TECHNICAL PARAMETERS USED TO MEASURE AND MONITOR LENGTH OF MILLING SEASON IN THE SOUTH AFRICAN SUGAR INDUSTRY

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Abstract

The impact of season length on cane quality in the South African sugar industry has resulted in most mill areas agreeing on an optimal season length and implementing mechanisms to identify the cause of any season length extension beyond the agreed length of milling season. The impact of milling efficiency parameters such as budgeted and actual overall time efficiency (OTE), budgeted and actual mill stops, design and achieved crush rates (tons cane crushed per hour), horizontal expansion (increases in area) and vertical expansion (increases in yield) on season length are familiar to many industry stakeholders. The effects of 'slow' and 'fast' crushing (i.e. when actual throughput is slower/faster than mill design throughput) are less understood. This paper proposes a technical mechanism for matching cane supply to milling capacity within an agreed length of milling season, and quantifies the parameters that cause season length extensions. Identifying all the factors, including the impact of slow and fast crushing, that contribute to season length extensions is an important step in highlighting local inefficiencies. While the proposed mechanism identifies the parties responsible for any season length extension, it is likely that in many cases collaboration between the miller, growers and transporters will be required to rectify the cause of the inefficiency.

Keywords: sugarcane, milling season, mill stops, slow crushing, time account, cane supply

Introduction

The impact of season length on cane quality is well documented. In the South African sugar industry, most mill areas have agreed on an optimal season length and have implemented mechanisms to identify the cause of any extension beyond the agreed length of milling season (LOMS). The impact of milling efficiency parameters such as budgeted and actual overall time efficiency (OTE), budgeted and actual mill stops, design and achieved crush rates (tons cane crushed per hour), horizontal expansion (increases in area) and vertical expansion (increases in yield) on season length are familiar to many industry stakeholders. Less understood are the effects of 'slow' and 'fast' crushing, when actual throughput is slower or faster than mill design throughput. This paper proposes a technical mechanism for matching cane supply to milling capacity within an agreed LOMS, and quantifies the parameters that cause season length extensions, including 'slow' and 'fast' crushing in such a way that together they equal the actual season length extension. A worked example is used to illustrate this methodology.

The methodology involves the adjustment of overall time efficiency (OTE) to take into account the impacts of slow (or fast) crush rates to give a modified OTE or MOTE. A budgeted MOTE (bMOTE) is determined for the season ahead on the basis of the MOTEs achieved in the previous three seasons. Budgeted mill stoppages are then determined in their various causative categories such that in total they align with the bMOTE for the season.

The combination of length of milling season (LOMS), bMOTE and design mill throughput (dTCH) gives a cane crush budget for the season. Agreed yields of tons cane per hectare, based on historical yield figures together with the cane crush budget, are used to calculate the mill supply area. With this basic budget in place any variances in time efficiency, cane yield and mill supply area can be analysed in terms of their effects on the agreed LOMS.

Determining the 'base-case' milling season length

The first important step in quantifying the parameters that cause a season length extension is to determine what the 'base-case' milling season is, and to clarify how it is constituted. It must be assumed that in a 'base-case' milling season all the cane available is crushed within the agreed time; i.e. cane supply equals milling capacity given an agreed season length and other 'foundation' parameters. Only after this 'base-case' milling season has been agreed can 'actual' seasons be compared and extensions calculated. This section describes the 'foundation' parameters and how they are determined.

Agreed length of milling season (Clause 2.1)
By international standards, the South African LOMS is relatively long. While this ensures high capacity utilisation, it contributes to declining season average cane quality as a result of the seasonal nature of cane quality under South African growing conditions. To facilitate the introduction of mill area season length controls, the South African Cane Growers' Association developed an economic model to estimate the optimum economic season length in an individual mill area (Moor and Wynne, 2001). The model optimised season length for a mill by considering growers and millers as a single business entity, and then estimated the point at which marginal losses due to declining cane quality would exceed the benefits of increased capacity utilisation. In many of the South African mill areas, this model provided the basis for an objective season length from which an agreed LOMS was negotiated. This agreed LOMS is a 'foundation' parameter for the calculations that follow.

The budgeted modified overall time efficienc (Clause 2.2)
Given the agreed LOMS as above, a budgeted modified overall time efficiency (abbreviated as bMOTE and expressed as a percentage) is the next 'foundation' parameter that needs to be determined. Changing management practices and the adoption of new technology in the growing and milling sectors (or lack thereof) will influence the bMOTE, and this parameter can therefore not be fixed, but is determined on past performance as illustrated in the formula:

bMOTE = (factor A x MOTE of the mill for the last season) + (factor B x MOTE of the mill two seasons ago) + (factor C x MOTE of the mill three seasons ago)

where:

MOTE = the overall time efficiency of the mill for the appropriate season, as determined in terms of Clause 3.6.
Factor A = a weighting factor for the MOTE of the mill for the last season.
Factor B = a weighting factor for the MOTE of the mill two seasons ago.
Factor C = a weighting factor for the MOTE of the mill three seasons ago.

The bMOTE will change from season to season as the preceding season's MOTE values in the bMOTE formula change, and if the factors A, B and C are reviewed as and when new technology or increased milling capacity is installed. A three-season weighted average is used here for illustrative purposes; this may not be appropriate for all mill areas.

Furthermore, the MOTE in a short season (e.g. during a drought) may not be representative of the mill's achievable MOTE in an extended season because of the incentives for the miller and grower to slow crush. Clause 3.6 addresses this issue in more detail.

Budgeted mill stoppages (Clause 2.3)

It is necessary that the bMOTE calculated in Clause 2.2 is aligned with the various stoppage budgets, which are listed together with their abbreviations in Table 1. If these budgeted stoppages have been agreed in advance, the agreed numbers can be adjusted *pro rata* such that the formula below for bMOTE equals the bMOTE calculated in Clause 2.2. This process is necessary for the purpose of determining stoppage variances (Clause 5.1).

$$bMOTE = \{[Agreed\ LOMS \times 168] - BMSa - BGSa - BNSa\} / [Agreed\ LOMS \times 168]$$

By definition, any modified overall time efficiency (MOTE) should include the equivalent stoppage hours due to fast and/or slow crushing (Clause 3.6) as opposed to the overall time efficiency (OTE), which does not (Clause 4.1). No provision is made in the bMOTE for fast and/or slow crushing because it is assumed that the mill's design crush rate (Clause 2.4) will be achieved, i.e. the equivalent stoppage hours due to fast and/or slow crushing have a zero budget.

Table 1. Budgeted stoppage categories for the Agreed LOMS.

Stoppage categories (budget hours)	For period of Agreed LOMS		
	Hours per week	**Total hours**	**Adjusted hours**
Budgeted miller stoppages Scheduled stops Mechanical stops Operational stops Other stops **Budgeted miller stoppages for Agreed LOMS**			**BMSa**
Budgeted grower stoppages No cane stops (including rain stops) Foreign matter stops Other stops **Budgeted grower stoppages for Agreed LOMS**			**BGSa**
Budgeted neutral stoppages Due to *force majeure* and other **Budgeted neutral stoppages for Agreed LOMS**			**BNSa**

If the milling season is extended beyond the Agreed LOMS, additional budgeted mill stoppages are required for each category, as presented in Table 2. The default should be the same 'hours per week' in Table 1, although this may underestimate the actual stoppages incurred when crushing towards the end of the season as a result of unfavourable harvesting and milling conditions. Regardless of the approach adopted, the total budgeted mill stoppages for the season can be determined only at the end of the extension.

Table 2. Budgeted stoppage categories for the extension period.

Stoppage categories (budget hours)	For extension period	
	Hours per week	Total hours
<u>Budgeted miller stoppages</u> Scheduled stops Mechanical stops Operational stops Other stops **Budgeted miller stoppages for extension period**		**BMSe**
<u>Budgeted grower stoppages</u> No cane stops (including rain stops) Foreign matter stops Other stops **Budgeted grower stoppages for extension period**		**BGSe**
<u>Budgeted neutral stoppages</u> Due to *force majeure* and other **Budgeted neutral stoppages for extension period**		**BNSe**

Hourly average design crush rate of the mill (Clause 2.4)
The mill's season average hourly design crush rate (i.e. tons cane per hour) is another 'foundation' parameter that is usually determined when a mill or an expansion thereof is commissioned. This parameter (dTCH) is theoretical in nature because the mill's actual crush rate varies throughout the crushing season. It is constrained by different factors at different times; e.g. fibre % cane at the beginning of the season, sucrose % cane in the middle and non-sucrose % cane at the end. If this parameter is set too high (or low), the prevalence of slow (or fast) crushing will increase.

Milling capacity (Clause 2.5)
Given the 'foundation' parameters already discussed, the milling capacity of the mill (expressed in tons cane crushed in the 'base-case' milling season) is determined by the formula:

Milling capacity = Agreed LOMS x 168 hours x bMOTE x dTCH

where:

Agreed LOMS = the number of weeks as determined in Clause 2.1.
bMOTE = the budgeted modified overall time efficiency of the Mill as determined in Clause 2.2 (expressed as a percentage).
dTCH = the hourly average design crush rate of the mill as determined in Clause 2.4 (expressed in tons cane per hour).

Agreed yield (Clause 2.6)
In order to match milling capacity with cane supply in the 'base-case' milling season the agreed yield (tons cane/ha under cane) needs to be determined and constitutes another 'foundation' parameter. Practically, the agreed yield is difficult to determine accurately. In principle, it should be the total tons cane crushed per season less net inward diversions divided by the actual area under cane (Clause 5.4).

In practise, however, the total tons cane crushed per season varies as a consequence of climatic conditions, which can create bias because yield decline in drought years is generally more severe than yield increases during favourable seasons. An arithmetic average is therefore not appropriate. Given these difficulties, a helpful guide is to set the agreed yield as the median of the seven highest actual yields recorded in a 10-year period, assuming a drought cycle of three years in 10. Until recently, accurate cane areas (within 1% error) were not available; however, many of the South African mill areas have now adopted comprehensive mapping programmes to address this problem (Clause 4.4).

2.7 Mill supply equivalent area
With agreed yield, the mill supply equivalent area for the 'base-case' milling season (abbreviated as MSEA and expressed in hectares under cane) can now be determined by the formula:

$$\text{MSEA} = \text{milling capacity} / \text{agreed yield}$$

where:

milling capacity	=	the milling capacity of the mill as determined in Clause 2.5 (expressed in tons cane).
agreed yield	=	the agreed yield as determined in Clause 2.6 (expressed in tons cane/ha under cane).

The MSEA is that area under cane which results in cane supply equalling milling capacity in those seasons when the 'base-case' parameters are achieved. The MSEA will change from season to season if the milling capacity (Clause 2.5) and agreed yield (Clause 2.6) change.

Determining actual milling performance

With a 'base-case' milling season having been established (Section 2), the next step in determining the factors that impact on season length extensions is to measure actual milling performance or the actual modified overall time efficiency (MOTE; expressed as a percentage). To achieve this, certain parameters need to be measured during the crushing season so that the MOTE can be calculated. This section describes these parameters and the MOTE calculation.

Total actual mill stoppages (Clause 3.1)
The total actual stoppages (TAS; expressed in hours) for the mill in the current milling season, will be determined by the MGB according to the formula:

$$\text{TAS} = \text{TAMS} + \text{TAGS} + \text{TANS}$$

The monitoring and recording of actual stoppages during the milling season can in practise be difficult, because a stoppage may be caused by a number of factors occurring simultaneously. These difficulties can be mitigated by using guidelines agreed locally at weekly meetings between the miller and growers, with the MGB acting as arbitrator in disputes. Examples of such guidelines are presented in the appendix.

Table 3 gives the actual stoppage categories.

Table 3. Actual stoppage categories.

Stoppage categories (actual hours)	For LOMS	For extension	Total hours
Miller actual stoppages Scheduled stops Mechanical stops Operational stops Other stops **Total miller actual stoppages**			**TAMS**
Grower actual stoppages No cane stops (including rain stops) Foreign matter stops Other stops **Total grower actual stoppages**			**TAGS**
Neutral actual stoppages Due to *force majeure* only **Total neutral actual stoppages**			**TANS**
Total actual stoppages			**TAS**

Actual tons cane crushed (Clause 3.2)
At the end of the season the actual total tons cane crushed (aTCC; expressed in tons cane) needs to be verified by the MGB.

Actual length of milling season (Clause 3.3)
The actual length of milling season (aLOMS; expressed in weeks) also needs to be determined at the end of season. Although measured in weeks for calculation purposes, aLOMS should be accurate to the nearest hour.

Actual average crush rate (Clause 3.4)
The actual tons cane per hour (aTCH; expressed as tons cane crushed per hour) is determined according to the formula:

$$\text{aTCH} = \text{aTCC} / ((\text{aLOMS} \times 168) - \text{TAS})$$

where:
aTCC = the actual tons cane crushed in the current milling season as determined by the MGB in terms of Clause 3.2 (expressed in tons cane).
aLOMS = the actual length of milling season as determined by the MGB in terms of Clause 3.3 (expressed in weeks).
TAS = the total actual stoppage hours as determined by the MGB in terms of Clause 3.1 (expressed in hours).
Slow/fast crushing hours during hours crushing (Clause 3.5)

The equivalent stoppage hours attributable to slow or fast crushing during the hours the mill is crushing (cTSFCH; expressed in hours) relative to average hourly design crush rate is determined according to the formula:

$$\text{cTSFCH} = ((\text{dTCH} - \text{aTCH}) \times (\text{aTCC} / \text{aTCH})) / \text{dTCH}$$

where:

dTCH = the hourly average design crush rate of the mill for the season as specified in Clause 2.4 (expressed in tons cane per hour).

aTCH = the actual hourly season average milling capacity of the mill as specified in Clause 3.4 (expressed in tons cane per hour).

aTCC = the actual tons cane crushed in the current milling season as determined by the MGB in terms of Clause 3.2 (expressed in tons cane).

Note: aTCC / aTCH = actual crushing hours during the milling season. cTSFCH calculates the equivalent stoppage hours (or hours gained) due to slow (fast) crushing, assuming that no slow/fast crushing would have occurred during actual stoppage hours.

Mill's modified overall time efficiency (Clause 3.6)

The MOTE of the mill (expressed as a percentage) in the current milling season is determined according to the formula:

$$MOTE = [(aLOMS \times 168) - (TAMS + TAGS + TANS + cTSFCH)] / (aLOMS \times 168)$$

where:

aLOMS = the actual length of milling season as determined by the MGB in terms of Clause 3.3 (expressed in weeks).

TAMS = total actual stoppages of the mill in the milling season that are caused by the Miller, as determined by the MGB in terms of Clause 3.1 (expressed in hours).

TAGS = total actual stoppages of the mill in the milling season that are caused by the Growers, as determined by the MGB in terms of Clause 3.1 (expressed in hours).

TANS = total actual stoppages of the mill in the milling season that are caused by Neutral factors, as determined by the MGB in terms of Clause 3.1 (expressed in hours).

cTSFCH = the total number of hours attributable to slow or fast milling at design capacity by the mill in the current milling season, as determined by the MGB in terms of Clause 3.5 (expressed in hours).

In drought seasons it might be appropriate to crush slowly to facilitate cane growth. This will lead to a MOTE that is not representative of a 'base-case' milling season. Consequently, the use of this abnormal MOTE in calculating bMOTE (Clause 2.2) is clearly inappropriate, and it is suggested that the MOTE for short seasons be replaced by the bMOTE (i.e. the average of the previous three seasons' MOTES) in the calculation of subsequent bMOTES.

Determination of other important parameters

Other parameters in addition to the actual milling performance or MOTE need to be calculated to determine some of the factors contributing to season length extensions. This section details these calculations, the results of which are used in the subsequent section.

Actual overall time efficiency (Clause 4.1)

The actual overall time efficiency (aOTE; expressed as a percentage) in the current milling season is determined according to the formula:

$$aOTE = ((aLOMS \times 168) - TAS) / (aLOMS \times 168)$$

where:
aLOMS = the actual length of milling season as determined by the MGB in terms of Clause 3.3 (expressed in weeks).
TAS = the total actual stoppage hours as determined by the MGB in terms of Clause 3.1 (expressed in hours).

Adjusted budgeted mill stoppages (Clause 4.2)
As explained in Clause 2.3, the total budgeted stoppages can only be determined at the end of the extension (i.e. the sum of the budgeted stoppages for the Agreed LOMS and the budgeted stoppages for the extension). These total budgeted stoppages then need to be adjusted in accordance with the actual mill performance exclusive of fast/slow crushing relative to the budgeted mill performance. Table 4 details this calculation.

Table 4. Adjusted budget mill stoppage categories.

Stoppage categories (budget hours)	Total budgeted hours at season end
Budgeted miller stoppages Scheduled stops Mechanical stops Operational stops Other stops **Total budgeted miller stoppages**	**TBMS = (BMSa + BMSe) x (aOTE / bMOTE)**
Budgeted grower stoppages No cane stops (including rain stops) Foreign matter stops Other stops **Total budgeted grower stoppages**	**TBGS = (BGSa + BGSe) x (aOTE / bMOTE)**
Budgeted neutral stoppages Due to *force majeure* only Due to fast/slow crushing **Total budgeted neutral stoppages**	**TBNS = (BNSa + BNSe) x (aOTE / bMOTE)**

where:
aOTE = the actual overall time efficiency for the season under review as determined in Clause 4.1 (expressed in weeks).
bMOTE = the budgeted modified overall time efficiency of the mill, as specified in Clause 2.2 (expressed as a percentage).

Net inward diversions (Clause 4.3)
Although net inward diversions form part of the actual total tons cane crushed as determined in Clause 3.2, net inward diversions needs to be isolated as a possible cause of a season length extension. Net inward diversions (abbreviated as aNID) are expressed in tons cane.

Actual area under cane (Clause 4.4)
The actual area under cane (aAUC; expressed in hectares) needs to be determined by the MGB cartographic programme. To maintain accuracy within 1% error, this cartographic programme should be updated annually.

Actual yield (Clause 4.5)
The actual yield (expressed as tons cane per hectare under cane) in the current milling season is determined according to the formula:

Actual yield = (aTCC – aNID) / aAUC

where:
aTCC = the actual tons cane crushed as determined by the MGB in terms of Clause 3.2 (expressed in tons cane).
aNID = the actual net inward diversions as determined by the MGB in terms of Clause 4.3 (expressed in tons cane).
aAUC = the actual area under cane farmed by the growers and miller-cum-planter as determined by the MGB in terms of Clause 4.4 (expressed in hectares).

Determination of factors contributing to a season length extension

The difference between the 'base-case' milling season and the actual milling season is the basis of determining the different factors that impact on season length extensions. There are seven factors that contribute to a season length extension, *viz.* miller, grower and neutral stoppage variances (i.e. actual stops less budgeted stops), slow/fast crushing, horizontal expansion due to net inward diversions and cane area expansion and vertical expansion. This section illustrates how these parameters are calculated, as well as the actual extension itself.

Miller, grower and neutral stoppage variances (Clause 5.1)
The miller, grower and neutral stoppage variance (MSV, GSV and NSV respectively; expressed in hours) is determined according to the formulae:

MSV = TAMS – TBMS

GSV = TAGS – TBGS

NSV = TANS – TBNS

where:

TAMS = total actual stoppages of the mill caused by the miller as specified in Clause 3.1 (expressed in hours).
TBMS = total budgeted stoppages of the mill caused by the miller as specified in Clause 4.2 (expressed in hours).
TAGS = total actual stoppages of the mill caused by the growers as specified in Clause 3.1 (expressed in hours).
TBGS = total budgeted stoppages of the mill caused by the growers as specified in Clause 4.2 (expressed in hours).
TANS = total actual stoppages of the mill caused by *force majeure* as specified in Clause 3.1 (expressed in hours).
TBNS = total budgeted stoppages of the mill caused by *force majeure* as specified in Clause 4.2 (expressed in hours).

Slow/fast crushing hours during actual hours open (Clause 5.2)
The hours attributable to slow or fast crushing during actual hours open (oTSFCH; expressed in hours) is determined by the formula:

oTSFCH = ((dTCH – aTCH) x (aTCC / aTCH)) / (dTCH x bMOTE)

where:
dTCH = the hourly average design crush rate of the mill as specified in Clause 2.4 (expressed in tons cane per hour).
aTCH = the actual hourly season average crush rate of the mill as specified in Clause 3.4 (expressed in tons cane per hour).
aTCC = the actual tons cane crushed in the current milling season as determined by the MGB in terms of Clause 3.2 (expressed in tons cane).
bMOTE = the budgeted modified overall time efficiency of the mill as specified in Clause 2.2 (expressed as a percentage).

Note: (aTCC / aTCH) / bMOTE = actual hours open. oTSFCH calculates the equivalent stoppage hours (or hours gained) due to slow (fast) crushing, assuming some slow/fast crushing would have occurred during actual stoppage hours as determined in Clause 3.1.

Horizontal expansion due to net inward diversions (Clause 5.3)
The hours attributable to net inward diversions (dHE; expressed in hours) will be determined by the MGB according to the formula:

dHE = aNID / (dTCH x bMOTE)

where:
aNID = the tonnage of net inward diversion as determined by the MGB in terms of Clause 4.3 (expressed in tons cane).
dTCH = the hourly average design crush rate of the mill as specified in Clause 2.4 (expressed in tons cane per hour).
bMOTE = the budgeted modified overall time efficiency of the mill as specified in Clause 2.2 (expressed as a percentage).

Horizontal expansion due cane area expansions (Clause 5.4)
The hours attributable to horizontal expansion due to area under cane expansions (aHE; expressed in hours) is determined by the formula:

aHE = ((aAUC – MSEA) x Agreed Yield) / (dTCH x bMOTE)

where:
aAUC = the actual area under cane farmed by the growers and miller-cum-planter as determined by the MGB in terms of Clause 4.4 (expressed in hectares).
MSEA = the mill supply equivalent area as specified in Clause 2.7 (expressed in hectares under cane).
Agreed yield = the agreed yield as specified in Clause 2.6 (expressed in tons cane per hectare under cane).
dTCH = the hourly average design crush rate of the mill as specified Clause 2.4 (expressed in tons cane per hour).
bMOTE = the budgeted modified overall time efficiency of the mill as specified in Clause 2.2 (expressed as a percentage).

Determination of vertical expansion in a milling season (Clause 5.5)
The hours attributable to vertical expansion (VE; expressed in hours) is determined by the formula:

$$VE = [(aAUC \times Actual\ Yield) - (aAUC \times Agreed\ Yield)] / (dTCH \times bMOTE)$$

where:

aAUC	=	the actual area under cane farmed by the growers and miller-cum-planter as determined by the MGB in terms of Clause 4.4 (expressed in hectares).
Actual yield	=	the actual tonnage of cane per hectare of area under cane in the supply area as specified in Clause 4.5 (expressed in tons cane per hectare under cane).
Agreed yield	=	the Agreed Yield as specified in Clause 2.6 (expressed in tons cane per hectare under cane).
dTCH	=	the hourly average design crush rate of the mill as specified in Clause 2.4 (expressed in tons cane per hour).
bMOTE	=	the budgeted modified overall time efficiency of the mill as specified in Clause 2.2 (expressed as a percentage).

Milling season extension – calculated and actual (Clause 5.6)
The actual milling season extension (EXT; expressed in hours) is determined by the formula:

$$EXT = (aLOMS - Agreed\ LOMS) \times 168$$

where:

aLOMS	=	the actual length of milling season as determined by the MGB in terms of Clause 3.3 (expressed in weeks).
Agreed LOMS	=	the number of weeks as determined in Clause 2.1.

The actual milling season extension (EXT) should be equal to the calculated milling season extension which is the sum of miller, grower and neutral stoppage variances (Clause 5.1), slow/fast crushing (Clause 5.2), horizontal expansion due to net inward diversions (Clause 5.3), horizontal expansion due to cane area expansion (Clause 5.4) and vertical expansion (Clause 5.5). A spreadsheet model has been developed to test this hypothesis and a worked example is presented below.

Worked example

Sections 2 to 4 are summarised in the worked example presented in Table 5. This example uses figures representative of an average mill area in the South African sugar industry.

Conclusion

In recent times commodity prices in general, and sugar prices in particular, have been declining in real terms. This puts all sugar industry participants under constant pressure to reduce costs and to look for ways of increasing efficiency. Identifying all the factors that contribute to season length extensions, including the impact of slow and fast crushing, is an important step in highlighting local inefficiencies. While the proposed mechanism identifies the parties responsible for any season length extension, it is likely that in many cases collaboration between the miller, growers and transporters will be required to rectify the cause of the inefficiency.

Table 5. Worked example of Sections 2 to 4.

Determining the "base-case" milling season

2.1	**The agreed length of milling season (AGREED LOMS - weeks)**	**36.5**
2.2	**The budgeted Modified Overall Time Efficiency (bMOTE - %)**	**78.33%**

Year	History LOMS	History aMOTE	Weight factor
02/03	37.0	75.00%	33%
01/02	35.0	80.00%	33%
00/01	36.5	80.00%	33%

2.3 **The budgeted mill stoppages (hours)**

BUDGETED STOPPAGES	WITHIN LOMS	Hours per Week	Scaled Hours	WITHIN EXTENSION	Hours per Week	Total Hours
Budgeted Miller Stoppages						
Scheduled Stops		5.7	226.3		6.2	7.6
Mechanical Stops		5.7	226.3		6.2	7.6
Operational Stops		5.7	226.3		6.2	7.6
Other Stops		4.4	175.1		4.8	5.8
Total Budgeted Miller Stoppages	**BMSa =**	**21.6**	854.1	**BMSe =**	**23.4**	28.5
Budgeted Grower Stoppages						
No Cane Stops (incl. rain stops)		6.2	244.4		6.7	8.2
Foreign Matter Stops		3.3	131.9		3.6	4.4
Other Stops		2.5	98.2		2.7	3.3
Total Budgeted Grower Stoppages	**BGSa =**	**12.0**	474.5	**BGSe =**	**13.0**	15.8
Budgeted Neutral Stoppages						
due to force majeure and other		0.0	0.0		0.0	0.0
Total Budgeted Neutral Stoppages	**BNSa =**	**0.0**	0.0	**BNSe =**	**0.0**	0.0
MOTE (assuming zero fast/slow crushing)		80.00%	78.33%		78.33%	78.33%

2.4	**The hourly average design crush rate (dTCH - tons cane crushed per hour crushing)**	**300**
2.5	**The milling capacity (tons cane)**	**1441020**
2.6	**The agreed yield (tons cane per hectare under cane)**	**65**
2.7	**The mill supply equivalent area (MSEA - hectares)**	**22170**

Determining actual milling performance

3.1 **The total actual mill stoppages (hours)**

ACTUAL STOPPAGES	WITHIN LOMS	Total Hours	WITHIN EXTENSION	Total Hours	TOTAL	ACTUAL HOURS
Actual Miller Stoppages						
Scheduled Stops		0.0		0.0		0.0
Mechanical Stops		0.0		0.0		0.0
Operational Stops		0.0		0.0		0.0
Other Stops		0.0		0.0		0.0
Total Actual Miller Stoppages	**AMSa =**	**0.0**	**AMSe =**	**0.0**	**TAMS =**	**870.0**
Actual Grower Stoppages						
No Cane Stops (incl. rain stops)		0.0		0.0		0.0
Foreign Matter Stops		0.0		0.0		0.0
Other Stops		0.0		0.0		0.0
Total Actual Grower Stoppages	**AGSa =**	**0.0**	**AGSe =**	**0.0**	**TAGS =**	**500.0**
Actual Neutral Stoppages						
due to force majeure and other		0.0		0.0		0.0
Total Actual Neutral Stoppages	**ANSa =**	**0.0**	**ANSe =**	**0.0**	**TANS =**	**0.0**
Total Actual Stoppages					**TAS =**	**1370.0**

3.2	**The actual tons cane crushed in the current milling season (tons cane - determined by the Mill Group Board)**	**1465200**
3.3	**The actual length of milling season (LOMS - weeks)**	**37.72**
3.4	**The actual average crush rate (aTCH - tons cane crushed per hour crushing)**	**295**
3.5	**Slow/fast crush hours during hours crushing (cTSFCH - hours)**	**82.8**
3.6	**The mill's modified overall time efficiency (MOTE - %)**	**77.07%**

Determination of other important parameters

4.1	Actual overall time efficiency	78.38%
4.2	Adjusted budgeted mill stoppages	

BUDGETED STOPPAGES		TOTAL Adjusted Budgeted HOURS
Budgeted Miller Stoppages		
Scheduled Stops		234.0
Mechanical Stops		234.0
Operational Stops		234.0
Other Stops		181.0
Total Budgeted Miller Stoppages	**TBMS =**	883.2
Budgeted Grower Stoppages		0.0
No Cane Stops (incl. rain stops)		252.7
Foreign Matter Stops		136.4
Other Stops		101.6
Total Budgeted Grower Stoppages	**TBGS =**	490.6
Budgeted Neutral Stoppages		0.0
due to force majeure and other		0.0
Total Budgeted Neutral Stoppages	**TBNS =**	0.0

4.3	Net inward diversions (tons cane - determined by the Mill Group Board)	0
4.4	Actual area under cane (hectares - determined by the Mill Group Board))	22200
4.5	Actual yield (tons cane per hectare under cane)	66.00

Determining the factors contributing to season length extensions

5.1	Miller stoppage variance (MSV - hours)	-13.2
5.2	Grower stoppage variance (GSV - hours)	9.4
5.3	Neutral stoppage variance (NSV - hours)	0.0
5.4	Slow/fast crush hours during hours open (oTSFCH - hours)	105.7
5.5	Horizontal expansion due to net inward diversions (dHE - hours)	0.0
5.6	Horizontal expansion due to area expansion (aHE - hours)	8.4
6.7	Vertical expansion due yield increases (VE - hours)	94.5
5.8	Sum of season length extension factors (4.2.1 - 4.2.7 - hours)	204.8
	Actual season length extension (hours)	204.8

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REFERENCES

Moor GM and Wynne AT (2001). Economic maximisation of grower and miller sugar cane profits: optimising the length of milling season at South African sugar factories. *Proc int Soc Sug Cane Technol* 24: 245-248.

APPENDIX
Guidelines for the Allocation of Mill Stoppages

Force majeure stops

A guideline for *force majeure* no-cane stops is 'any no-cane stop lasting more than 24 hours which arises from circumstances beyond the control of the responsible party'. Any *force majeure* no-cane stops relating to the mill's mechanical operation needs to be substantiated by written evidence explaining the reasons for the stop, failing which the stop will be allocated to the responsible party. *Force majeure* stops also include the effects of public holidays, strike action and acts of God.

Neutral/grower overlap

An example of this could be the effects of *force majeure* and a no-cane stop. A guideline for neutral/grower overlapping stops is 'neutral stops take precedence'.

Neutral/miller overlap

An example of this could be the effects of *force majeure* and a mechanical breakdown. A guideline for neutral/miller overlapping stops is 'neutral stops take precedence'.

Grower/miller overlap

An example of this could be the effects of a no-cane stop and a scheduled stop. A guideline for the grower/miller overlapping stops is 'the party responsible for initiating the stop will be responsible until such time that the cause of the stop has been rectified, after which the other party will be responsible for the remaining time if the stop continues'.