REVIEW OF SOUTH AFRICAN SUGARCANE PRODUCTION IN THE 2009-2010 SEASON FROM AN AGRICULTURAL PERSPECTIVE

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Abstract

The objectives of this paper were to characterise South African sugarcane production for the 2009/10 (denoted 2009) milling season from an agricultural perspective, in order to provide insight into successes and failures of recent production strategies and identify priorities for improved efficiency in producing high quality sugarcane in South Africa. Cane yield and quality were related to the main production factors, namely climate, irrigation water supply, pests and diseases, soil fertility and economic conditions.

Below average solar radiation and temperature, combined with below average or poorly distributed rainfall during the growing period, caused rainfed yield potential to decrease from 2008 to 2009 for most of the industry. Decreases from 2008 to 2009 in actual yields matched model-estimated decreases in most cases. Model estimates suggest that yields in fully irrigated areas should have increased slightly due to improved water availability (in Mpumalanga) and above average, well distributed rainfall. Actual yields, however, declined from 2008 to 2009 in these areas. Yields in Umfolozi increased significantly from 2008 to 2009 despite less favourable climatic conditions. This could possibly be ascribed to lower pest and disease pressures. Cane quality declined in some mill areas and improved in others. These changes were mostly driven by climatic factors.

Generally, pest survey information suggests that *Eldana saccharina* Walker (Lepidoptera: Pyralidae) (henceforth referred to as Eldana), was not a major factor influencing yield in 2009. Populations of *Fulmekiola serrata* (Kobus) (Thysanoptera: Thripidae) (henceforth referred to as thrips), in the Umfolozi region declined from 2007/08 to 2008/09; however, thrips numbers in the remainder of the industry are not clear due to a lack of empirical data. Smut levels declined in problem areas and it is unlikely that this disease had any significant effect on industry cane production in 2009.

The ratio of real input prices to real recoverable value (RV) price reached a high in 2008/09, exacerbating the negative economic returns experienced by large-scale growers since 2002/03. Lack of cash flow is likely to have constrained production inputs below optimal levels.

Generally, the changes in cane yield and quality from 2008 to 2009 were driven mainly by climate. Positive factors were the low diseases and pest levels and good irrigation water supplies. However, the poor economic situation of many cane growers is a limitation to optimal production input and crop management. Yield estimates from the Canesim model suggest that, although agronomic performance in 2008 and 2009 improved when compared with 2007, it could be further improved to achieve yields closer to potential.

Keywords: sugarcane, production, diseases, pests, modelling, review

Introduction

South African cane production has been in decline since 2005. Although this can largely be attributed to a decline in area under cane (Figure 1), it would be useful to investigate the extent to which other factors have contributed to this decline and to identify remedial actions.

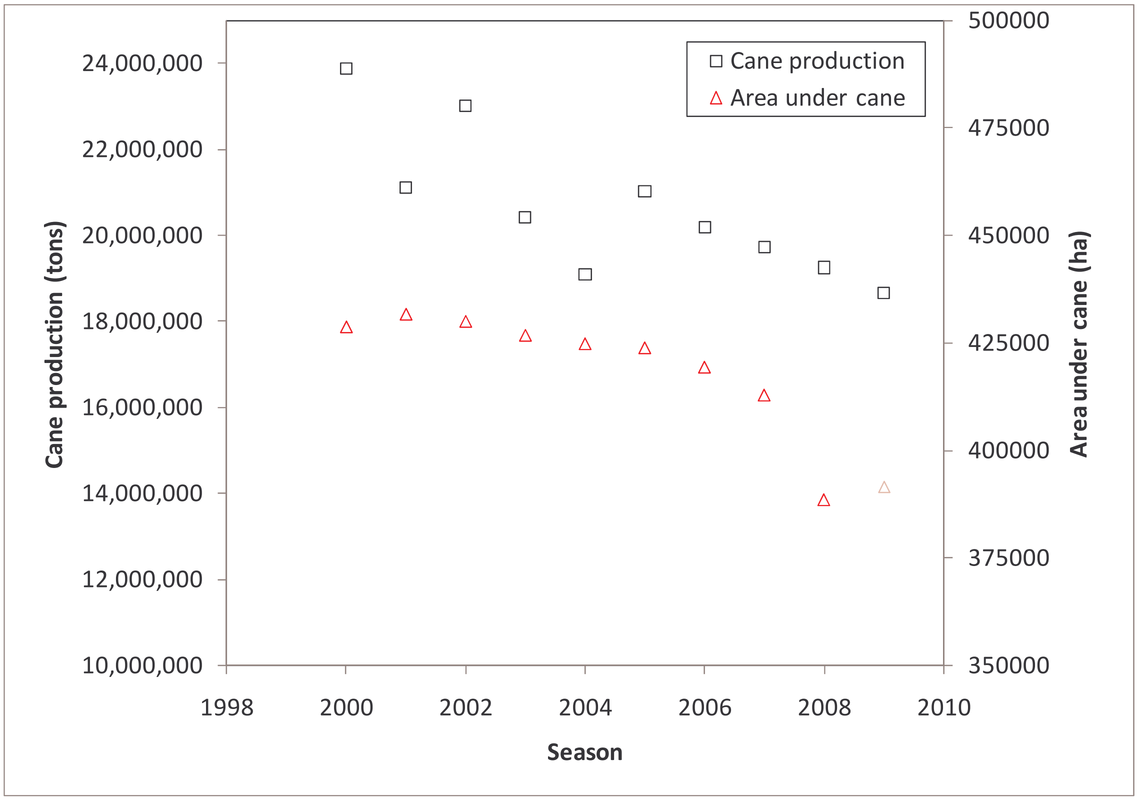

Figure 1. South African sugar industry production and area under cane over the last decade. The area under cane for 2009 is an optimistic estimate.

The objectives of this paper are to characterise South African sugarcane production for the 2009/10 (denoted 2009) milling season from an agricultural perspective. Cane yield and quality were related to the main production factors, namely climate, irrigation water supply, pests and diseases, soil fertility and economic conditions. Where possible the analysis was done at mill level. It is envisaged that the study will provide some insight into the successes and failures of recent production management strategies. It should also provide useful information for indentifying priorities and actions for more efficient production of high quality sugarcane in South Africa (SA).

Methods

A similar methodology was followed to that used in previous reviews (van den Berg *et al.*, 2008, 2009). The impact of the main climatic factors (rainfall, solar radiation and temperature) was assessed by comparing 12-month average (total in the case of rainfall) values leading up to each month of the 2009 milling season (e.g. April 2008 to April 2009, May 2008 to May 2009, and so forth) to the corresponding long term mean value. Reference soil water content (calculated as the available soil water content for a soil with a water holding capacity of 100 mm and with a full canopy cane crop growing on it) was assessed in a similar way.

Local Pest, Disease and Variety Control Committee field survey results were used to provide information on Eldana and diseases (smut, mosaic, rust and ratoon stunting disease). Information on thrips populations was obtained from the monitoring programme conducted by the SA Sugarcane Research Institute (SASRI) at selected study sites in the Umfolozi mill area.

Damage caused by Eldana is quantified in the SA industry as the total length of stalk tissue with a red colouration (caused by a fungal infection at the site of the borer damage) expressed as a percentage of total stalk length examined, referred to locally as 'Stalk Length Red' and abbreviated as SLR. It is estimated that the Eldana larval feeding habit causes 0.1% sucrose mass loss for every 1% SLR (Horton *et al.*, 2002). Damage recorded in surveys was averaged over the 12-month period from June to May.

Monitoring at Umfolozi has shown that thrips populations consistently peaked in the period from October to February, whereas populations were very low between March and September (van den Berg *et al.*, 2009). It is surmised that the effect on yield may occur during the peak period and thus the magnitude of the peak, namely the average number of thrips recorded over the 5-month period from October to February, was taken as an indication of the impact on cane yield.

Survey methods for smut and mosaic have been described previously (van den Berg *et al.*, 2008, 2009). For determination of ratoon stunting disease (RSD) xylem sap was extracted from 20-stalk samples collected from growers' fields and tested using the evaporative binding-enzyme immunoassay (McFarlane *et al.*, 1999).

Farm economics were analysed using data from SA Cane Growers' Association Large Scale Cost Survey, which is conducted at the end of each financial year. Only data up to the 2008/09 financial year was available. The survey elicits cost and income data from 15-20% of large-scale growers from all the major sugarcane producing regions in SA. Average cost and income statistics reported in this paper are weighted by the number of growers in each region to account for relative over- or under-sampling of any mill regions. Real values (adjusted for inflation to 2009 values) of average production cost (excluding interest, rent and leases, but including depreciation and a management allowance), cost of capital (calculated at 7% per annum) and gross income was used to determine the profitability of sugarcane production over the past nine seasons.

Actual yield data (average per mill supply area) were compared with yield estimated by the Canesim model (Bezuidenhout and Singels, 2007). Actual yield data was derived from cane production data (SA Sugar Association Cane Testing Services database) and area harvested data (SA Sugar Association Industrial Affairs annual survey). Model estimates provide a benchmark of the agro-climatic potential for sugarcane production, taking into account soil properties (Bezuidenhout and Singels, 2007), radiation, temperature and effective rainfall (SASRI meteorological database) as well as irrigation water supply (respective Water Users' Associations) in irrigated areas.

Estimated recoverable crystal content of cane expressed as a percentage on a fresh mass basis (ERC%) was chosen as the measure of cane quality. Seasonal average values for each mill supply area were obtained from the SA Sugar Association Cane Testing Services database. Actual ERC% was compared to a cane quality climate index (calculated as the index formulated by Singels *et al.,* 2003, multiplied by ten), which is a measure of how favourable temperature and soil water conditions are for sucrose accumulation, and hence cane quality.

Results and Discussion

Weather

Sugarcane requires high temperatures to build structure, and high levels of solar radiation to fill the structure with mass. It also requires adequate water to maintain growth processes at high rates. Cane quality is promoted by high radiation and cool, dry conditions during the period leading up to harvest.

Temperatures during the 2009 growing season were slightly below average in most mill areas (the exception being Midlands North mills) and were all lower than the previous two seasons (data not shown). Radiation was significantly below average in all mill areas and lower than for the previous two seasons. The 2009 growing season therefore had lower climatic potential for well watered cane than the preceding two seasons.

Rainfall in the 2009 growing season varied across the industry (see Figure 2). The Zululand and North Coast mill areas received below average rainfall, while South Coast and Midlands regions received above average rainfall. Nonetheless, rainfall in the South Coast and Eston mill areas was poorly distributed, leading to below average soil water status for the 2009 growing season (data not shown). This would have had a huge impact on rainfed cane yields in these regions. Rainfall in Mpumalanga was well above average, leading to a more favourable irrigation water supply during the 2009 season.

For the industry as a whole, rainfall was above average. Poor distribution of rainfall, however, together with lower radiation and temperatures, led to a decrease in the industry average yield potential (Figure 9).

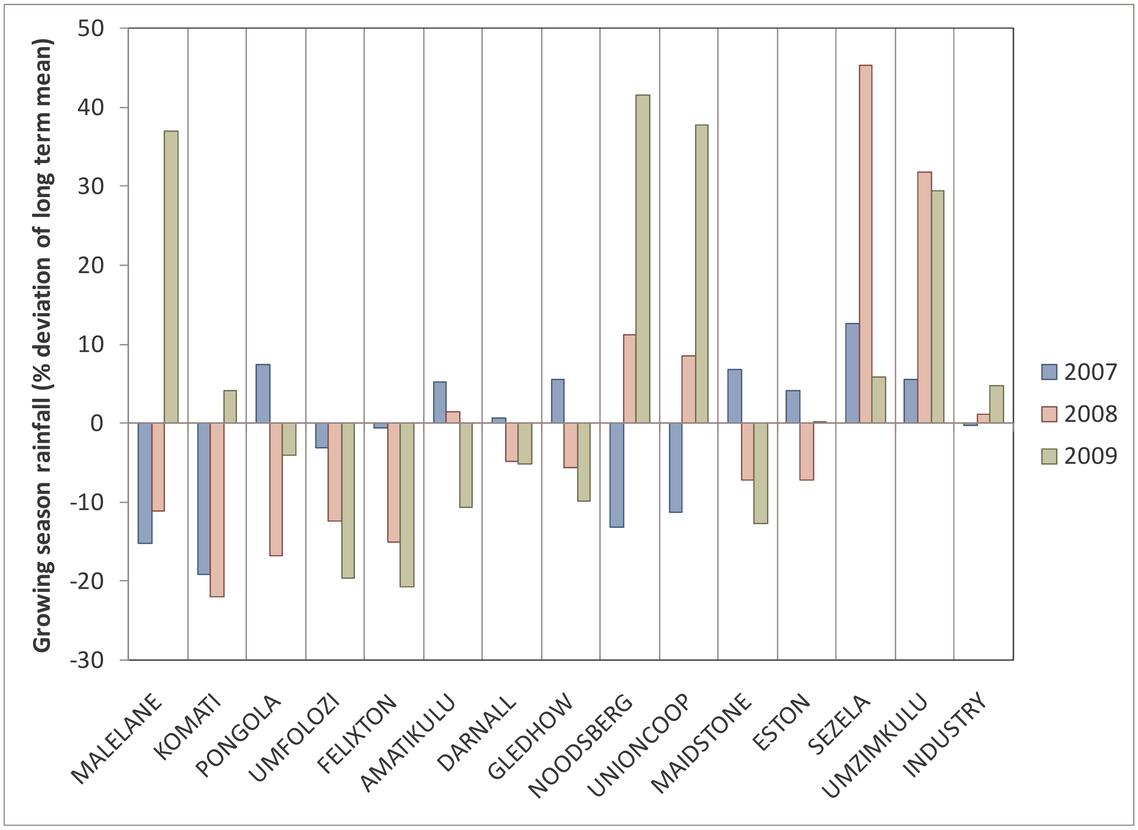

Figure 2. Total 12-month rainfall expressed as a percentage deviation from the long term mean, averaged over each month of the harvest season for different mill areas and seasons.

Irrigation water supply

The information in Table 1 shows that irrigation water supply was better in 2009 than in 2008 in Mpumalanga and Umfolozi. This should have benefitted the growth of irrigated cane in these areas. The impact of the restrictions in the Felixton mill area in 2009 is regarded as negligible.

Table 1. Irrigation water allocations, expressed as the percentage of the maximum allowable weekly extraction averaged over the growing season and over irrigated homogenous climate zones within a given mill area.

Mill\Year	2007	2008	2009
Malelane	68.3	61.1	70.2
Komati	66.4	57.8	66.8
Pongola	100	100	100
Umfolozi	43.1	55.3	61.2
Felixton	100	100	82.0

Pests

Eldana borer

Eldana survey data indicate that the damage in the 2009 growing season (2008/09 surveys) decreased in the industry from 1.56 to 1.19% SLR. Figure 3 shows Eldana damage recorded in the different mill areas. Significant decreases from 2008 to 2009 were recorded at Malelane (from 1.76 to 0.14%), Entumeni (from 1.94 to 0.68%) and Sezela (from 1.22 to 0.67%). Marginal decreases were recorded at Gledhow and Darnall. In the Midlands regions of Eston and Noodsberg, where stalk damage levels remain relatively high, part of this damage is attributed to the moth borer *Sesamia calamistis* and/or red rot disease. At Umfolozi, damage due to Eldana borer remained negligible, and was marginal at Umzimkulu (0.53%). In contrast, at Amatikulu a significant increase from 0.78 to 1.47% was recorded, although the level was below the 2.0% long term mean for this region. A marginal increase in damage at Felixton from 0.85 to 0.89% was recorded. The situation in Pongola is unclear because no data was recorded in 2008/09, a situation that was rectified in 2009/10.

Overall, Eldana appeared not to be a major factor influencing the 2009 production.

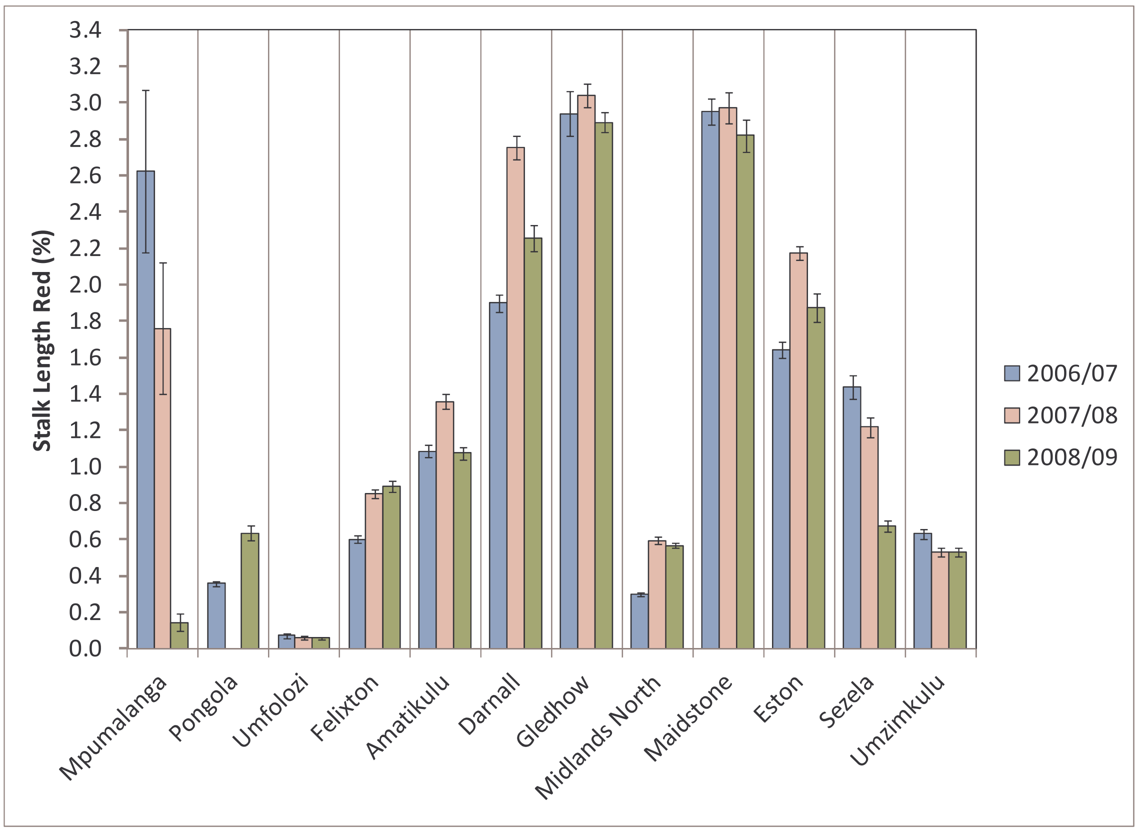

Figure 3. *Eldana saccharina* damage expressed as the mean stalk length red over the 12-month period from June to May for different mill areas and survey seasons. No data for Pongola in 2007/08 is presented. Error bars indicate the standard error of the mean.

Thrips

In the 2008/09 survey season the peak population was lower than the previous season, suggesting a lower negative impact from this pest on yield in the 2009 milling season

(Figure 4). The data provided an indication of infestation levels only in the Umfolozi region, which may not be representative of other mill regions. Data from 2009/10 that has yet to be collated, will likely confirm the perception from field observations that, in 2009/10, there was a resurgence of the pest, especially in the coastal regions of the industry.

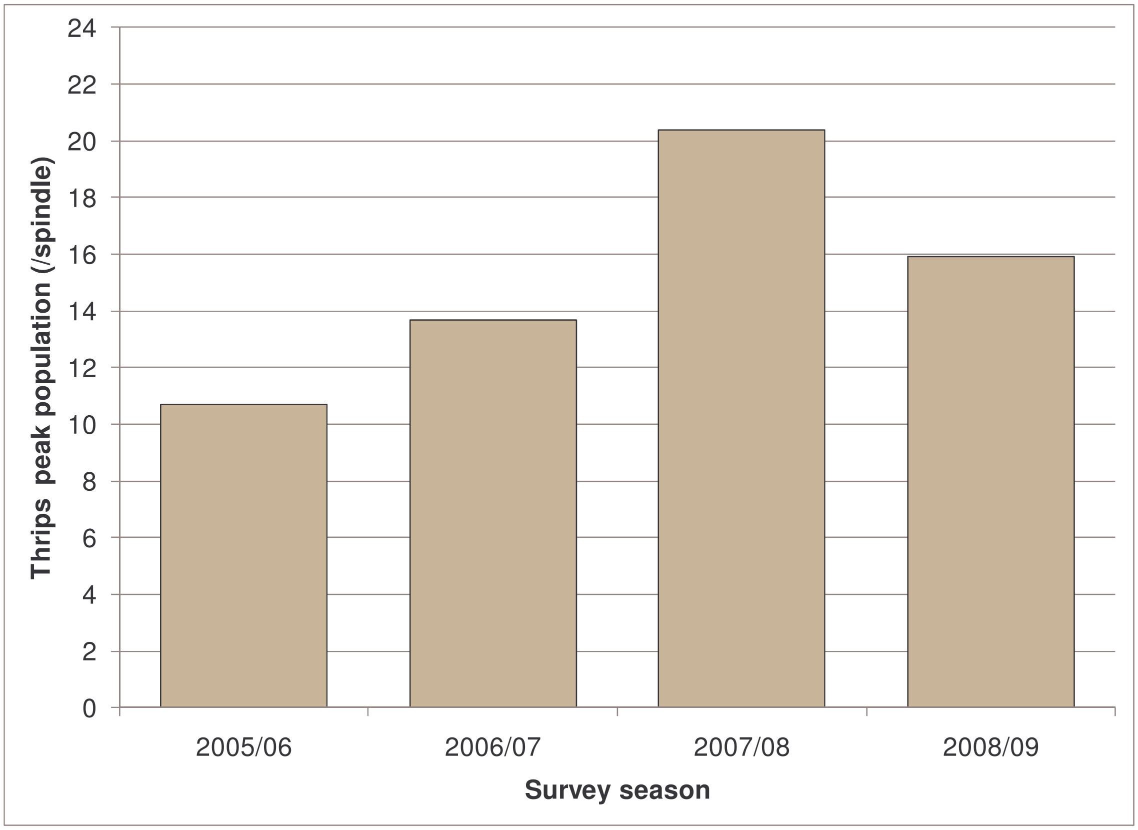

Figure 4. Peak population (mean over the period from October to February) of *Fulmekiola serrata* (thrips) in sugarcane surveyed at Umfolozi.

Diseases

Mean smut (*Ustilago scitaminea*) and mosaic (s*ugarcane mosaic virus*) levels in the industry were low for the period June 2008 to May 2009. Smut declined from a mean level of 0.5% stools infected in the 2007/08 survey season to 0.3% in the 2008/09 survey season, while mosaic levels decreased from 0.2 to 0.1% stools infected. Slight increases in the incidence of ratoon stunting disease (RSD) (*Leifsonia xyli* subsp *xyli*) have been noted over the past three seasons. Although brown rust (*Puccinia melanocephala*) was prevalent, infection was short-lived in most varieties.

Smut was widespread in Pongola and Mpumalanga (Malelane and Komati), with over 50% of the fields inspected being infected to some degree. While the percentage stools infected within these fields increased to almost 1% in Pongola, there was an apparent decrease in Mpumalanga, particularly in Malelane, when compared to the incidence in the 2007/08 season (Figure 5).

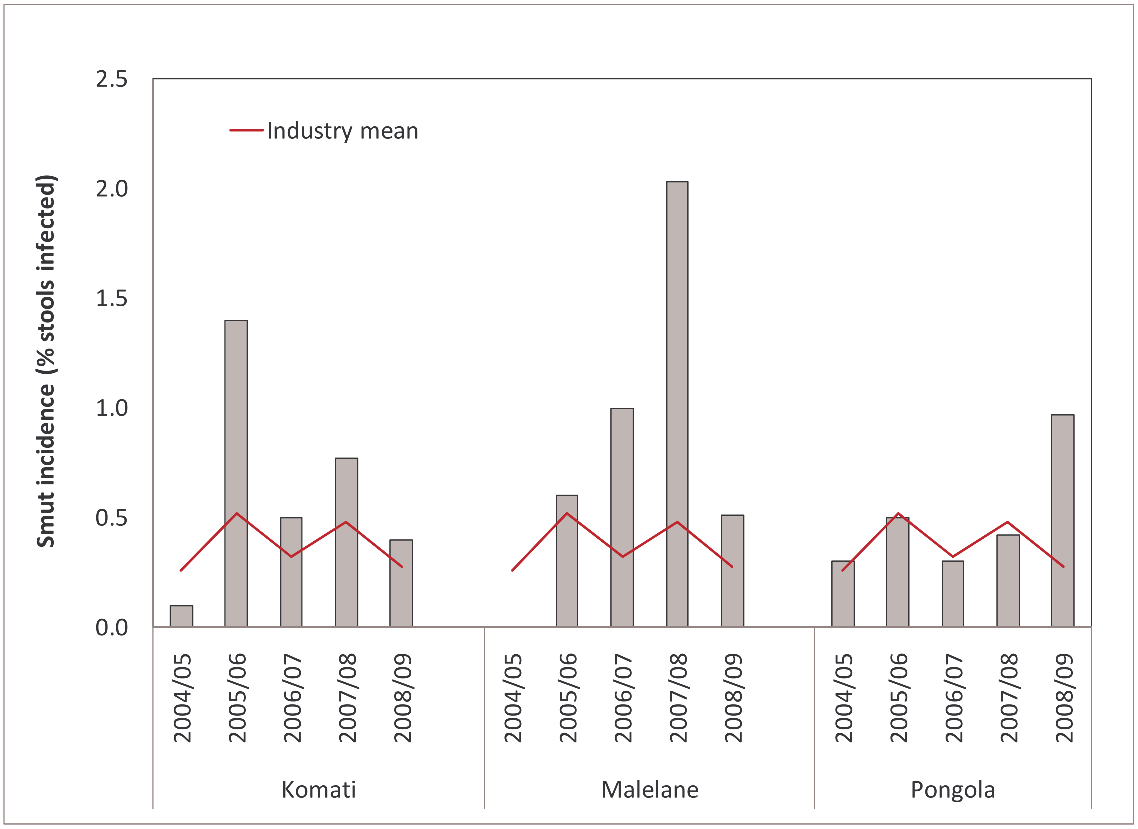

Figure 5. Smut incidence in commercial fields surveyed in different seasons in three smut-prone mill areas. The mean incidence for the industry is shown for comparison.

Smut continued to decline in Umfolozi and Zululand North and mean levels of 0.5% or less were recorded in these smut-prone areas. Since susceptible varieties are usually targeted when conducting smut surveys, actual smut incidence would have been lower than the survey results suggest. The extent of yield loss due to smut is dependent on the level of infection, variety, crop stage and growing conditions (Bailey, 1979a). Production losses of 0.25% can be expected for every 1% stools infected in cane grown under good growing conditions, increasing to a 0.75% loss in severely stressed crops (Bailey, 1979b, 1983; de Lange and McGugan, 1989). With smut levels below 1% in all areas and good rainfall over summer, it is unlikely that the disease would have had a substantial effect on cane production.

Routine surveys of more than 4500 commercial fields indicated that yield losses due to ratoon stunting disease (RSD) were possible in some parts of the industry where the disease was widespread. The percentage of commercial fields infected increased in Pongola (34%), Umfolozi (19%) and Durban North Coast (19%). Although the disease was also widespread in Mpumalanga (15%), prevalence was lower than for the previous season. To provide an indication of the yield loss that could be expected in these infected fields, an estimation of the percentage of infected stalks within fields is necessary. Routine surveys do not provide this information and more intensive, random surveys are planned.

Soil fertility and crop nutrition

Van der Laan and Miles (2010) reported that leaf sample data from the SASRI Fertiliser Advisory Service (FAS) show that high levels of nitrogen (N), phosphorus (P) and potassium (K) deficiencies are currently being observed in many regions of the industry, with the most severe deficiencies occurring for N. For the 2006 to 2009 period, 36% of samples analysed by the FAS were deficient in N, compared to 10% during the 1980-1982 period and 26% during the 1996-1997 period (Meyer *et al.*, 1998). This increase in number of samples deficient in N may be the result of a combination of factors, most notably escalated fertiliser prices over this period and a reduction in fertiliser N application rates by growers in response to the Eldana threat. In addition to P and K, extremely high silicon deficiencies, occurring almost exclusively in the rainfed regions of the industry, may be further contributing to the recent decline in yield below the climatic potential as shown by van den Berg *et al.* (2008). Widespread soil acidification, and the associated calcium and magnesium deficiency and aluminium toxicity problems also remain a serious, ongoing hindrance to sugarcane production.

Farm economics

Relative input and product prices are important determinants of optimum (profit maximising) levels of input use, and hence yields. Real (inflation adjusted) price indices of the recoverable value in cane (RV in units of tons – a measure according to which growers are paid for cane in South Africa – see Groom, 1999) and primary farm input prices are shown in Figure 6. Over the period 2000/01 to 2009/10, the real RV price index remained relatively constant, fluctuating within a range of 25% of its average value of 107.3 index points. Ratios of real price index of energy derived inputs (fertiliser, fuel and lubricants) to the real RV price index were relatively constant from 2000/01 to 2006/07, but spiked sharply in 2008/09 before partially recovering in 2009/10. Because the industry average crop production cycle is longer than 12 months, the impact of input and product price changes on cane production tends to lag the price change by a season. The 2008/09 spike in fertiliser and fuel prices is therefore expected to negatively impact on cane production in the 2009/10 season.

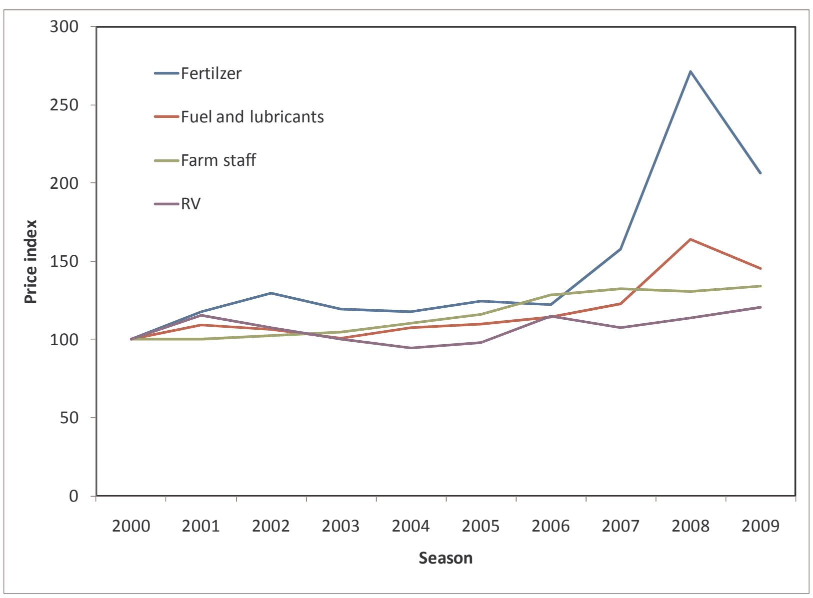

Figure 6. Price indices of the sugarcane recoverable value (RV) and primary farm inputs from 2000 to 2009 (adjusted to 2009 values).

The input price trends shown in Figure 6 indicate that fertiliser, fuel and lubricants and farm staff costs all tended to increase at a faster rate than the RV price from 2000 to 2009. Figure 7, which presents the development since 1997 in growers' estimated average real gross income and costs per hectare under cane for the industry, shows that this general cost-price squeeze diminished returns to cane production. The shaded area represents the shortfall between actual average gross income per hectare for the Cost Survey respondents, and the average gross income per hectare required to cover costs plus a return on capital (ROC) of 7% of the determined average capital value per hectare. A recurring shortfall implies an economic environment that cannot sustain cane production, which has been the case since the 2003 season. In 2007 and 2008 survey respondents' average total costs per hectare excluding ROC exceeded their estimated average gross income per hectare, indicating a negative rate of return on capital invested. The impact of the spike in prices of energy derived inputs in 2008 largely accounts for the 8.7% increase in average real total costs per hectare. Growth in survey respondents' average real gross income per hectare, primarily attributable to a 5.96% increase in the real RV price and a 2.13% increase in the average cane yield from 2007 to 2008, off-set the change in real average total costs. Consequently, the magnitude of the shortfall per hectare under cane declined marginally from R1656 in 2007 to R1608 in 2008 (measured in 2009 Rand value).

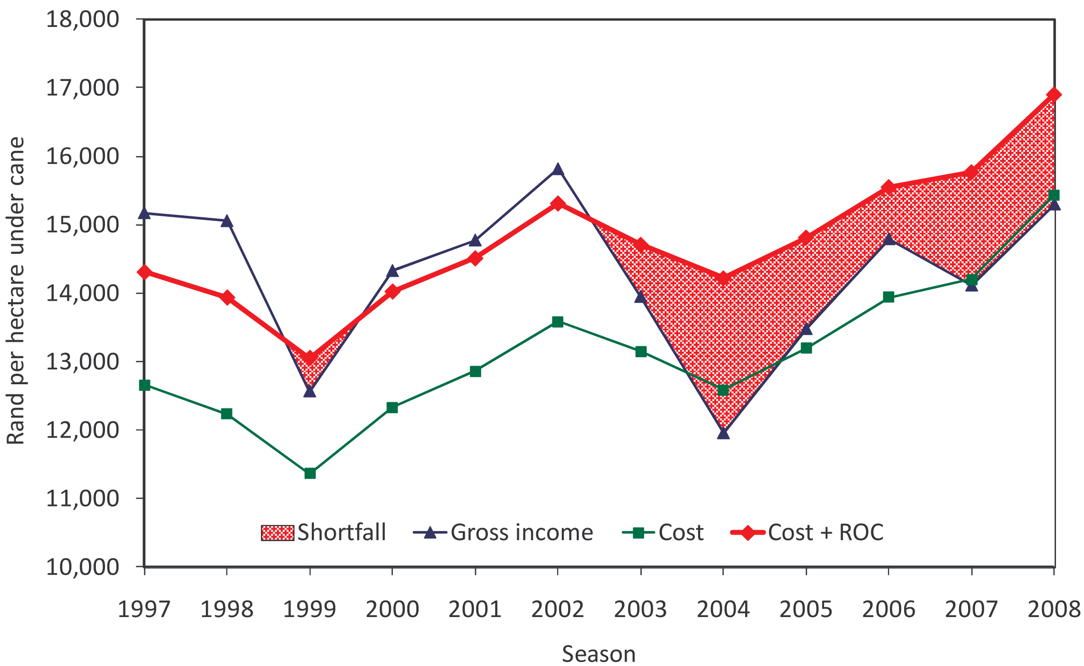

Figure 7. Real (2009 values) average gross income, production cost and the sum of production cost plus return on capital invested (ROC) per hectare under cane of large-scale growers for the period 1997 to 2008.

Cane yields

Mean yields for the past three seasons are shown in Figure 8. Yields in fully irrigated areas have decreased from 2008 to 2009. Although the irrigation water supply was more favourable in Mpumalanga (Table 1), less radiation and lower temperatures (see section on weather) may have caused this decrease in yields. In Pongola, lower radiation, as well as the increased incidence of smut (see section on diseases) and poor agronomic performance on small-scale farms and farms under land claims (personal communication[1]) may have contributed to this yield decrease. The yield decrease trend from 2008 to 2009 in irrigated areas was not mimicked by the Canesim model (Figure 9). It is plausible that the slight increase in estimated yields is due to well distributed rainfall that mitigated short periods of mild stress that are normally experienced during periods of high water demand.

Yields at Umfolozi increased substantially from 2008 to 2009, despite the less favourable climatic conditions that existed in 2009 compared to 2008 (lower rainfall, radiation and temperature). This could be due to improved agronomic management and lower pest (especially thrips – see Figure 4) and disease incidence.

Yields decreased by more than 5% from 2008 to 2009 in Felixton, Amatikulu, Maidstone, Eston and Sezela (Figure 9). This is ascribed to lower climatic potential in 2009 compared to 2008 as calculated by the Canesim model (Figure 9), mainly due to poorly distributed rainfall and low radiation. Poor ratoon husbandry by new freehold growers, localised frost damage and thrips infestation may also have contributed to lower yields in Sezela (personal communication[2]). Yields in Gledhow also improved (by 20%) against expectations, while yields in Maidstone decreased by a dramatic 28% – a much larger reduction than expected (Figure 9). The latter mill areas experienced similar climatic conditions and the large fluctuations in yield are partly ascribed to substantial changes in home mill assignments, with associated uncertainties in area harvested for each mill area. When yields are averaged over these two mill areas, the yield decrease from 2008 to 2009 amounts to 6.8%, which is more than the 2.8% decrease calculated by the model.

The industry mean yield decreased by 4.6% from 67 t/ha in 2008 to 63.9 t/ha in 2009, which agrees well with the Canesim estimate of a 3.3% decrease (Figure 9).

In Figure 10 industry mean yields over the past 12 years are compared to the potential yield calculated by the Canesim model. The model assumes perfect agronomic management, adequate nutrition and no adverse effects from diseases, pests and weeds and thus the simulated yield is the theoretical maximum value that could possibly be achieved under ideal circumstances (mindful of model and data shortcomings). The ratio of actual to simulated yields provides a coarse measure of the efficiency of sugarcane production. The ratio was above 0.75 for the 2003, 2004 and 2005 seasons and then declined to a low of 0.61 in 2007. This ratio has increased to approximately 0.67 over the past two seasons, which indicates that there is opportunity for improving agronomic management of sugarcane production to achieve yields closer to the predicted potential.

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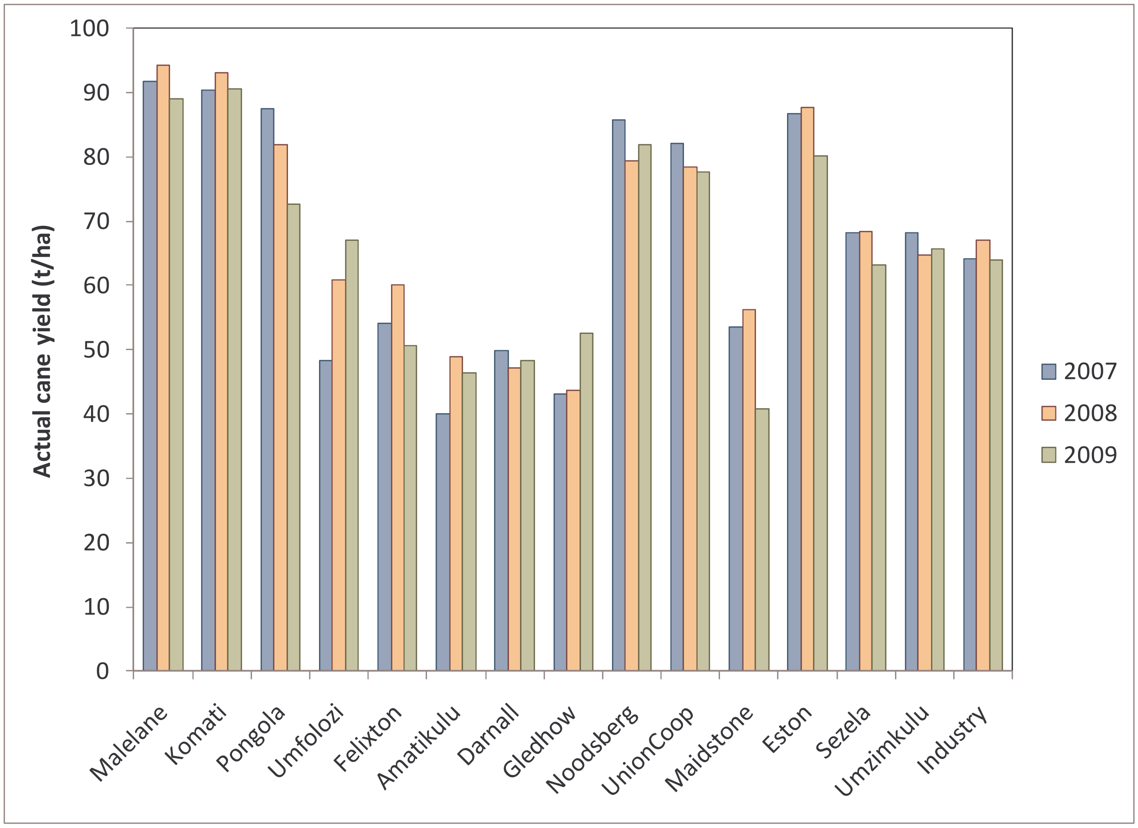

Figure 8. Mean cane yields for different mills and for the industry calculated from production and area harvested for three seasons (for 2009 the area harvested is an estimate).

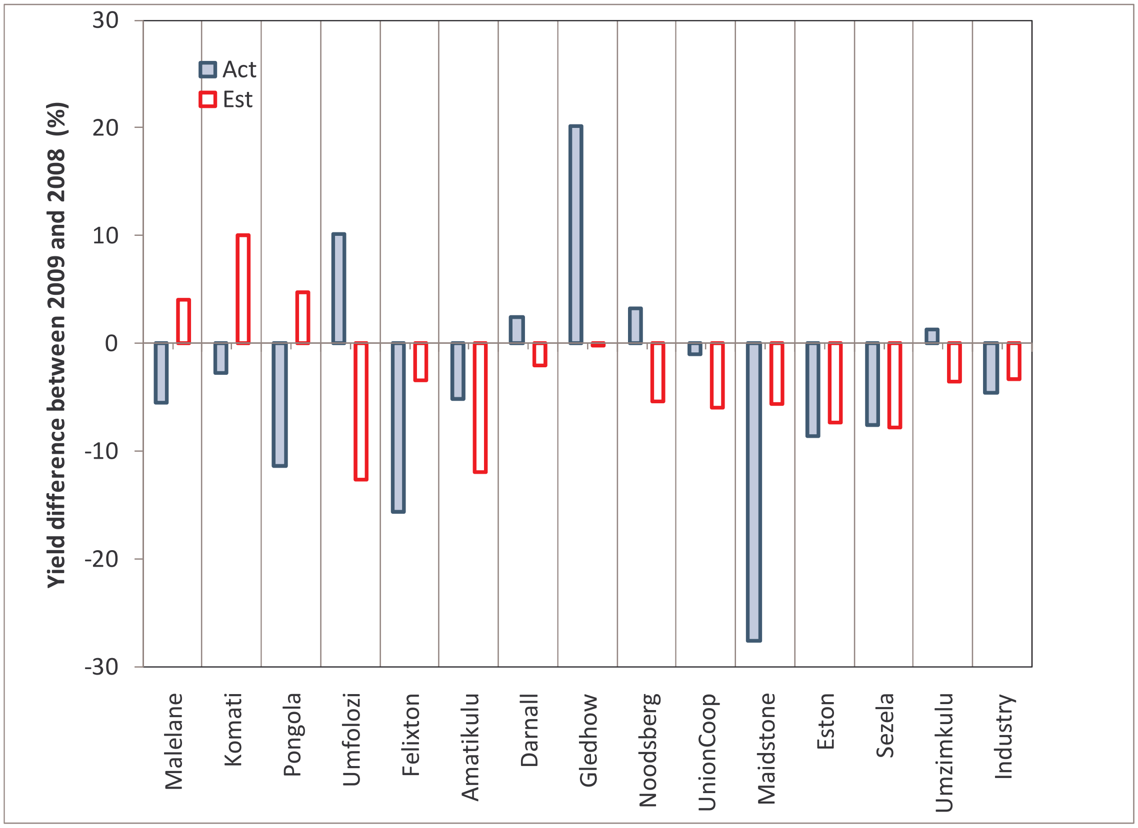

Figure 9. Yield difference between the 2008 and 2009 seasons for the different mills and for the industry, expressed as percentage of the 2008 yield. Differences in actual yields (Act) and in estimated yields (Est) are shown.

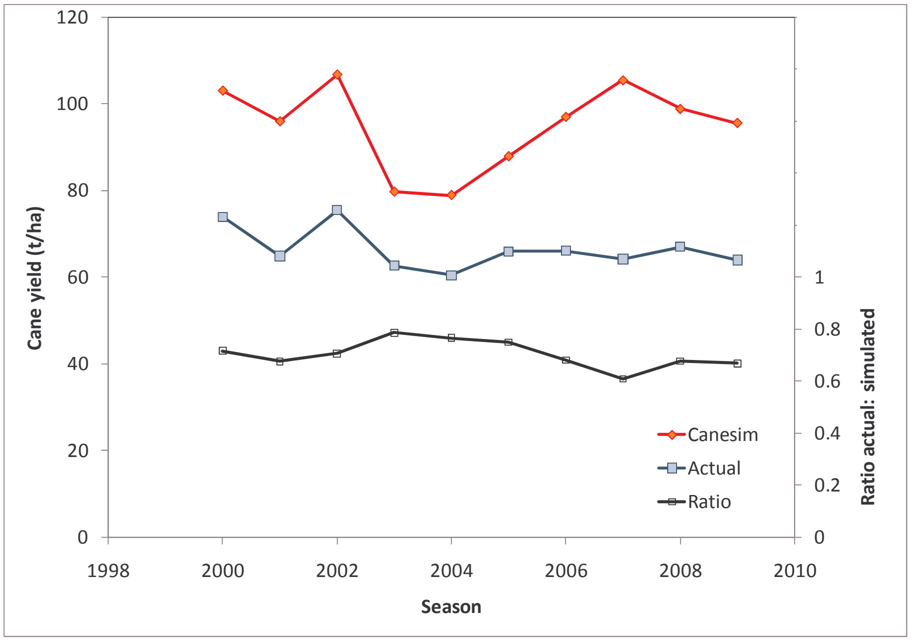

Figure 10. Actual and simulated (Canesim) industry average yields and the ratio between the actual and simulated yields for recent seasons.

Cane quality

Cane quality trends are depicted in Figure 11. ERC% has declined over the past three years at Pongola, Darnall, all three Midlands mills and in the industry as a whole. ERC% for the 2009/10 season was lower than the 2008 season at Malelane, Pongola, Amatikulu, Darnall, Geldhow, Maidstone and the three Midlands mills. Quality was higher than the previous season for Komatipoort, Umfolozi, Felixton and the two south coast mills. This coincides with the cane quality climate index (Figure 12) for most cases except Komati, where cane quality improved against expectations, and Darnall and Gledhow, where cane quality declined against expectations.

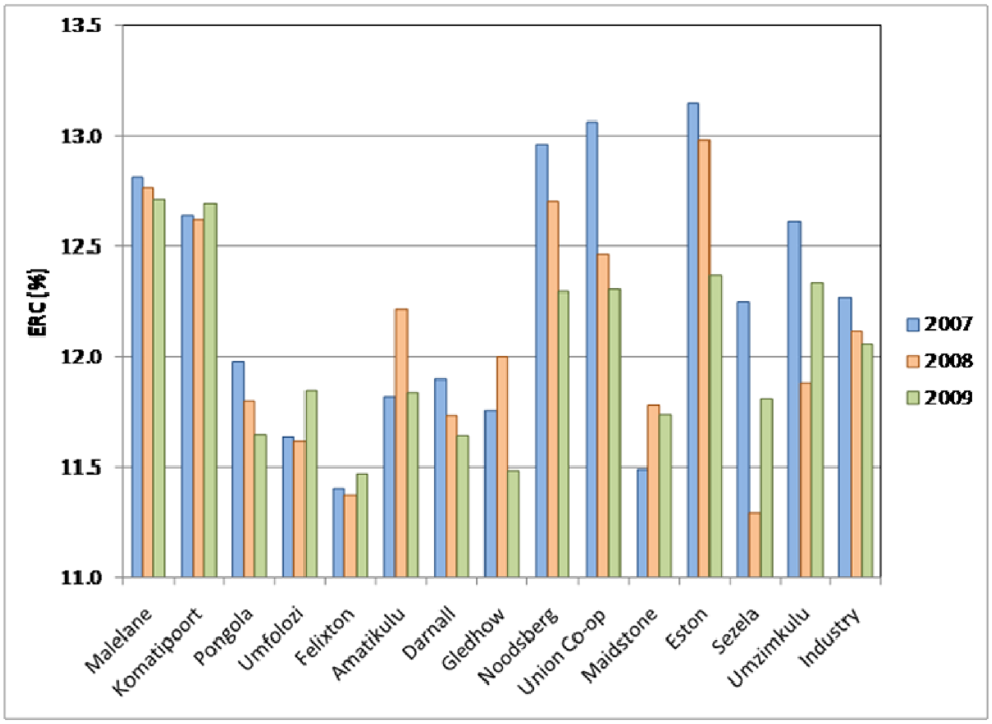

Figure 11. Estimated recoverable crystal content of cane on a fresh mass basis (ERC%) for different mills and for the industry for the 2007, 2008 and 2009 seasons.

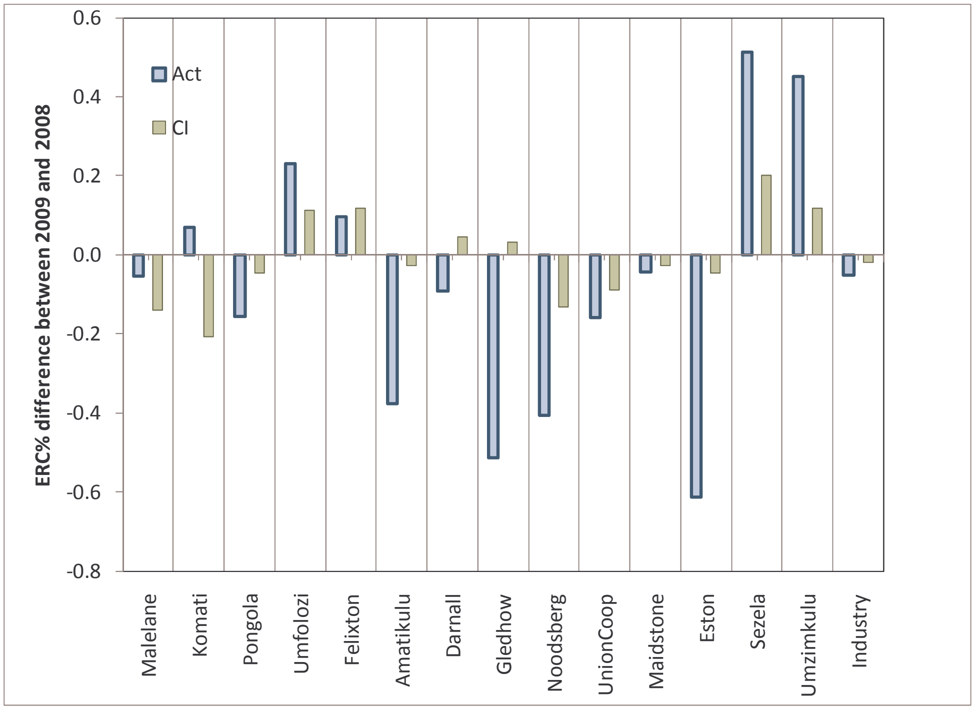

Figure 12. Difference in estimated recoverable crystal content (Act in units of ERC%) and the difference in the cane quality climate index (CI; a measure of how favourable climate was for sucrose accumulation; see Singels *et al.*, 2003) between the 2008 and 2009 seasons for the different mills and for the industry.

Summary

Below average radiation and temperature combined with below average or poorly distributed rainfall resulted in a decrease in rainfed yield potentials from 2008 to 2009 in most of the industry. Decreases from 2008 to 2009 in actual yields matched model estimations in most cases. Although radiation and temperatures were also below average in fully irrigated areas, model estimates suggest that yields should have increased due to improved water availability (in Mpumalanga), well distributed and above average rainfall. However, actual yields declined from 2008 to 2009 in these areas, suggesting that agronomic performance could be improved. Despite less favourable climatic conditions, yields at Umfolozi increased significantly from 2008 to 2009, which might have been due to the decrease in pest and disease pressure.

Cane quality declined in some mill areas and improved in others. These changes in most instances corresponded with the cane quality climate index, indicating that climate played a role. The exceptions were Komati (better than expected), and Darnall and Gledhow (worse than expected).

Generally, pest survey information suggested that Eldana was unlikely to be a major factor influencing yield changes in 2009. The decline in thrips populations in Umfolozi from 2007/08 to 2008/09 appeared to be reflected in the yield from this area. The possibility of an effect from thrips infestation in other regions is not known. Smut levels in Mpumalanga

decreased from 2007/08 to 2008/09 and were low in other areas, and it is unlikely that this disease had any significant effect on industry cane production.

The ratio of real input prices to real RV price reached a high in 2008/09, exacerbating the negative economic returns experienced by large-scale growers since 2002/03. It is believed that this situation has led to changed farming practices such as reduced fertiliser application and replanting rates, which was identified as a major cause of recent yield declines below attainable levels (van den Berg *et al.*, 2008). The effects of these practices are likely to be evident in future seasons.

Generally, the changes in cane yield and quality from 2008 to 2009 seem to have been influenced predominantly by climatic factors. Relatively low disease and pest levels coupled with adequate irrigation water supply, appeared to influence yields favourably. In contrast, poor economic resources remain a limitation to optimal production input and crop management. Canesim yield estimates suggest that although agronomic performance in 2008 and 2009 improved from 2007, this could be further improved to achieve yields closer to the potential.

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