

SOME OBSERVATIONS ON RECENT MILLING STATISTICS

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Abstract

During the 1972-73 season an improved system was adopted by the industry for bagasse analysis. cursory examination showed that the statistics for this season gave stronger associations between cane quality and mill performance than in the past. Multiple regression analysis of the statistics including all available process data confirmed this. Tables are presented to show that strong correlations can be obtained for both pol and fibre in cane with pol lost in bagasse. Regression coefficients are to some extent influenced by variable mill operation and a by-product of the exercise has been some interesting indications of the influence of the level and variation in imbibition rates at some factories on loss of pol in bagasse.

Introduction

Sugar technologists in South Africa have for the past decade or more grown to gauge mill efficiencies on the basis of "lost absolute juice percent fibre". The use of this term implies that, in addition to fibre content, the concentration of the juice in the cane being milled has an influence on the attainable level of extraction. On the other hand, the alternative expression "milling loss", ignores the juice concentration and compares the pol lost in bagasse as a percentage of the fibre in cane. Follet-Smith¹ has provided calculations which suggest that the most appropriate basis for comparing milling efficiency would lie midway between these two extremes. Webre⁵ and Shaw³ have published data from milling tests to show that the influence of cane quality diminishes as milling efficiency and imbibition rates increase, while Hugot² has suggested that the influence of pol per cent cane is restricted to the Nth root of pol per cent cane where N is the number of mills in the train. The use of the term "lost absolute juice per cent fibre" was advocated by Sijlmans⁴ in 1929 who stated that "in Java it has been accepted as a fact for many years that pol in bagasse per cent fibre is not a good basis for comparison because of its dependence on pol per cent cane". Understandably, the efficiency of the mills on which the supposition was based was low (as indicated by a milling loss in the region of 4 to 8 pol bagasse per cent fibre). The average in South Africa is under 4 per cent at present. Unfortunately (but again not unexpected for the time) the data published were superficially analysed and a recent regression analysis of the data indicates that they are statistically non-significant. However, it is interesting to record that they seem to confirm the contention of the authors mentioned previously in that the effect of sucrose per cent cane on milling loss diminishes with longer and more efficient milling trains.

With the introduction of a more sophisticated method of final bagasse sampling and analysis by high-speed extractor, coupled with the high degree of

efficiency with which South African mills are usually operated it is of considerable interest to re-examine the statistics of milling on the new data obtained during the 1972-73 season. Naturally, historical data even from the immediate past season have limitations in providing the basis for statistical analyses on which to estimate the contribution of cane quality to mill extraction. Too frequently the range of data is limited and the sources of variation in milling efficiency are unlimited and difficult to quantify. Ideally the exercise would be conducted on data from a statistically planned experiment, systematically changing the level of selected variables as would be possible in the case of an experimental factory which could be fed with cane at different quality levels for representative periods under consistent operating conditions. Such a factory exists for example in Cuba where, on a small commercial scale of 36 tons cane per hour, practical investigations are conducted on all aspects of industrial development. While appreciating the unavoidable limitations, recent developments in the improved evaluation of milling loss have prompted a statistical analysis of milling data for the 1972-73 season which is the subject of this paper.

Nomenclature

- n = data set number
- x_1 = dependent variable, pol in final bagasse % cane, S_b
- x_2 = week number
- x_3 = fibre % cane, F_c
- x_4 = pol % cane, S_c
- x_5 = imbibition % fibre
- x_6 = tons fibre per hour
- x_7 = moisture % final bagasse

Preliminary graphical and statistical analysis of industrial data

A cursory examination of the average milling data for the whole industry on a monthly basis during the 1972-73 season showed (probably for the first time in the history of the industry) remarkably steady trends in fibre and pol percent cane and in pol lost in bagasse per cent cane. These trends are shown in Figures 1 to 4 which record the monthly average levels of the three previously mentioned variables during the seasons; 1969-70, 1970-71, 1971-72 and 1972-73. Data for the 1972-73 season, in Figure 4, show a more consistent trend than in any of the previous seasons. Multiple regression analysis of these data (eliminating February data which are not representative) provides the following regression equation:

$$S_b = 0,074F_c + 0,031S_c - 0,913 \dots (i)$$

with a multiple correlation coefficient of 0,989. The average milling loss for the season was 3,98 pol in bagasse per cent fibre — noticeably inconsistent with the regression coefficient of 0,074 in the equation above. The simple correlation on fibre alone provided

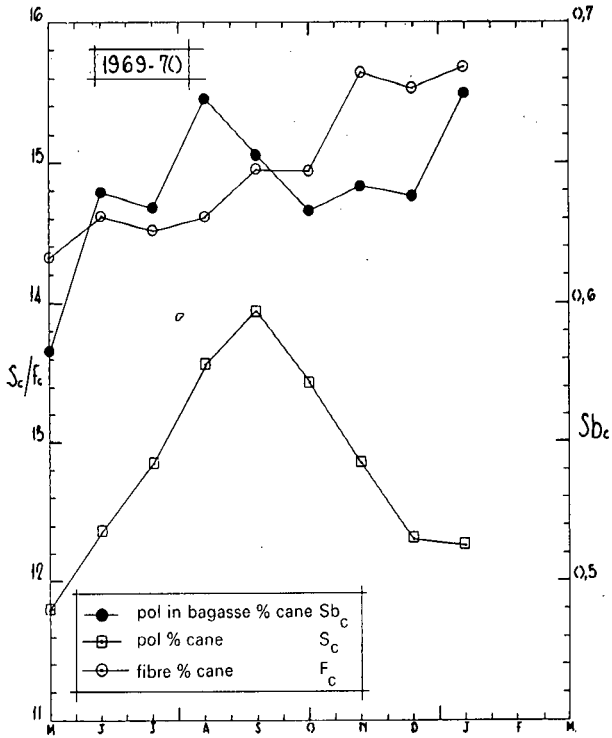


FIGURE 1 Average monthly milling data for 1969-70 season.

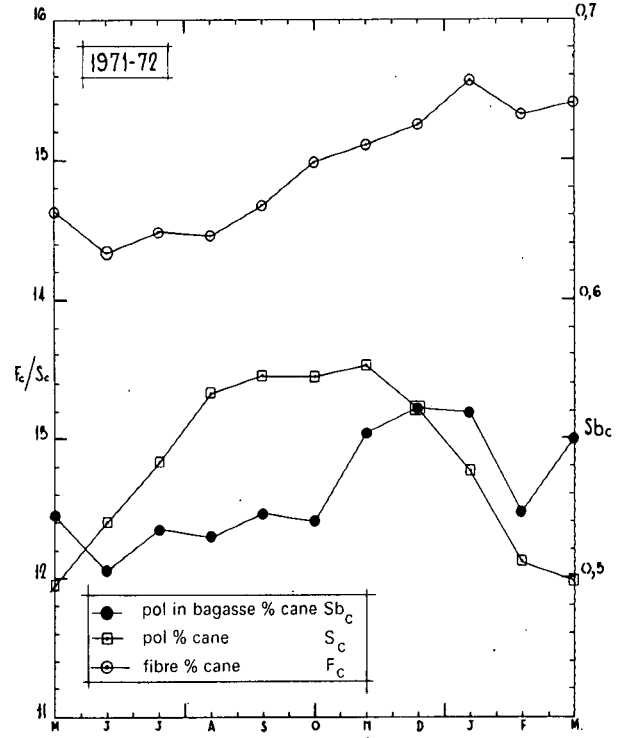


FIGURE 3 Average monthly milling data for 1971-72 season.

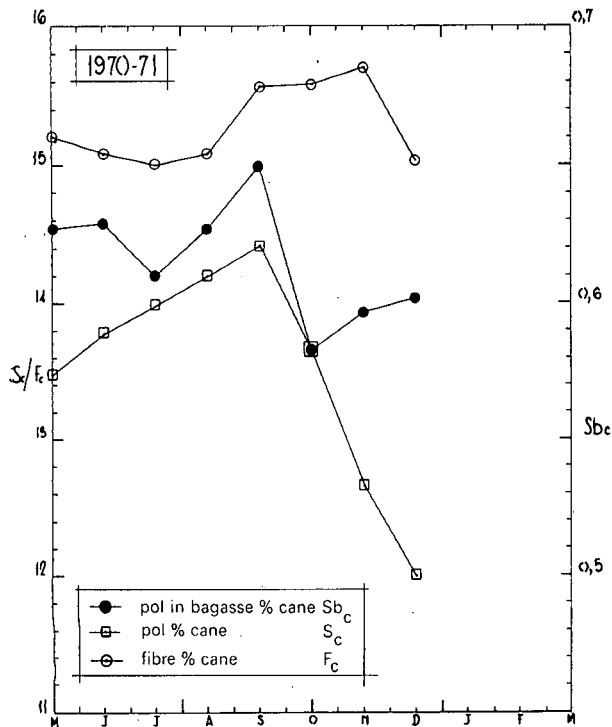


FIGURE 2 Average monthly milling data for 1970-71 season.

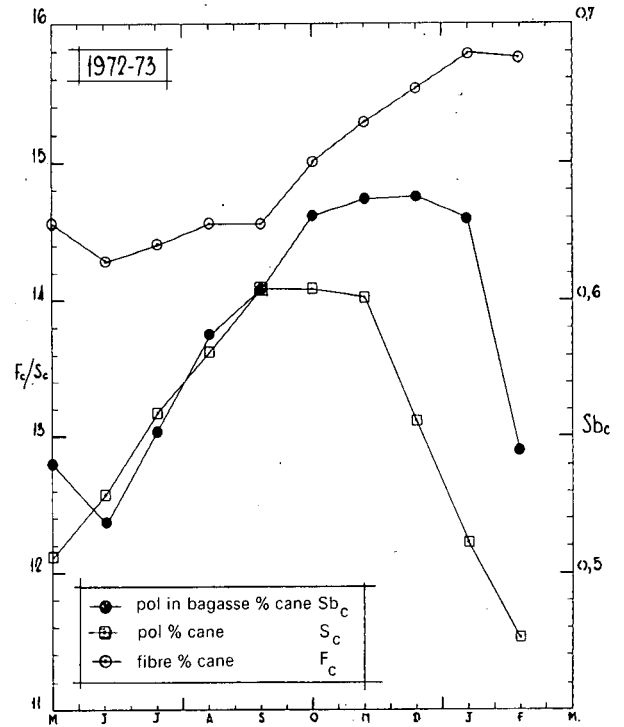


FIGURE 4 Average monthly milling data for 1972-73 season.

a regression coefficient of 0,072 and a simple correlation coefficient of 0,835. Finally, to complete the confusion, the loss in bagasse was found to be time dependent after obtaining the equation:

$$Sb_c = 0,015 n + 0,575 \dots\dots(ii)$$

with a simple correlation coefficient of 0,919 on the same data.

The latter relationship does not necessarily render the former invalid for it simply indicates that the loss in bagasse increased fairly steadily through the season. Examination of Figure 4 would suggest that the reason for this is that in the first half of the season the fibre was fairly constant while the sucrose increased steadily and the resulting increase in cane juice concentration would logically contribute to an increase in pol lost in bagasse. In the second half of the season the sucrose levelled off as the fibre began to rise steadily in September and October. The milling loss continued to increase due to the increasing fibre in cane. After November the sucrose dropped sharply and the pol lost in bagasse levelled out in spite of a continued increase in fibre. After December the pol loss dropped as the fibre levelled out and the pol in cane dropped further. The final result for February is not representative since many factories were closed. Although the statistics follow an expected trend the time dependency cannot be ignored entirely for this is not entirely unexpected. Firstly, the mass of bagasse is influenced by evaporation losses from cane and imbibition during milling and this may be accentuated by the climatic change from the beginning to the end of the season. Secondly, in spite of the most efficient maintenance during the season there can still be a progressive fall off in mechanical efficiency which could reduce extraction. Since there still appeared to be a good chance that the statistics could provide useful conclusions a detailed statistical analysis of all individual weekly data for each factory was undertaken as discussed in the following section.

Three variable regression analysis of weekly data for each factory

The weekly data analysed for each factory are listed under Nomenclature. In each case the first two weeks and clearly inconsistent data at the end and during the season, were eliminated. The average and standard deviation of all variables is given in Table 1, which also shows the number of sets of data analysed and the average milling loss in terms of pol lost in bagasse per cent fibre for each factory. Also listed in Table 1 is the simple correlation coefficient between each independent variable and the dependent variable. It is evident from this table that significant time trends as indicated by a coefficient for variable 2 of about 0,4 or more are accompanied by significant coefficients for variables 5, 6 or 7. This would suggest therefore that the time trend is associated with the effect of changing imbibition rate, fibre rate or milling efficiency as represented by moisture in final bagasse. The vast majority of regression coefficients are in a logical sense if they are significant. In only a few cases is the fibre strongly correlated with the pol loss when there exists a strong time trend. For this reason it has been accepted that the time trend is more

TABLE 2
Multiple regression analysis of pol and fibre on pol lost in bagasse
 $x_1 = ax_3 + bx_4 + c$

Factory	Regression Coefficients		t Values		Multiple Correlation Coefficient
	a	b	a	b	
ML	0,042	0,073	2,028	4,375	0,857
PG	0,056	0,029	4,900	3,016	0,740
UF	0,073	0,016	13,900	3,112	0,934
EM	0,046	0,034	4,140	2,973	0,767
FX	0,043	0,022	4,942	3,604	0,722
EN	0,030	-0,032	3,861	-2,872	0,591
AK	0,040	0,079	3,915	10,158	0,904
DK	0,065	0,047	5,254	4,933	0,725
GD	0,020	0,031	1,953	3,671	0,562
DL	0,033	0,062	2,928	7,382	0,880
GH	0,010	0,050	1,352	4,590	0,625
MV	0,046	0,011	5,426	1,252	0,782
JB	-0,016	0,118	-1,629	5,095	0,734
UC	0,006	0,085	0,213	3,995	0,718
TS	0,034	0,050	3,272	6,128	0,878
ME	0,030	0,029	5,312	3,500	0,812
IL	0,049	0,040	5,380	3,744	0,692
RN	0,045	0,053	2,740	7,312	0,895
SZ	-0,003	0,004	-0,643	0,707	0,147
UK	0,024	0,007	3,851	0,745	0,626

appropriately represented by variables 5, 6 and 7. This aspect is discussed again later.

It is also evident from Table 1 that the regression coefficients for variables 4 and 5 are to some extent complementary and this prompted the multiple regression analysis of pol and fibre on the loss of pol in bagasse shown in Table 2. For most factories a good level of correlation is obtained for the relationship between fibre and pol in cane against loss of pol in bagasse per cent cane. However, the regression coefficients vary considerably — even more so than would be expected from variation in average efficiency from mill to mill. With a few obvious exceptions it is encouraging to note that the regression coefficients against fibre, i.e. coefficients 'a', correspond fairly well to the milling loss on the average for each mill (shown in the final column in Table 3). The latter, being expressed as a percentage in the standard manner, should be divided by 100 for comparison. In most cases where there is a marked divergence in coefficient 'a' from the average milling loss the 't' value is low indicating a low level of significance, and thus the possibility that other factors intruded on the relationship. Unfortunately space limitations preclude presentation of the detailed data for each factory but the averages and standard deviations given in Table 1 provide some indication of the scope for influences from other sources of variation. For example, at Umzimkulu, Melville and Glendale, a relatively steady fibre rate was maintained by adjusting the cane rate when the fibre in cane changed and both these factories show a reduced regression coefficient against fibre than would be expected from the milling loss. The reverse applied at Umfolosi and Tongaat where the cane rate increased during the high fibre periods to exaggerate the fibre regression coefficients. The large discrepancy in the case of Empangeni would seem to be associated with the strong correlation between the pol loss and the moisture in final

TABLE I
Simple regression analysis for all independent variables; mean, standard deviation and simple correlation coefficient

Mill	VARIABLES																					No. of Sets
	1			2			3			4			5			6			7			
	Aver	S Dev	Coef	Aver	S Dev	Coef	Aver	S Dev	Coef	Aver	S Dev	Coef	Aver	S Dev	Coef	Aver	S Dev	Coef	Aver	S Dev	Coef	
ML	0,727	0,089		20,769	8,852	0,764	14,748	0,712	0,473	13,866	0,892	0,790	286,92	11,221	-0,583	33,761	1,322	0,331	54,195	0,587	-0,263	13
PG	0,693	0,095		22,618	10,144	0,853	13,364	1,002	0,644	13,782	1,179	0,444	283,94	41,720	-0,518	17,865	1,008	0,201	51,538	0,679	0,266	34
UF	0,551	0,093		25,618	10,485	0,892	13,962	1,136	0,912	13,255	1,154	0,277	287,71	20,137	-0,762	31,800	3,164	0,816	53,727	0,710	0,367	34
EM	0,476	0,077		27,500	11,803	0,570	16,606	1,034	0,630	12,806	0,986	0,466	278,50	19,478	0,010	33,438	1,844	0,332	53,155	0,734	0,774	22
FX	0,607	0,047		25,452	10,680	0,794	16,085	0,732	0,548	13,061	1,010	0,324	282,55	16,215	0,050	29,642	1,113	0,618	52,264	0,310	0,650	31
EN	0,416	0,031		20,000	9,092	-0,015	14,202	0,810	0,398	13,918	0,571	-0,058	306,61	30,550	-0,046	6,871	0,844	0,260	52,834	0,405	-0,007	31
AK	0,601	0,087		29,038	11,766	-0,021	15,365	0,802	0,037	12,895	1,058	0,835	257,35	14,519	-0,698	46,714	2,324	0,546	52,927	0,587	0,080	26
DK	0,038	0,052		24,368	11,803	0,394	14,448	0,520	0,442	13,404	0,685	0,389	249,82	17,796	0,370	10,264	1,181	0,325	53,479	0,663	0,275	38
GD	0,820	0,041		25,722	10,843	-0,101	14,788	0,577	0,191	13,524	0,706	0,487	273,47	9,984	-0,229	6,319	0,209	0,243	51,204	0,487	0,088	36
DL	0,533	0,070		27,467	11,066	0,116	15,181	0,624	0,564	13,410	0,823	0,838	328,13	16,150	-0,524	31,611	1,765	0,779	52,907	1,005	-0,129	30
GH	0,562	0,059		25,216	11,126	-0,108	15,814	1,094	0,115	13,212	0,732	0,598	232,00	16,217	-0,629	38,716	2,557	0,265	51,896	0,749	-0,101	37
MV	0,573	0,037		23,091	9,913	0,577	16,298	0,559	0,769	13,141	0,560	0,480	271,18	14,668	0,313	12,556	0,362	0,463	51,997	1,126	0,440	33
JB	0,499	0,070		20,500	7,649	-0,001	15,525	1,001	-0,134	13,530	0,431	0,697	334,92	13,452	-0,320	31,341	1,769	0,528	52,403	0,675	0,137	26
UC	0,414	0,061		18,960	8,974	0,872	14,080	0,411	-0,372	13,111	0,533	0,707	228,50	28,553	-0,704	8,357	0,330	0,786	50,487	0,704	0,091	25
TS	0,644	0,045		22,618	10,144	0,386	15,378	0,450	0,703	13,066	0,577	0,832	218,85	22,926	-0,130	41,628	3,386	0,559	53,749	0,857	0,590	34
ME	0,497	0,040		23,042	10,162	0,921	15,318	0,903	0,679	13,165	0,616	0,450	321,42	11,045	0,612	28,627	1,158	0,240	52,528	0,462	-0,773	24
IL	0,719	0,070		22,154	11,634	0,491	14,491	0,982	0,525	13,594	0,838	0,245	232,74	22,101	-0,617	15,314	0,839	0,644	54,267	0,837	-0,429	39
RN	0,711	0,061		21,407	9,696	0,422	15,653	0,381	0,598	13,479	0,861	0,860	236,44	14,561	-0,529	11,815	0,426	0,646	51,944	0,631	-0,284	27
SZ	0,572	0,020		20,531	9,436	-0,197	15,378	0,806	-0,091	13,420	0,690	0,049	299,69	24,557	-0,513	36,522	1,499	0,280	51,634	0,642	0,295	31
UK	0,508	0,029		19,704	8,310	0,497	14,535	0,817	0,614	13,956	0,564	-0,126	349,56	21,800	0,346	22,946	0,632	0,321	53,140	0,326	-0,460	27

TABLE 3
Multiple regression analysis data; multiple correlation coefficient, regression coefficients and t values for variable 3 to 7 on variable 1

Factory	Multiple Correlation Coefficient	VARIABLE														Milling Loss %
		3		4		5		6		7						
		Regression Coefficient	t Value	Regression Coefficient	t Value	Regression Coefficient	t Value	Regression Coefficient	t Value	Regression Coefficient	t Value					
ML	0,864	0,034	1,101	0,068	2,582	-0,0008	-0,326	0,005	0,235	-0,001	-0,040	0,005	0,235	-0,001	-0,040	4,93
PG	0,876	0,055	4,833	0,041	4,414	-0,0006	-2,636	-0,017	-1,361	0,032	1,699	-0,017	-1,361	0,032	1,699	5,19
UF	0,941	0,057	4,628	0,022	2,563	-0,0008	-1,467	0,000	0,027	0,018	1,374	0,000	0,027	0,018	1,374	3,95
EM	0,931	0,011	1,080	0,020	2,183	-0,0002	-0,510	0,011	2,026	0,077	5,654	0,011	2,026	0,077	5,654	2,87
FX	0,846	0,040	2,825	0,009	1,151	-0,0006	-1,448	-0,003	-0,297	0,085	4,091	-0,003	-0,297	0,085	4,091	3,78
EN	0,634	0,031	2,816	-0,036	-2,544	0,0002	1,184	0,006	0,612	-0,003	-0,172	0,006	0,612	-0,003	-0,172	2,93
AK	0,926	0,015	0,928	0,068	6,715	-0,0004	-0,424	0,008	1,100	-0,009	-0,626	0,008	1,100	-0,009	-0,626	3,91
DK	0,841	0,067	5,561	0,055	5,766	-0,0001	-0,276	0,007	1,502	0,027	3,303	0,007	1,502	0,027	3,303	5,80
GD	0,772	0,046	4,224	0,046	5,891	-0,0002	-0,139	0,014	0,199	0,057	4,431	0,014	0,199	0,057	4,431	5,54
DL	0,910	0,025	1,722	0,078	5,206	-0,0008	-1,505	-0,007	-0,771	0,017	2,111	-0,007	-0,771	0,017	2,111	3,51
GH	0,778	0,006	0,604	0,042	3,535	-0,0015	-2,622	0,003	0,790	0,006	0,447	0,003	0,790	0,006	0,447	3,56
MV	0,803	0,036	3,080	0,007	0,582	0,0005	0,892	0,025	1,350	0,000	0,072	0,025	1,350	0,000	0,072	3,51
JB	0,916	-0,050	-5,030	0,094	5,348	-0,0009	-1,195	0,024	3,305	-0,029	-2,236	0,024	3,305	-0,029	-2,236	3,22
UC	0,929	-0,037	-1,500	0,041	2,435	-0,0008	-2,283	0,078	2,440	0,011	1,160	0,078	2,440	0,011	1,160	2,97
TS	0,951	0,007	0,847	0,048	7,455	-0,0004	-2,168	0,001	0,771	0,025	4,256	0,001	0,771	0,025	4,256	4,19
ME	0,897	0,020	1,386	0,012	1,509	0,0009	1,559	-0,006	-0,652	-0,032	-2,161	-0,006	-0,652	-0,032	-2,161	3,25
IL	0,811	0,021	1,585	0,047	3,881	-0,0014	-2,341	0,024	2,079	0,021	1,549	0,024	2,079	0,021	1,549	4,96
RN	0,951	0,018	1,169	0,054	9,771	-0,0013	-1,840	0,023	1,013	0,027	2,656	0,023	1,013	0,027	2,656	4,55
SZ	0,665	0,007	0,542	0,014	1,939	-0,0004	-1,772	-0,005	-0,179	0,001	1,410	-0,005	-0,179	0,001	1,410	3,72
UK	0,734	0,002	0,119	-0,016	-1,126	0,0007	2,462	0,015	1,682	-0,037	-1,163	0,015	1,682	-0,037	-1,163	3,50

TABLE 4
Multiple regression analysis data; multiple correlation coefficient, regression coefficients and t values for variables 2 to 7 on variable 1

Factory	Multiple Correlation Coefficient	VARIABLE											
		2		3		4		5		6		7	
		Regression Coefficient	t Value	Regression Coefficient	t Value	Regression Coefficient	t Value	Regression Coefficient	t Value	Regression Coefficient	t Value	Regression Coefficient	t Value
ML	0,875	-0,0049	-0,711	0,0648	1,197	0,095	2,029	-0,0015	-0,564	0,0028	0,134	-0,011	-0,292
PG	0,925	0,0102	4,034	-0,0214	-1,013	0,024	2,788	-0,0000	-0,061	-0,0208	-2,054	-0,013	-0,705
UF	0,958	0,0032	3,265	0,0364	2,975	0,021	2,853	-0,0005	-1,116	-0,0005	-0,144	0,016	1,446
EM	0,935	0,0009	0,925	0,0035	0,284	0,019	1,933	-0,0001	-0,265	0,0135	2,218	0,074	5,254
FX	0,930	0,0023	5,119	0,0291	2,876	0,011	1,919	-0,0007	-2,276	-0,0030	-0,447	0,042	2,515
EN	0,685	-0,0022	-1,744	0,0455	3,389	-0,025	-1,706	-0,0001	-0,263	-0,0067	-0,531	-0,012	-0,795
AK	0,929	0,0019	0,830	-0,0078	-0,243	0,066	6,483	-0,0012	-0,870	0,0042	0,461	-0,011	-0,765
DK	0,845	0,0007	0,865	0,0569	3,426	0,057	5,755	-0,0002	-0,466	0,0078	1,630	0,021	1,804
GD	0,778	0,0009	0,817	0,0371	2,438	0,049	5,637	0,0002	0,101	0,0445	0,564	0,070	3,466
DL	0,914	0,0020	0,997	0,0001	0,004	0,086	5,096	-0,0012	-1,798	0,0087	-0,997	0,009	0,787
GH	0,780	-0,0012	-0,485	0,0171	0,675	0,036	1,951	-0,0015	-2,633	0,2649	0,616	0,004	0,301
MV	0,806	-0,0006	-0,607	0,0411	2,811	0,002	0,154	0,0007	1,066	0,0320	1,452	0,002	0,245
JB	0,919	0,0023	0,907	-0,0644	-3,447	0,081	3,498	-0,0011	-1,367	0,0254	3,412	-0,025	-1,853
UC	0,964	0,0036	4,042	0,0072	0,371	0,023	1,757	-0,0002	-0,748	0,0644	2,748	0,010	1,510
TS	0,961	0,0014	2,588	0,0030	0,371	0,046	7,733	-0,0007	-3,511	-0,0009	-0,718	0,025	4,797
ME	0,950	0,0044	4,121	-0,0098	-0,759	0,018	2,940	0,0000	0,053	0,0069	0,951	0,017	1,072
IL	0,837	0,0024	2,123	-0,0049	-0,273	0,045	3,946	-0,0014	-2,377	0,0328	2,781	0,023	1,778
RN	0,953	-0,0007	-0,856	0,0251	1,434	0,058	7,623	-0,0011	-1,501	0,0232	1,012	0,030	2,760
SZ	0,651	0,0000	0,035	0,0069	0,451	0,013	1,855	-0,0004	-1,598	0,0010	0,173	0,017	1,321
UK	0,735	0,0004	0,235	-0,0019	-0,867	-0,017	-1,125	0,0007	2,360	0,0167	1,506	-0,035	-1,038

bagasse. Both Union Co-Op and Jaagbaan show markedly low regression factors, apparently due in the first case to a high imbibition rate during the high fibre period and in the second case to a drop in fibre rate and moisture in bagasse at the high fibre levels. The above few comments point to the fact that the regression coefficients for fibre can be influenced by factory operation.

The variable level of the regression coefficients for pol in cane, 'b' in Table 2, also appears to have an association with the variation in the operating data. For example the mills which show average imbibition levels of 250 per cent on fibre or less all show a high coefficient and 't' value. These include Amatikulu, Renishaw, Gledhow, Union Co-Op and Tongaat. In some cases this appears to have been accentuated by failure to adjust the imbibition rate with the pol to fibre ratio in cane. This seems to accentuate the pol loss at the peak pol period. The coefficients for Malelane and Pongola show considerable divergence for identical imbibition levels. However, Table 1 shows that the standard deviations for imbibition rate (variable 5) are respectively 11 and 42. The original data suggest that the high pol coefficient at Malelane is due to failure to adjust the imbibition rate to compensate for changes in pol to fibre ratio in cane, while the reverse appears to apply to the data from Pongola. Very high imbibition rates at Entumeni, Mount Edgecombe, Sezela and Umzimkulu may provide the reason for low pol coefficients at these factories. In two cases high levels of imbibition rate are associated with positive simple correlation coefficients and this could be taken as a precaution against excess levels.

Comprehensive multiple regression analysis of weekly data

The above observations point to the (not unexpected) fact that the regression coefficients for pol and fibre in cane shown in Table 2 are influenced by changes in process variables and in an attempt to isolate these influences the additional independent variables 5, 6 and 7 were included in the multiple regression analysis. The results of these analyses are shown in Table 3. In addition, the analyses were repeated to include the data set number, variable 2, the results of this being shown in Table 4. Table 4 indicates that relatively few factories show a significant relationship between loss of pol in bagasse and time. This is a reassuring result since it indicates that the influence of a spurious relationship between loss of pol in bagasse and fibre due to a progressive increase in bagasse mass error (with increased evaporation losses towards the summer months) is small. In fact the changes in the fibre coefficients from Table 3 to Table 4 would appear to confirm that the time trend in the loss is fortuitous and probably due to the dependence of the loss on fibre, which in turn is prone to a real increase with time. Table 1 also confirms this since in no case is there a significant correlation of pol loss and time without there being a significant correlation in addition with fibre.

Undoubtedly however, this phenomenon could be present and its effects are no doubt superimposed on

the relationships but to a very small degree. A further source of time trend is the mechanical aspect since it is quite conceivable that progressive wear could result in a steady decline in milling efficiency through the season. Table 4 provides some reassurance in this respect since, of the factories which show significant time dependence for the pol loss (Pongola, Umfolosi, Felixton, Union Co-Op, Tongaat, Mount Edgecombe and Illovo) only Felixton, Tongaat and (to a lesser extent) Illovo show significant dependence on moisture in final bagasse. This argument naturally assumes that the moisture in final bagasse may be taken as a guide to the general mechanical well-being of the whole milling train — a theory which is open to speculation but which is true to some extent.

Having made every attempt possible (within the limitations of data on record) to eliminate the relationship of pol loss to pol and fibre in cane, it is encouraging to note from Table 3 that a number of factories still show dependence of pol loss on cane quality. In some cases the regression coefficients are somewhat lower than in Table 2 and this has had the effect of bringing the fibre coefficient closer in line with the milling loss. Some possible reasons may be advanced for inconsistencies in several of the fibre or pol coefficients in Table 3. At Malelane the initial few months of data were determined by the mill using an old model extractor and the sets of data were restricted in number due to fortnightly reporting. The pol factor (coefficient 4) would have been exaggerated by this but not the fibre factor, since the fibre was constant during this period. Empangeni also reported fortnightly and in addition, haphazard imbibition rates could have reduced the fibre coefficient. Felixton showed an increase in final moisture after the sucrose peak and the resulting decline in extraction may have obscured the effect of declining pol in cane. The variation in pol was too limited at Entumeni to place confidence in the low coefficient for this variable. The influence of pol in cane at Amatikulu appeared to be exaggerated by adjusting the low imbibition rate in inverse proportion to the pol to fibre ratio in cane. The small range in fibre at Darnall combined with an unexpectedly high loss at the pol peak, appears to have exaggerated the pol coefficient. An extremely low imbibition rate at Gledhow could have accentuated the influence of pol in cane over fibre. At Melville the small variation in pol and a drop in milling efficiency following the sucrose peak may have obscured the effect of sucrose. A similar trend is apparent at Jaagbaan. At Union Co-Op a small variation in fibre and a progressive drop in imbibition rate as pol increased appears to have accentuated the pol coefficient. Tongaat showed a small variation in cane quality and variable final bagasse moisture as well as a very low imbibition rate which could have accentuated the pol coefficient. It appears that at Illovo the drop in imbibition rate as fibre increased resulted in a better correlation between imbibition rate and pol loss than between fibre and pol loss. At Renishaw the increase in moisture in bagasse accompanying the increase in fibre probably led to a reduction in the fibre coefficient. At Umzimkulu the extremely high imbibition rates may have increased

final bagasse moisture (hence pol loss) at low fibre periods thus obscuring the relationship between pol loss and fibre in cane.

While the above comments are essentially speculative in the absence of firsthand information they are a logical consequence of an examination of the original data drawn up conveniently by computer in table form for each factory. They indicate that there are plausible reasons for unexpected levels in the factors associated with pol and sucrose obtained by regression analysis of process data. These explanations are necessary in order to indicate that the absence of expected levels for coefficients of pol and fibre in some cases should not necessarily cast doubt on the validity of all coefficients.

Conclusions

The statistical evidence presented in this paper would seem to justify some confidence in the authenticity of the trends shown at the outset in Figure 4. Clearly however, the quantitative aspects as given by equation (i) are questionable. There is some indication from the detailed statistical analysis that the coefficient 0,074 against fibre has been exaggerated by increased fibre throughput towards the end of the season, variable imbibition rates with increasing fibre and (possibly) a time trend associated with decreased mechanical performance towards the end of the season as well as an increase in bagasse mass error towards the hotter months. The statistics indicate that in the case of some less efficient factories there is strong dependence of the pol loss in bagasse on pol in cane which is less marked in the case of some more efficient factories. However, several of the more efficient factories show abnormal dependence on pol in cane (typically Amatikulu, Darnall and Tongaat) but here the statistics suggest that inconsistent mill operation coincident with the pol in cane peak was responsible. On this account support for the contention that the pol loss at efficient mills is more dependent on fibre than pol (in cane) is rather limited.

A by-product of the analysis is the strong association found at some factories between imbibition rate

and changes in pol lost in bagasse. The season average imbibition rate on fibre varies from 225 to 347 at individual mills while within each mill the rate can be equally variable. At a number of factories strong statistical associations suggest that failure to adjust imbibition rates to compensate for peaks in pol to fibre ratio in cane (high juice concentration) exaggerated the statistical dependence of pol loss on pol in cane. In addition, significant positive correlations between pol loss and imbibition rate at several factories having imbibition rates well in excess of 300 would suggest an examination of the ability of these mills to achieve reasonable dewatering under these conditions. Mills having very low imbibition rates show a pol loss which is particularly sensitive to pol in cane.

The ability to achieve statistically significant relationships at a greater number of factories than past data have permitted would seem to be a direct result of improved laboratory techniques. It is therefore pertinent to express the hope that with more experience in the use of the new equipment the level of accuracy of process data will improve to the extent that the influence of cane quality on mill performance will become more statistically evident in the forthcoming season and not suppressed by process variables.

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