VALUE AND FEASIBILITY OF ALTERNATIVE CANE SUPPLY SCHEDULING FOR A SOUTH AFRICAN MILL SUPPLY AREA

P-Y LE GAL[1], E MEYER[2], P LYNE[2] and O CALVINHO[3]

[1]*CIRAD-TERA, TA 60/15, 34398 Montpellier Cedex 5 and Centre for Rural Development Systems, University of Natal, Scottsville, 3209, South Africa*
[2]*South African Sugar Association Experiment Station, P/Bag X02, Mount Edgecombe, 4300, South Africa*
[3]*Institut National Agronomique, 16 Rue Claude Bernard, 75005 Paris, Franc*
E-mail: pierre-yves.le_gal@cirad.fr

Abstract

In South Africa, sugarcane is delivered to the mill uniformly over the milling season and across all supply areas. This delivery schedule does not exploit the cane quality patterns, represented by the 'recoverable value' (RV) of sugar, which shows distinct regional trends, primarily due to climate differences and resulting differences in agronomic practices. A 2002 study conducted in the Sezela mill supply area showed that total RV production could be increased by 1-5%, by dividing the mill supply area into four homogenous zones and adapting allocation according to cane quality variations. Based on these positive results, a second study was requested by the Mill Group Board to assess the feasibility of the supply scenarios. A 2003 study focused on the analysis of (i) delivery curves per sub-area, (ii) inter-annual variations in quality within the supply sub-areas determined in 2002, and (iii) available capacities along the supply chain, i.e. harvest, transport and milling. Both delivery and quality curves showed a fairly stable profile from one year to another. Deliveries increased progressively during the first month of harvest and decreased quickly from the beginning of the last month onwards. Inland cane supplies usually showed a more stable quality than coastal cane during the first half of the season. Extra capacities were available all along the chain, although the amounts varied from one stakeholder to another. On average, growers were able to double their daily ratable delivery, while hauliers could increase their capacity by 35%. These results were used to design and simulate scenarios similar to the real supply chain management. They took into account the quality variations between Inland and Coastal zones and the impact of stalk borer on Coastal cane quality. Both scenarios showed RV gains of 1-3%. However, implementing the proposed changes would impact differently on growers' incomes according to their location in the supply area. This statement implies further investigation on the relationship between cane payment system and cane supply organisation.

Keywords: sugarcane, cane quality, mill supply, supply chain management, delivery allocation, simulation

Background

Since its liberalisation in 1998, the South African sugar industry has been facing a new economic environment, as half of its production is exported at a price that fluctuates according to the global market. The industry has to improve its efficiency in order to remain competitive internationally, especially in view of strong local currency and variable rainfall.

While profitability gains can be sought at different stages of the sugar production chain (growing, milling and marketing), potential also exists at the mill area level by improving cane supply management. This process involves interaction between farmers and contractors in charge of the harvest, hauliers who transport the cane to the mill, and millers who organise supplies for the mill operation. Improving cane supply management requires a system analysis and specific methodology in order to provide useful information to both growers and millers (Muchow *et al*., 2000).

Various options can be explored to maximise sugar production, ranging from changes in harvest and transport techniques to new rules of delivery allocation (Gaucher *et al*., 2003). One option is to change the structure of cane deliveries from the fields to the mill by taking advantage of quality variations within the mill supply area during the harvest season. Such delivery organisation has been studied in Australia (Higgins and Muchow, 2003) and in La Réunion (Lejars *et al*., 2003). An exploratory study based on similar principles was conducted in 2002 in the Sezela mill area (Guilleman *et al*., 2003). Based on these initial results, a second study was conducted in 2003 to design and simulate realistic alternatives of supply organisation that could be implemented by the mill.

Problem statement

The Sezela mill crushed an average of 2.17 million tons of sugarcane between the 1998 and 2002 seasons. The mill is supplied by a large variety of growers including its mill-cum-planter estate (13%), 180 large-scale farmers (72%) and about 5000 small-scale farmers (10%). The remaining 5%, called diversion cane, is supplied by two other Illovo mills (Eston and Umzimkulu) which operate at full capacity. The mill supply management involves (i) growers who grow their cane, often cutting and sometimes transporting it as well (the latter called grower/haulier - grw/hlr - in this study), (ii) harvest-contractors who cut and load the cane on behalf of the growers (the usual arrangement for the small-scale growers), and (iii) hauliers dedicated to cane transport (called haulier/haulier: hlr/hlr) and the mill.

The Mill Group Board (MGB) is responsible for season planning and cane supply co-ordination between these operators. Daily rateable deliveries (DRDs) are uniformly allocated to growers throughout the season and throughout the mill area according to production, and the selected length of milling season (LOMS). Each haulier gets a DRD which aggregates his growers' DRDs, and co-ordinates his daily supply in order to fulfil it.

Cane quality is a crucial parameter for the cane supply chain as it impacts on sugar production and stakeholders' profitability. The sugar industry has defined an indicator to assess the potential amount of sugar extracted from cane and to link the farmers' payment to the quality of cane they deliver. The Recoverable Value rate (%RV) is derived from the estimated recoverable crystal (ERC) formula (Murray, 2002; Moor, 2002), which includes the sucrose, non-sucrose and fibre contents of the cane, all of which impact on the milling process efficiency.

The %RV is dependent on many factors such as climate, production techniques and harvest/transport conditions. These factors might vary within a mill supply area and result in sub-regional patterns in sugarcane production and %RV distribution. Considering the current uniform delivery allocation, alternative supply systems based on quality variations in time and space could provide some gains in sugar production.

Based on this assumption the study conducted in 2002 showed that (i) the mill area could be split into five sub-areas, three of them based on variations of quality curve (Inland, Hinterland and Coastal) and two based on the type of supplier (Diversion cane and Small Scale Growers); (ii) gains of 1-5% of total tonnage RV (around R10 million) might be achieved by re-arranging cane supply scheduling according to homogeneous quality-based sub-areas. The main idea was to take advantage of the better quality of Inland and Hinterland zones at the beginning of the season by giving them supply priority at that stage, while the Coastal zone harvest was delayed (Guilleman *et al*., 2003).

These results were reported back to both growers and miller, who asked for further investigations to (i) assess the inter-annual stability of quality variations between sub-areas and (ii) to design supply scenarios which better take into account the circumstances of the Sezela mill area. The study conducted in 2003 analysed (i) the relevance of the quality-based zoning according to climatic variability (1998-2002), (ii) the supply curve shapes from 2000 to 2002 and (iii) the available capacities along the chain (growers, hauliers and mill). New scenarios were then simulated and discussed with both growers and miller (Le Gal *et al*., 2004).

Methods

A simulation approach

This second study is based on the same conceptual framework as the initial study (see Gaucher *et al*., 2003 for a detailed description). While optimisation techniques were used in Australia (Higgins, 1999; Higgins *et al*., 1998; Higgins and Muchow, 2003), a simulation approach was preferred because of the growers' relative autonomy as well as their large diversity in the South African industry.

This approach enables the assessment of alternative supply scenarios based on a simplified representation of the various operators in the supply chain, characterised by their constraints and relationships. Changes in structure and capacities are simulated and their consequences in terms of sugar production quantified at the mill area level. Balance between delivery performances and mill crushing capacity can be investigated and discussed according to various hypotheses of supply chain structure and planning/operation rules.

The model is made up of two sub-modules, the first one for supply planning and operation and the second one for cane processing. It is underlined by a three-level representation of the supply area, including mill, intermediate operators (transloading centres, hauliers) and production units. It simulates a crushing season on a weekly step basis, according to the cane flow paths between these three levels, their given characteristics (particularly their capacities) and some planning and operation rules.

Based on this conceptual model a computer program called MAGI© has been developed (Le Gal *et al*., 2003). As the software was not operational for this study, the spreadsheet application developed in 2002 was again used in 2003.

Data collection and analysis

The stability of the quality differential between zones was assessed by analysing the cane quality data (sucrose, fibre, non-sucrose, RV) captured at the weighbridge for 60% of all cane consignments, from 1998 to 2002. Data collected between 2000 and 2002 were directly processed from the mill database, while 1998 and 1999 data were supplied by the South African Sugar Association as they were not archived by the mill. Following the miller and growers' suggestion, it was decided to merge the Hinterland and Inland zones as their quality curves were very similar.

The supply curves analysis was based on the daily tonnages delivered during the 2000, 2001 and 2002 seasons, as recorded in the mill database. This database was used assess grower, haulier and mill capacities as well. This was completed by stakeholder interviews to evaluate potential spare capacities along the supply chain.

Twenty-five large-scale growers uniformly split over the two zones were interviewed. The selection was based on five criteria that could impact on the farm flexibility regarding harvest capacities: total annual tonnage, variability of weekly deliveries during the season, farm location, amount of delivery days during the season and farm age (the number of years the farmer had been farming). The following items were addressed: total area, cane area, other activities (potentially competing with cane production for work and equipment), harvest and transport equipment and techniques, current DRD, maximum DRD achievable with the current harvest system (without extra equipment), impacts of a shorter cutting season on cane yields, labour availability and cash flow.

Only hauliers transporting more than 10 000 tons of cane were interviewed, as it was assumed that they should be more flexible, able to provide extra capacities and to react to growers' request if necessary. Fifteen out of 22 were selected according to their business area and their category (hlr/hlr versus gwr/hlr). The following items were addressed: equipment, other hauling activities, current DRD, potential maximum DRD achievable without investment in new equipment, and truck management rules where DRDs increased.

The factors impacting on mill capacity were investigated by interviewing staff members from the process division. The objective was to estimate mill flexibility, taking into account the quality of cane crushed during the season, the cane supply management and constraints such as diversion cane.

When all this quantitative and qualitative information was recorded and processed, new scenarios were designed and simulated using the spreadsheet program. Their comparison against a reference scenario representing the current system was carried out (i) between years for a specific scenario and (ii) between scenarios for a particular year. Results were presented and discussed with miller and grower representatives during two meetings.

Results

Assessing the stability of quality curves

Evaluating the inter-annual stability of quality differences between Coastal and Inland zones was crucial as alternative delivery scenarios were based on that characteristic, especially at the beginning of the season. It was conducted over a longer period i.e. from 1998 to 2002, to take into account the impact of climatic conditions on quality variation (Singels and Bezuidenhout, 2002).

At the mill area level, cane quality (measured in %RV) varies according to a bell-shape curve during the season, but each year shows a particular profile (Figure 1). 1998 and 1999 show a higher mean %RV than average, with low variation throughout the season. The curves are asymmetric, with a peak around the beginning of August. 2000 and 2001 are low quality years characterised by low %RV and high variability. 2002 is atypical; its mean %RV is very high and very regular; the curve reaches an early peak and is almost flat throughout the season. These curves are probably a result of the weather patterns during the specific year.

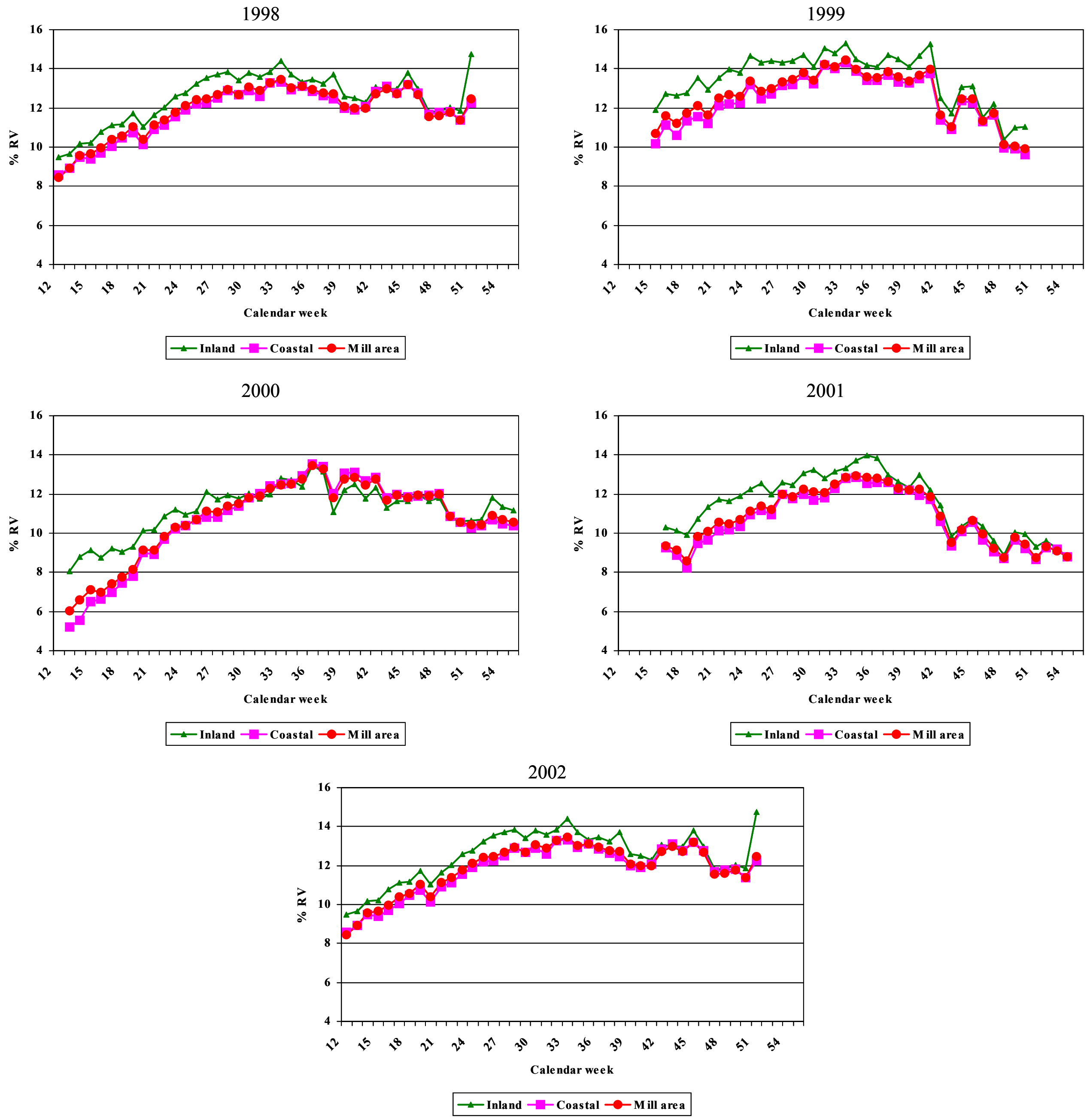


Figure 1. Weighted weekly %RV for coastal, inland and mill area (1998-2002).

Nevertheless, a general trend of variation occurs from one year to another. Cane quality is stable from mid-June to mid-October, but inter-annual variability increases both at the beginning and the end of the season (Figure 2). Deliveries should then be concentrated during the middle of the season while quality is also maximum. As this option is subject to capacities along the chain and a 38-week LOMS, a compromise is to vary the supply between Coastal and Inland zones throughout the season.

In general, Inland and Coastal quality curves follow the same profile as the mill area zone, but the %RV peak occurs later in Coastal, except in 2002, and inter-annual variability of Coastal quality is higher than the Inland zone at the beginning of the season (Figure 2). This explains the quality uncertainty at the mill area level at that stage, as 60% of the total cane production comes from the Coastal zone. This could be the result of a higher inter-annual climatic variability (temperature and rainfall) or the impact of the South African sugar industry's most serious insect pest, the stalk borer *Eldana saccharina* Walker (Lepidoptera: Pyralidae), particularly on carry-over cane (Goebel and Way, 2003).

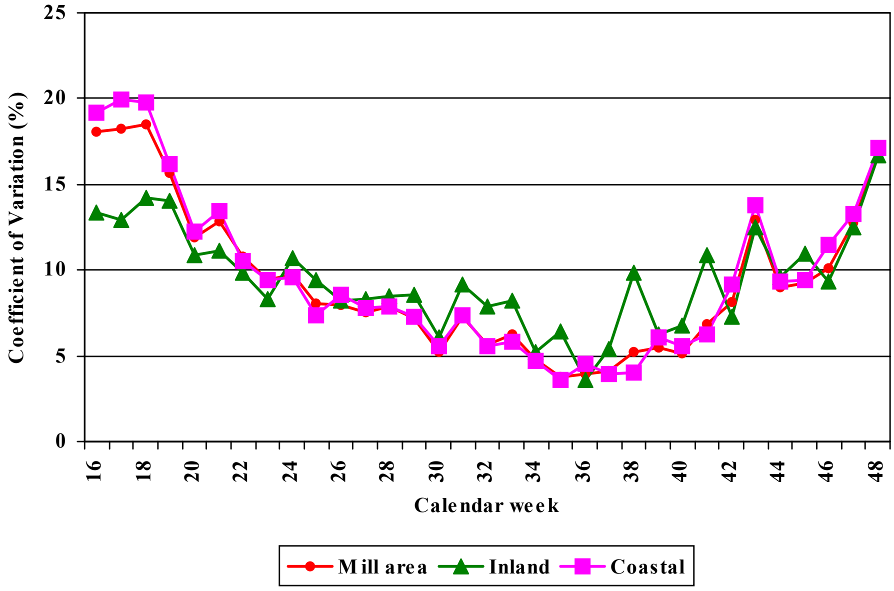


Figure 2. Inter-annual coefficient of variation of weekly %RV (1998-2002).

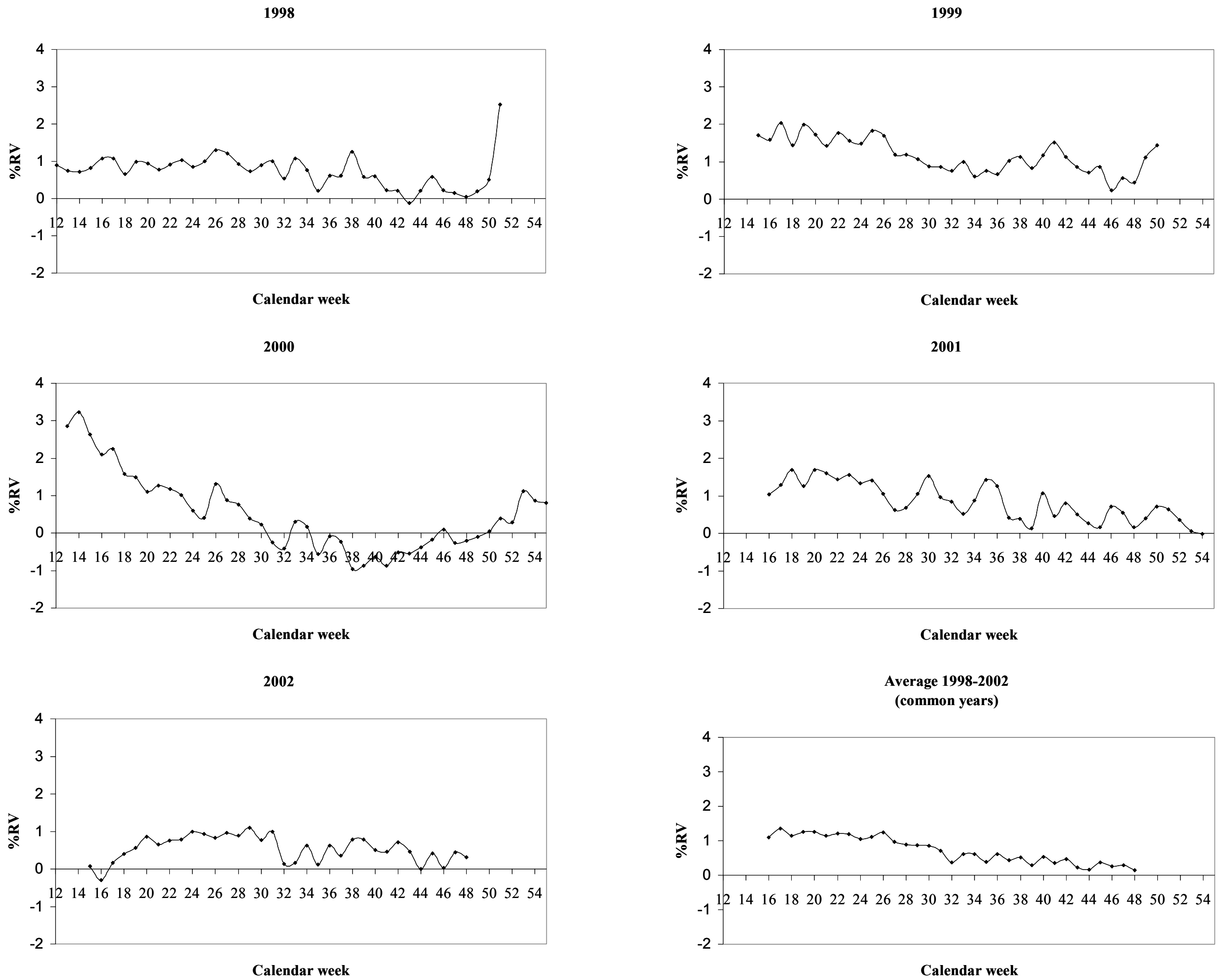


Figure 3. Difference in percentage recoverable value between inland and coastal zone per year.

Average Inland quality is higher than Coastal throughout the season. The gap varies by about 1% during the first half of the season and decreases once the RV peak is reached (from August onwards) (Figure 3). This mean profile varies from one year to another essentially according to the gap value at the beginning of the season; high to very high in 1999, 2000 and 2001, lower in 1998 and 2002.

These results confirm the potential of scheduling harvesting according to quality-based sub-areas. An increase in sugar production may be expected by delaying harvest of Coastal cane and starting with Inland cane. Then (i) the impact of the uncertain Coastal cane quality would be reduced, (ii) the entire mill supply area would take advantage of the better Inland cane quality at the beginning of the season and (iii) Coastal cane would be harvested closer to its RV peak. However, these alternative delivery schedules can be implemented only if extra capacity exists along the supply chain, as they lead to reduced harvest duration for each zone.

Refining scenario basis

Two issues were addressed to define more realistic scenarios: What are the values and constraints to be considered regarding the constant circumstances of the harvest season? What is the potential in term of extra capacities along the supply chain?

Constant circumstances of the harvest season

The total annual cane production crushed at the Sezela mill varies from one year to another, as does its LOMS, and consequently its average weekly crushing capacity (Table 1). For simplification, it was decided to keep a value close to the average for the 1997-2003 period (2.25 million tons). The distribution of production between the four zones included in the scenarios (Coastal 60%, Inland 23%, SSG 11% and Diversion 6%) followed the values observed from 2000 to 2002.

Table 1. Annual length of milling season (LOMS) and cane production in the Sezela mill area.

	1997	1998	1999	2000	2001	2002	Average
Starting week	14	12	15	13	16	15	
Closing week	56	55	50	55	54	51	
LOMS	43	44	36	43	39	36	40
Annual tonnage	2 021 102	2 119 001	1 970 559	2 426 405	2 187 319	2 321 365	2 174 292
Tons per week	47 002	48 159	54 738	56 428	59 117	62 740	54 357

The LOMS was kept at its agreed length (38 weeks), as this value is considered to be economically optimal (Moor and Wynne, 2001). Harvest was stopped before Christmas to take into account the low availability of cutters after this date.

Total weekly delivery curves showed a similar pattern from 2000 to 2002 (Figure 4). Deliveries increase gradually during the first 6-8 weeks of the season, then they reach a plateau that they follow roughly until the last 3-5 weeks. This general profile is observed for the four delivery zones as well. This means that (i) growers fulfil their DRD during most of the season (coefficients of variation vary from 15 to 30% according to the year and the impact of unforeseen events), (ii) they take around three weeks to reach their DRD at the beginning of the season and (ii) they gradually stop their deliveries over the last two weeks. Based on these observations, the values given in Table 2 were used in the 2003 scenarios.

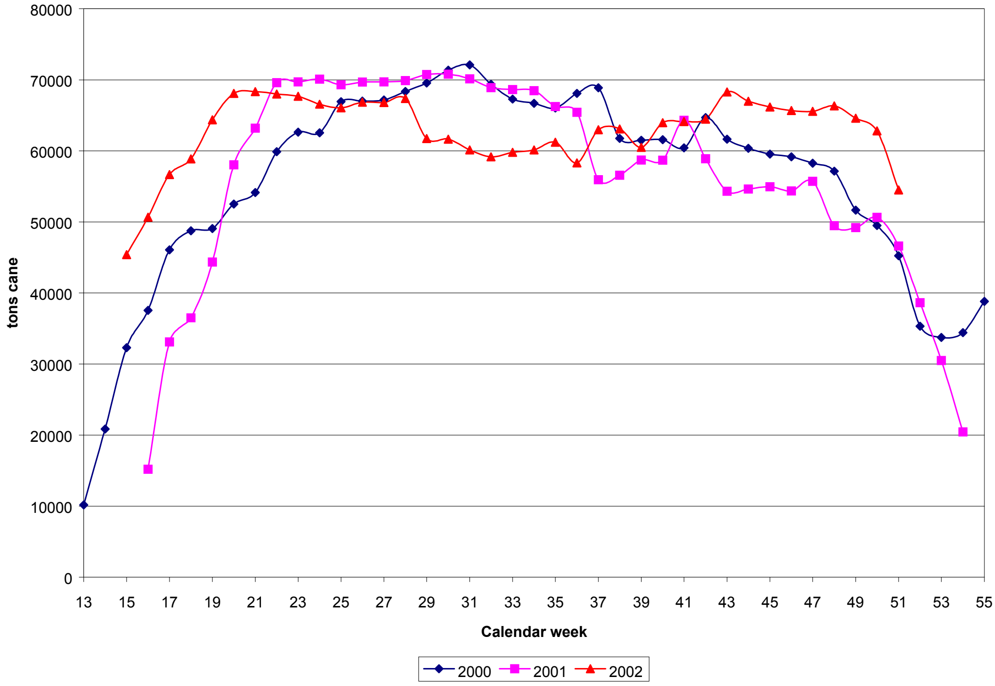


Figure 4. Total weekly delivery curves from 2000 to 2002 (4-year moving average).

Table 2. Distribution of deliveries at the beginning and the end of the season (% daily rated delivery).

Week 1	Week 2	Week 3	Week n-1	Last week
20%	50%	75%	50%	20%

Harvest capacities

Large commercial farms producing over 7000 tons per season harvest their own cane, whereas smaller commercial farms and small-scale growers usually use contractors for this task. Cane is generally burnt, then cut by hand. Cutting cane green is more time consuming, but is expanding for environmental reasons. Each grower matches the size of his cutting team to his DRD and his cutting technique. For instance, a certain farmer employs 25 cutters for a 90 ton DRD. Cane is harvested according to two main systems, the first based on windrowed cane loaded by a 3-wheel grab loader, and the second based on stacks that are chained and loaded onto specialised trailers.

Growers can manipulate number of labourers, loading and transport equipment and work organisation to increase their capacity. An increase in the labour force is constrained by cash-flow availability at the beginning of the season and cutter availability in case of a lower harvest duration, as each cutter will earn less money for the season. The equipment of 95% of the growers interviewed is under-utilised (less than 12 h per day) or is not used at all. These extra capacities give the grower more flexibility while facing unforeseen events and sudden DRD increases. Farms combining cane and timber production may also increase their DRDs by transferring equipment from one activity to the other, as the machinery used is similar in both cases, except for the trailers.

The work organisation of most growers includes some safety margins in case of a sudden increase in DRD, either because of a badly controlled fire or a break in harvest which needs to be caught up in the future. The growers use various ways of increasing their DRDs, such as delivering on Sundays, getting assistance from neighbours, transferring machine capacities from timber harvest on farms with a combined farming system, or using permanent staff to complement seasonal staff.

As a result, interviewed growers' potential capacity could be almost doubled compared with current DRD. Extra capacities are generally available for more than 7000 tons of cane, and mean DRD increase ratios are equivalent for growers and harvesting contractors. The Inland capacity ratio is higher than the Coastal ratio (2.1 and 1.7 respectively) probably because of the transfer of timber equipment to cane harvest and structural spare capacities required to face more variable climatic circumstances.

Hauling capacities

Only 22 out of the 35 contractors operating in the Sezela area haul more than 10 000 tons. Seven of these are transport companies (hlr/hlr), and 15 are growers hauling their own cane and cane produced by 1-5 neighbours (grw/hlr). Extra hauling capacities are based on under-used vehicles, capacity transfer from timber to cane production, mutual aid in the case of a sudden increase in DRD, or investment in new equipment. The latter concerns essentially hlr/hlrs.

Grw/hlrs are characterised by a low geographical flexibility and regular relationship with their customers. They show significant extra capacities (ratio 1.5), mainly because of safety margins required to deal with variations in DRD, and threshold effects regarding the ratio between transport capacities and DRDs. By comparison, hlr/hlrs have a greater geographical flexibility combined with a market-oriented strategy which makes them invest in new equipment when the transport demand increases. Their spare capacity ratio is quite low (average 1.25) with their current fleet size, but could be increased easily by purchasing new vehicles.

The hlr/hlr flexibility regarding capacity and customers reduces constraints on cane transport when the harvest window is reduced. Nevertheless, an increase in vehicles could impact on delays at the millyard and reduce transport efficiency. In any case, logistics issues should be addressed to optimise the relationship between the tonnage to be hauled, the fleet size and the selected supply organisation at mill area level.

Mill capacity

Because of the links between cane quality and milling process efficiency, two kinds of crushing capacity are considered in the scenarios for comparison with the weekly supplies: the crushing capacity and the quality driven (QD) capacity. The crushing capacity is based on the physical limits of quantity that can be crushed and diffused by the mill. It is linked to shredder and diffuser capacities and is also called 'design capacity', as it cannot be increased without extra investment. Design capacity at Sezela is 450 tons cane per hour.

At Sezela, the QD hourly capacity is based on the process capacities of 68 t/h fibre, 72 t/h brix and 10 t/h non-sucrose, and the weighed weekly average of fibre, brix and non-sucrose as measured on delivery. This is calculated for each week $_i$ as follows:

$$\text{QD-CH}_i = \min \{\text{QD-fibre}_i, \text{QD-brix}_i, \text{QD-non-sucrose}_i\}$$

with

$$\text{QD-fibre}_i = \text{CH-fibre}/F_i$$
$$\text{QD-brix}_i = \text{CH-brix}/B_i$$
$$\text{QD-non-sucrose}_i = \text{CH-non-sucrose}/NS_i$$

where

QD-fibre$_i$, QD-brix$_i$ and QD-non-sucrose$_i$ are the QD hourly capacities for fibre, brix and non-sucrose respectively, calculated in tons cane per hour.

CH-fibre, CH-brix and CH-non-sucrose are the industrial capacities for fibre, brix and non-sucrose respectively, calculated in tons fibre, brix and non-sucrose per hour.

F_i, B_i and NS_i are the weighed weekly averages of fibre, brix and non-sucrose, measured in %.

Simulating alternative supply scenarios
Five alternative scenarios based on these common circumstances and differing mainly in their harvest windows were simulated and compared with a reference scenario, where each zone delivers from the beginning to the end of the season. DRDs are uniform throughout the season, as variable DRDs increase the difficulties of delivery management both at grower and mill levels. They are calculated by dividing zone production by the duration of the harvest window.

S1: Coastal deliveries are delayed by two weeks, and Inland stops delivering four weeks before the end of the season. S1 aims at (i) decreasing the impact on the RV tonnage of the lower and more variable quality of Coastal cane at the beginning of the season, and (ii) focusing Inland deliveries around the RV peak.

S1bis: Coastal deliveries are delayed by four weeks, and Inland stops delivering nine weeks before the end of the season. This scenario is based on the same objectives as S1, but pushes the supply system to its capacity.

S2: Coastal delivers throughout the season, and Inland delivers from week 19 to week 47 (calendar weeks). S2 takes into account the necessity to harvest older Coastal cane at the beginning of the season, to minimise the risks of yield loss due to the borer *E. saccharina*. Inland deliveries are focused around the RV peak.

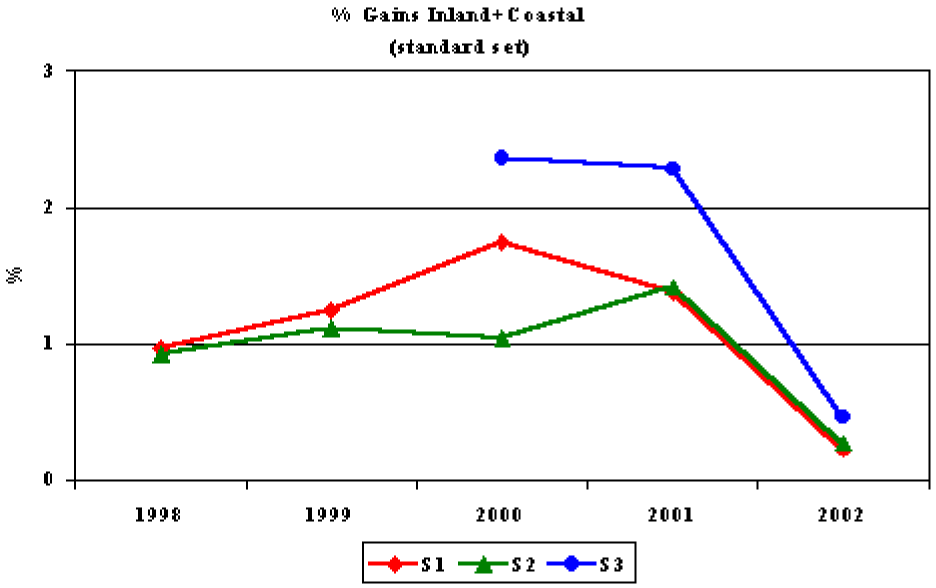
S3: Similar to S2, but the Diversion cane is now provided by Inland. This scenario aims at assessing the value for the mill area of an increase in Inland cane in the supply distribution.

Five seasons were taken into account (1998 to 2002) and two sets of scenarios were designed, which differ in their production data. The first set (called Real set) takes into account specific production data (total and per zone) and LOMS for each year (Table 1). It aims at addressing the question of what would happen if scenario X was applied during season Y. The second set (called Standard set) is based on a standard annual production of 2 250 000 tons cane and a standard LOMS of 38 weeks, from week 14 to week 51.

The difference between the RV tonnage produced by Inland and Coastal zones in the reference scenario and RV tonnages produced in alternative scenarios were computed for each year and each set. Expected gains for Coastal+Inland zones vary from 1-3% of the current production (Figure 5) and accounts for 500-7000 tons RV per season.

The best RV gains are regularly obtained with S1bis, which is the more risky as it uses mill crushing capacity to full extent, and is more sensitive to variations in cane quality (higher proportion of weeks where deliveries exceed the QD capacity). S3 ranks second in terms of RV gains, as Inland %RV is usually higher than that of Diversion cane. This scenario shows the value that Sezela would get from an increase in Inland production, combined with a shorter Inland harvest window. Extra harvest capacities would nevertheless be required to supply this extra amount of cane, which could be provided by increasing the cane area on existing farms or by contracting new farms in the sugar industry.

S1 and S2 show the lowest gains, as they are quite similar to the reference scenario. Their ranking differs according to year and is linked to the gap between Coastal and Inland cane quality at the beginning of the season. Although S2 requires the highest extra harvest and haulage capacities in the Inland zone (around 30%), these figures remain well below the current potential.



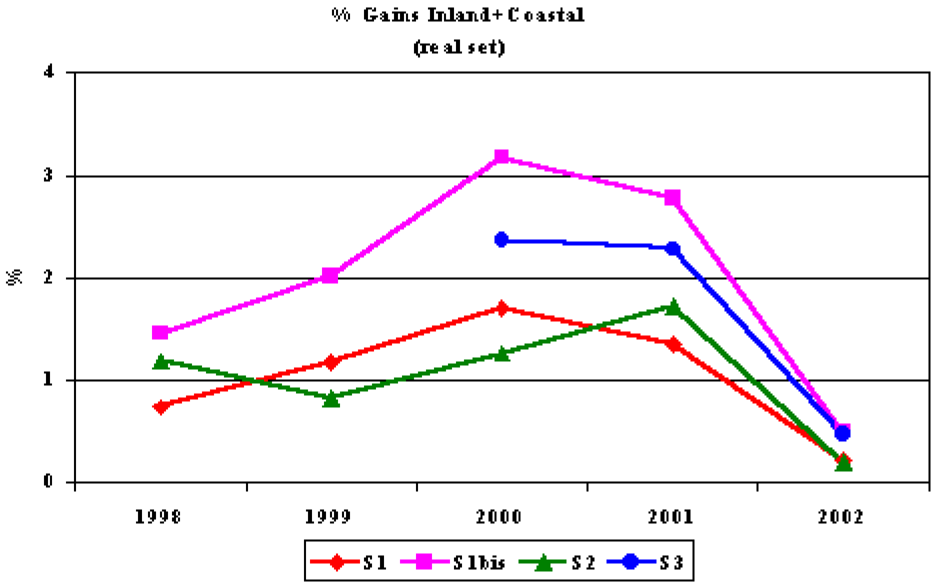


Figure 5. RV gains between alternative and reference scenarios according to year.

Differences between scenarios clearly depend on the season characteristic. Gaps are wide in 1999, 2000 and 2001, but almost nil in 2002. This contrast is mostly linked to the Coastal cane quality, which can vary widely from one year to another. The crush capacity is generally under-used, which leaves a large margin of flexibility in case of unforeseen events.

Discussion

Quality variations between sub-regions within the Sezela supply area are observed every year. So gains might be expected from supply organisation that would reduce harvest windows according to these homogeneous zones. Their amount will nevertheless be related to the level of risk stakeholders are ready to take in term of capacity constraints, harvest scheduling and agronomic performances.

Indeed, modifying supply scheduling implies that cane cycles are differently adjusted to climatic conditions throughout the year. This change could impact on cane yield and %RV at both field and mill area levels. In the same way, the impact of *E. saccharina* on cane yield and quality according to climatic conditions and cane age requires further investigation, especially in the Coastal area (Way and Goebel, 2003).

Modifying harvest windows will impact on farm functions and strategy. Specific adjustments would be required during the first season regarding cash-flow management and harvest re-organisation. In the longer term, growers could be encouraged to better adjust their harvest capacities with their current and future needs to improve their profitability. This evolution could lead to new modes of harvest management, such as contracting or co-operation between neighbours, including quota swapping. This could raise new issues of co-ordination between growers belonging to the same group, or between growers and contractors (Le Gal and Requis, 2002).

The labour issue could also be critical to the future of cane production. On one hand, cutters will be more difficult to find because of the impact of HIV/Aids, and the fact that today's youth are not attracted to this activity. On the other hand, cutter wages could increase with new labour legislation. This trend should increase the proportion of harvest mechanisation and should raise new issues such as how to cultivate steep fields in the Coastal zone, and what the impact will be on harvest capacities and DRD management.

At the mill area level, various issues will have to be addressed before putting alternative harvest scheduling into action. Boundaries between zones need to be clarified, especially in the Coastal area where cane cycles range from 12 to 18 months. Such a study could be conducted on a simulation basis, by using a model such as CANEGRO (Singels and Bezuidenhout, 2002). Extra capacities in cane transport are useful in the event of harvest window reductions, but they are costly and should be optimised, based on fleet reduction and better transport efficiency. This type of system has been successfully implemented in the timber industry and has shown significant savings through increased vehicle utilisation. The potential benefit is conservatively estimated at nearly R8 million per annum in a single mill area where cane delivery is 2.5 million tons per annum.

The current cane payment system needs to be investigated. Simulations conducted in 2002 showed that the RV system enables growers to improve their revenue, whatever their location, when practising alternative harvest scheduling. However, the expected gains are lower for Coastal growers and SSGs, as their %RV is generally lower and their revenue is calculated according to the mill RV average. Would it be relevant to change the cane payment system according to the new supply organization, and how would this be done? What would be the impact of alternative cane payment systems on grower revenue and cane cost for the mill? It was proposed to conduct a specific study in 2004 to focus on cane payment.

Conclusions

The study conducted in 2003 confirms the results of the 2002 study. Gains in RV can be expected in all cases where cane supply is modified to take into account cane quality variations within the Sezela supply area. However, the amount will vary according to the year and the risks stakeholders are ready to take. Gains will be marginal in seasons where variations in cane quality between the Coastal and Inland zones are small.

Gains are also sensitive to variations in Coastal cane quality, which is linked to specific annual climatic conditions and to *E. saccharina* infestation. For this reason, it is probably less risky to maintain the current Coastal delivery scheduling, and to reduce the harvest window of the Inland zone around its RV peak. This scenario would also take advantage of the extra harvest and hauling capacities found along the supply chain. In a broader perspective, it should be valuable to the mill to increase the proportion of Inland cane in its total supply. Indeed, Inland cane shows a higher and more regular quality than that of the Coastal zones.

These changes raise new issues. Evolution of the current cane payment system has to be investigated to evaluate the impact of various %RV references on grower revenue. With the economic pressure put on the sugar industry, optimisation of transport has become a critical topic. These issues will be addressed from 2004 onwards as part of a collaborative research project between CIRAD and SASEX.

Acknowledgements

The authors would like to thank all the stakeholders in the Sezela mill area for their kind contribution and their strong support during this study. We are grateful to the Directors of CIRAD and SASEX for having jointly funded this research, and to Louis-George Soler (INRA, France) and Marianne Le Bail (INA-PG, France) for their assistance.

REFERENCES

Gaucher S, Le Gal P-Y and Soler L-G (2003). Modelling supply chain management in the sugar industry. *Proc S Afr Sug Technol Ass* 77: 542-554.

Goebel FR and Way M (2003). Investigation of the impact of *Eldana Saccharina* (Lepidoptera: Pyralidae) on sugarcane yield in field trials in Zululand. *Proc S Afr Sug Technol Ass* 77: 256-265.

Guilleman E, Le Gal P-Y, Meyer E and Schmidt E (2003). Assessing the potential for improving mill area profitability by modifying cane supply and harvest scheduling: A South African study. *Proc S Afr Sug Technol Ass* 77: 566-579.

Higgins AJ (1999). Optimising cane supply decisions within a sugar mill region. *Journal of Scheduling* 2: 229-244.

Higgins AJ and Muchow RC (2003). Assessing the potential benefits of alternative cane supply arrangements in the Australian sugar industry. *Agric Syst* 76: 623-638.

Higgins AJ, Muchow RC, Rudd AV and Ford AW (1998). Optimising harvest date in sugar production: A case study for the Mossman mill region in Australia. I: Development of operations research model and solution. *Field Crops Res* 57: 153-162.

Le Gal P-Y and Requis E (2002). The management of cane harvest at the small scale grower level: A South African case study. *Proc S Afr Sug Technol Ass* 76: 83-93.

Le Gal P-Y, Lejars C and Auzoux S (2003). MAGI: A simulation tool to address cane supply chain management issues. *Proc S Afr Sug Technol Ass* 77: 555-565.

Le Gal P-Y, Calvinho O, Lyne P and Meyer E (2004). Assessing the value and feasibility of alternative cane supply scheduling in the Sezela mill supply area. CIRAD-University of Natal-SASEX, Cirad-Tera n°04/04, Mount Edgecoumbe, South Africa, 36 pp.

Lejars C, Letourmy P and Laurent S (2003). Building and assessing supply management scenarios based on cane quality variations: Example of La Réunion Island. *Proc S Afr Sug Technol Ass* 77: 580-591.

Moor GM (2002). Enhancing cane quality incentives in the South African sugar industry: The recoverable value (RV) cane payment system. In: Proceedings of the Farming for RV Workshop, South African Sugar Technologists' Association, Mount Edgecombe, South Africa.

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. *Int Sug J* 1235: 512-516.

Muchow RC, Higgins AJ, Inman-Bamber NG and Thorburn PJ (2000). Towards improved harvest management using a systems approach. *Proc Aust Soc Sug Cane Technol* 22: 30-37.

Murray TJ (2002). Derivation of the RV formula. In: Proceedings of the Farming for RV Workshop, South African Sugar Technologists' Association, Mount Edgecombe, South Africa.

Singels A and Bezuidenhout CN (2002). A new method of simulating dry matter partitioning in the Canegro sugarcane model. *Field Crops Res* 78(2-3): 151-164.

Way MJ and Goebel FR (2003). Patterns of damage from *Eldana saccharina* (Lepidoptera: Pyralidae) in the South African sugar industry. *Proc S Afr Sug Technol Ass* 77: 239-240.