SHORT, NON-REFEREED PAPER

ANALYSIS OF THE FELIXTON INTEGRATED SUPPLY AND PRODUCTION SYSTEM WITH AN EMPHASIS ON CANE QUALITY

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Abstract

Stakeholders in the South African sugarcane supply chain often optimize local processes at the expense of the global operation. The industry stands to benefit from research that aligns industrial processes using modern supply chain and cybernetics research approaches. This project seeks to determine how operations in the complex Felixton mill supply area can be described, analysed diagnostically and possibly improved. Significant problems cited at Felixton included poor cane quality and unreliable cane supply. Cane quality was identified as a logical place to drive improvements to the overall efficiency of the supply chain. Sugarcane quality aspects were analysed using control charts. A daily analysis of fibre % cane and pol % fibre using Shewhart control charts (X-bar charts), identified Monday deliveries to have abnormally high fibre and low pol values, respectively. Both these variables were beyond the control limits and represent an out of control process in Monday operations in the area. This is a strong indicator of cane deterioration and logistic inefficiency over the weekend. The indicators will enable the generation of a grower performance index that will allow stakeholders to improve operations.

Keywords: supply chain, quality control, Felixton, sugarcane, cane quality

Introduction

Cane quality is measured by the Cane Testing Service (CTS) at the mill. The information obtained from this analysis is used in the cane payment scheme. Quality can also be used for monitoring the supply chain (Zuniga-Arias *et al*., 2009). In agricultural systems product quality depends on growing conditions and management practices (Groom, 1999; Zuniga-Arias *et al*., 2009). When analysing product quality from climatically homogeneous regions, management practices will have a higher influence on product quality (Groom, 1999). Cane quality data can therefore be used as an indicator of the state of operations in the supply network. The aim of this study was to analyse CTS data using quality control approaches in an attempt to identify valuable information that could be used to improve the overall cane supply at Felixton mill.

Methodology

Cane quality variables measured by Cane Testing Services (CTS) at Felixton, were analysed using quality control charts (Shewhart, 1931). The assumption was that, through analysis of the quality of cane at the mill, one can detect problems upstream in the supply

chain. Data were provided by CTS with the consent of concerned growers. From these data, analyses were carried out on pol, brix, moisture, fibre, RV, purity and non-pol % cane. Quality characteristics were analysed per season, per week and per day in search of patterns. Day of the week analysis provided the strongest signal. It was noted that some quality aspects are inherently erratic and would provide false signals. Fibre % cane did not fluctuate as much as the other factors according to seasonal changes (Lonsdale and Gosnell, 1976). The analysis of six factors of cane quality was carried out and the outcome of a six season analysis is represented in Table 1. A new factor was derived considering that pol % cane appeared to change fast and can only be reduced, while fibre % cane was the slowest variable to change over time. In the absence of initial conditions in the field, pol % fibre, therefore, provided a relatively robust measurement of cane deterioration. All analysis was carried out per ward (Groom, 1999), and the sample consisted of 55 large commercial growers selected based on Pareto analysis.

Non-parametric statistical tests were carried out to verify whether growers were delivering significantly different sugarcane after weekends compared to mid to late week deliveries. Pol % fibre data were divided into two groups, *viz.* Sunday to Tuesday deliveries and Wednesday to Friday deliveries. Mann Whitney analysis was performed to compare these two sets of data. The percentage of weeks with a p-value of less than 0.05 for each grower was recorded over the six seasons.

Results and Discussion

Quality control charts

The results in Table 1 show the days of the week, over six seasons, which experienced out of control processes. Days where quality readings were above or below the upper or lower control limits respectively are shown. From the results it is apparent that Monday deliveries exhibit the most irregularity. Quality control charts plot the averages for each day and Monday shows below lower control limit averages for pol % cane, RV % cane and purity for most wards. The new factor, *viz.* pol % fibre also shows averages below the lower control limit for Mondays. This suggests that deliveries on this day could be significantly deteriorated due to delays incurred over the weekend. The result is further supported by the fact that fibre% cane and non-pol % cane show averages above the upper control limit on Monday. Tuesday and Sunday also show several anomalies in the quality factors. The quality control chart is a valuable tool and allowed for the identification of days of the week when burn to crush delay was probably longer than normal.

Non-parametric test

Figure 1 displays the average percentage of significant deviation weeks per grower over six seasons. A deviation week is defined as a week where cane qualities after the weekend differed with more than 95% significance from cane qualities later in the week. This was based on a Mann Whitney analysis on pol % fibre. Figure 1 shows that certain growers have a substantial amount of deliveries that are affected by weekend deterioration and that this phenomenon can be detected in the quality of cane delivered. The information suggests that the burn/harvest to crush delay on weekends and subsequent inefficiency of logistics can be monitored at the mill by using existing CTS quality data.

Table 1. Cane quality variables at Felixton mill that lie outside control limits on certain days of the week.

Ward	Fibre % cane	Purity	Pol % cane	RV % cane	Non-pol % cane	Pol % fibre
Empangeni central	Mo^{U} Tu^{U} Fr^{L}	Mo^{L} Tu^{L}	Mo^{L} Tu^{L}	Sa^{U} Mo^{L} Tu^{L}	Mo^{U} Tu^{U}	Mo^{L} Tu^{L} Fr^{U}
Empangeni east	Mo^{U}	Mo^{L}	Mo^{L}	Mo^{L}	Mo^{U} Tu^{U}	Mo^{L}
Empangeni west		Su^{U}			Tu^{U}	Mo^{L}
Felixton flats	Su^{U} Mo^{U}	Mo^{L}	Mo^{L} Su^{L}		Mo^{U}	Mo^{L}
Felixton hills	Sa^{L} Mo^{U}	Mo^{L}	Mo^{L}	Mo^{L}	Mo^{U} Tu^{U} Th^{L}	Sa^{U} Mo^{L}
Heatonville riperian	Mo^{U}	Mo^{L}		Mo^{L}	Mo^{U} Su^{L}	Mo^{L}
Heatonville scheme	Mo^{U}	Mo^{L} Th^{U} Fr^{U}	Sa^{L} Mo^{L} Th^{U}	Sa^{L} Mo^{L} Th^{U}	Mo^{U} Tu^{U} Th^{L} Fr^{L}	Mo^{L} Su^{L}
Mposa			Su^{U}	Su^{U}	Tu^{U}	
Mtunzini	Sa^{L}	Mo^{L}	Mo^{L}	Mo^{L}	Mo^{U} Th^{L}	Sa^{U}
Nkwalini	Mo^{U}	Su^{U} Mo^{L}	Su^{U} Mo^{L}	Su^{U} Mo^{L}	Su^{L} Mo^{U} Tu^{U}	Mo^{L}
Northern areas		Mo^{L}			Mo^{U}	

^{U}=Above the upper control limit, ^{L}=Below the lower control limit. The days of the week are represented by the first two letters of the day.

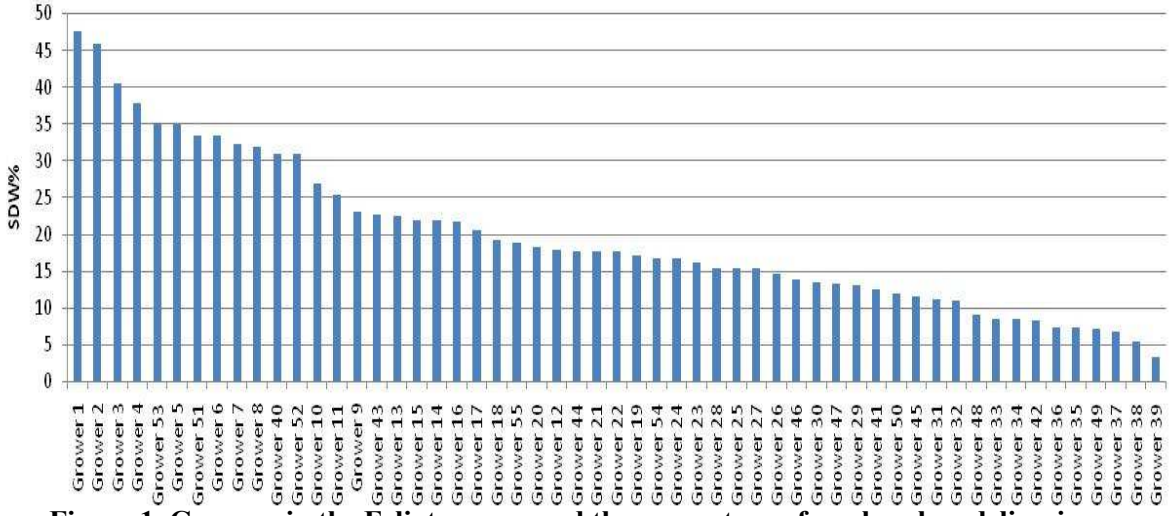

Figure 1. Growers in the Felixton area and the percentage of weeks when deliveries were significantly different (p value <0.05) in quality after weekends compared to late-week deliveries. SDW% refers to Significant Deviation Week percentage.

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