Feeder ratio (on discharge work-opening) unit 1	Specific hydraulic pressure unit 1, ton/sq. ft.	Top-roller surface speed unit 1, ft./min.	Fibre index unit 1, lb fibre/cu. ft. escr. vol.	100 pressure/speed ratio*
High Efficiency First Mills	205	IL	IICS5	575	1.9	6.2	25.8	26.4	19.3	**98**
	208	DL	**IIS6**	517	2.1	5.3	25.4	33.7	**32.8**	75
	218	FX_1	IICC6	570	1.7	5.6	18.5	18.5	30.7	**100**
	232	ZM	**IIS6**	494	2.2	6.2	19.1	48.4	26.7	39
	245	MV	IICS5	540	3.1	10.9	19.7	23.9	**40.8**	41
	254	TS_2	IICS5	515	2.9	—	20.9	15.6	**46.2**	**133**
	271	UK	II5	538	2.0	7.7	31.7	22.5	**26.6**	**141**
	273	TS_1	**IIS6P**	492	1.7	6.2	**16.0**	21.8	**41.7**	73
Mean:	280	**Mean**	—	537	2.2	7.1	21.5	25.8	31.0	83
Low Efficiency First Mills	281	NE	II1S5P	543	2.2	—	**15.2**	35.1	23.0	43
	283	DK	II1S5	508	2.3	—	19.5	23.3	33.6	84
	307	AK	II2S4	514	2.1	—	**17.5**	31.5	25.7	56
	374	PG	IIG5	626	2.2	8.49	26.4	27.0	27.1	98
	392	FX_2	I1S5	533	1.9	7.3	20.8	16.4	29.4	127
		RN	—	—	—	—	—	—	—	—
	No	$SZ_{1/2}$	—	—	—	—	—	—	—	—
	Data	$UF_{1/2}$	—	—	—	—	—	—	—	—

$$*100 \times \frac{\text{lb./sq. ft. projected area (of top roller, unit 1)}}{\text{ft./min.}}$$

TABLE 5

MILLING DATA IN ORDER OF LOST JUICE

Data:	Lost absolute juice % Fibre in bagasse, unit Z	Tandem	Units	T.R.V.	Lbs. fibre/(hour) (T.R.V.)	Imbibition % fibre	Absolute juice % fibre in cane	Moisture % bagasse ex unit Z	Specific hydraulic pressure unit 1, ton/sq. ft.	Specific hydraulic pressure unit Z, ton/sq. ft.	Top-roller surface speed unit 1, ft./min.	Top-roller surface speed unit Z, ft./min.	Residual absolute juice % fibre in bagasse, unit 1	Fibre index, unit 1, lb fibre/cu. ft. escr. vol.	Fibre index, unit Z, lb. fibre/cu. ft. escr. vol.	Dilution Ratio
High Efficiency Tandems	27.1	DL	**IIS6**	**1212**	50.8	383	517	**51.38**	25.4	25.2	33.7	28.9	208	32.8	59.5	**83**
	30.8	TS_2	IICS5	653	33.4	203	515	**49.49**	20.9	22.7	15.6	22.2	254	46.2	43.0	**77**
	31.2	TS_1	**IIS6P**	**1176**	42.2	179	492	**49.47**	16.0	15.9	21.8	—	273	41.7	—	**76**
	31.3	NE	II1S5P	**1212**	40.9	228	543	**51.41**	15.2	20.0	35.1	34.1	281	23.0	62.1	**79**
	32.4	RN	IICC5	379	42.7	204	553	**50.40**	24.5	23.2	16.5	18.5	—	30.7	53.8	**75**
	33.0	$SZ_{1/2}$	**IIS5**	520	(43.0)	(249)	—	**(50.54)**	—	—	—	—	—	—	—	—
	33.3	ZM	**IIS6**	**986**	58.2	367	494	53.10	19.1	20.3	48.4	45.1	232	26.7	44.1	**82**
	36.2	AK	II2S4	**745**	45.9	251	514	52.81	17.5	24.5	31.5	24.9	307	25.7	43.1	**77**
	38.0	$UF_{1/2}$	II6P	**1045**												
			IIC6	**777**	(22.0)	(294)	—	(52.88)	—	—	—	—	—	—	—	—
Mean:	38.1	**Mean**	—	728	45.1	254	537	52.22	21.5	22.5	25.8	27.8	280	31.0	53.9	74
Low Efficiency Tandems	38.7	FX_2	I1S5	549	36.4	280	533	52.01	20.8	22.5	16.4	22.9	**392**	29.4	78.9	72
	39.3	FX_1	IICC6	886	30.5	305	570	53.75	18.5	25.1	18.5	23.1	218	30.7	74.4	75
	40.2	IL	IICS5	625	45.4	244	575	51.17	25.8	27.6	26.4	21.7	205	19.3	62.1	70
	46.0	MV	IICS5	304	55.3	217	540	52.87	19.7	18.6	23.9	26.1	245	40.8	49.7	68
	46.4	DK	II1S5	541	43.3	216	508	52.49	19.5	23.3	23.3	26.3	**377**	33.6	62.8	67
	50.1	PG	IIG5	588	53.7	227	626	56.51	26.4	24.6	27.0	34.9	**374**	27.1	40.6	73
	50.9	UK	II5	378	52.5	258	538	54.17	31.7	22.0	22.5	32.8	**271**	44.3	44.3	67

For discussion on this paper see page 99.