

AUTOMATION OF THE SEZELA WEIGHBRIDGE

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Abstract

The repetitive task of capturing data from consignment notes presented at Sezela weighbridge often resulted in errors. Errors were caused by incorrect data on consignment notes, carelessness, stress at peak delivery periods and fatigue. The problems have been eliminated with the development and introduction of an automated data capture and weighing system at the Sezela weighbridge. Apart from eliminating incorrect data capture, the system improved millyard productivity and effected significant cost savings. The development and operation of the system and the problems encountered are discussed in this paper.

Keywords: weighbridge, millyard, weighbridge automation, delivery delays

Introduction

The repetitive task of manually capturing data from consignment notes presented at a mill weighbridge can be stressful and tiring. A data capture clerk is required to stand for most of the eight-hour working day, weighing cane deliveries as they arrive at the mill. In addition he has to collect and collate data on expected cane deliveries and answer delivery queries. His job further entails weighing other products leaving the millyard, such as molasses and furfural related products, filtercake and scrap metal.

The clerk is expected to control rateable delivery, the flow of vehicles into the millyard according to set parameters, and to monitor the quality of the cane being delivered. The complement of three clerks worked in single shifts. With only one clerk performing multiple tasks, occasional errors were made.

Frequent errors were made by semi- or barely-literate loading zone clerks when transcribing information onto consignment notes. Grower quota numbers often did not correspond with the growers' names or farm names on the notes, and loading zone numbers were also often incorrect. This resulted in complaints from haulage and harvester contractors. Growers, particularly those participating in the SASEX Field Record System, found that reports produced by the system were rendering incorrect information.

Cane Testing Service (CTS) staff and the mill Cane Payments Department frequently complained that valuable working hours were being wasted in correcting errors. Observation of the stressful nature of data capture and its associated problems

prompted investigation into automating the tasks. An investigation conducted during the 1995-96 season showed that no 'off the shelf' system could be used or adapted to automate the weighbridge, and that a system would have to be designed that would incorporate all the data capturing functions of the clerks.

As it was vital that the automated system be compatible with existing AutoLab program, AutoLab Computer Systems and Instrumentation Division of the SA Sugar Association were requested to investigate the technical feasibility of the project.

Preliminary investigations suggested that replacing consignment notes with Optical Mark Sense (OMS) cards, and using a system of transponders to identify vehicles, would enable data collection and vehicle traffic control into and out of the millyard to be automated at a cost that would yield a reasonable return on investment.

Development of the system

Apart from being cost effective, initial indications were that automation of the weighbridge would effect significant improvements in productivity at the mill, and would also be of benefit to the growers and hauliers of cane to Sezela. The project was approved during the 1994-95 season, and implementation was scheduled for the 1996-97 season.

A project team consisting of members of the Cane Procurement Department at Sezela and AutoLab CSI was formed, with the Sezela members being tasked with investigating the operational aspects of the project, while the AutoLab team investigated the technical aspects. Deadlines for development were set during the 1995-96 season, with criteria that all equipment to be used would need to be bench tested at the AutoLab workshop at Mount Edgecombe before being approved. This was to assess the reliability of the equipment and compatibility with the system's computer software.

To understand all aspects of cane supply to Sezela mill, and how interruptions influence the supply of cane, a 'brown paper' exercise was conducted. This involved the systematic mapping and critiquing, on a continuous roll of brown paper, of all operations and documents necessary from the time the cane is harvested to the time it is milled. This exercise proved invaluable when designing the software and procedures for capture of data.

As semi-literate zone clerks would be transcribing information onto the OMS cards, the design was done in consultation with growers and their zone staff. Because the size of the OMS card

was limited and hence also the amount of data which can be captured, a decision had to be made regarding information which would suit the growers, the CTS and the milling company.

Although satisfactory under simulated conditions, it was necessary to test the system on-site to evaluate problems and measure the reactions of the haulage drivers operating the system. Towards the end of the 1995-96 season the system was installed at the Sezela weighbridge, where it was operated in parallel with the existing AutoLab system. Speed of operation, accuracy of data capture, the 'resistance to change' factor among haulage drivers and equipment reliability were measured, and further adjustments or enhancements were made.

General description of the system

Overview

The automated weighbridge was designed to identify a vehicle by means of a transponder and to capture information concerning the delivery by means of an optically marked document.

As an add-on to the AutoLab Cane Testing System installed in all weighbridges in the South African sugar industry, the system was designed to allow cane (and other products) to be weighed on an unattended weighbridge for 24 hours per day, seven days per week.

The system consists of an independent local area network (LAN) installed in the weighbridge building, with both the gross and tare weighbridges each having a PC file server and a PC work

station (Figure 1). The two work stations are identical and each is connected to an automatic data capture panel situated in a cubicle at each end of the gross and tare weighbridges. Vehicle drivers enter the cubicles through exterior doors (Figure 2).

In addition to the gross and tare work stations, there is an operator PC which enables work to be done to the system without disrupting the two operating work stations. This PC has the added feature of serving as a spare unit in case of failure of either of the operating work stations. The LAN is also connected to the CTS AutoLab network.

Each work station is connected to a panel that controls external traffic lights and a siren that instruct drivers to advance their vehicles onto the weighbridge. Infra red beams at each end of the gross and tare weighbridges ensure that vehicles are correctly positioned to prevent incorrect or fraudulent weighing. The beams also control indicator lights that show the driver when the vehicle is correctly placed on the weighbridge.

Hardware

The file server is an Allied 486SX computer with 16mb of RAM and two duplexed 1Gb disks in separate cases, each with an independent power supply. The LAN uses a Novell v3.12, 10-user operating system, and the PCs use MS DOS operating systems. The other PCs on the network are Allied 486SX machines with 8mb of RAM, SVGA monitors and 101 keyboards. Booting of the computer system is from 1,44 Mb diskette drives.

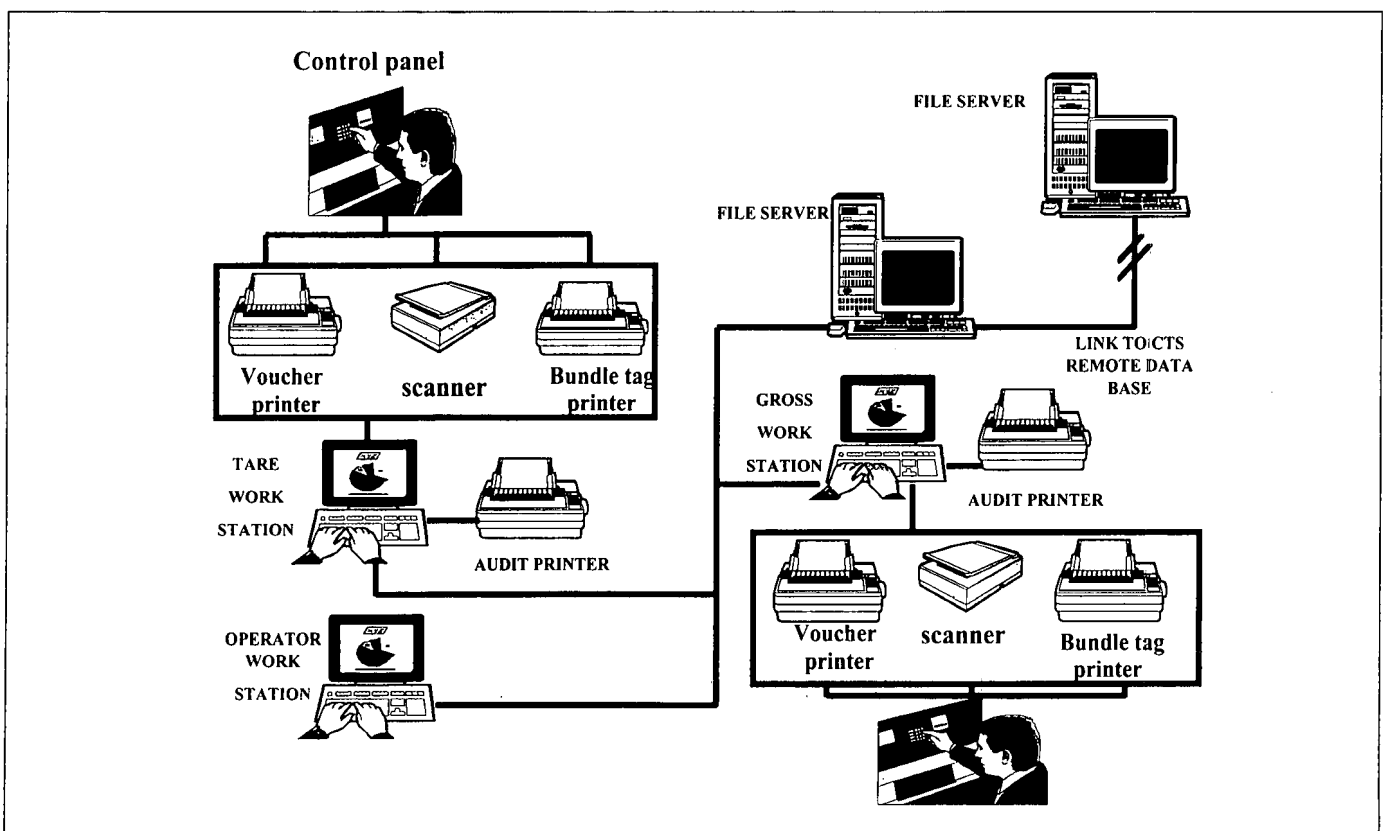


Figure 1. Topography of the computer system.

The three work stations are identical and are each fitted with an intelligent eight port RS232 card, a 16-bit digital I/O card and an RS485 port. The RS485 and one of the RS232 ports also provide power from the PC power supply to external devices. Located behind each control panel are a bar code scanner, an optical card reader, a transponder scanner and printers.

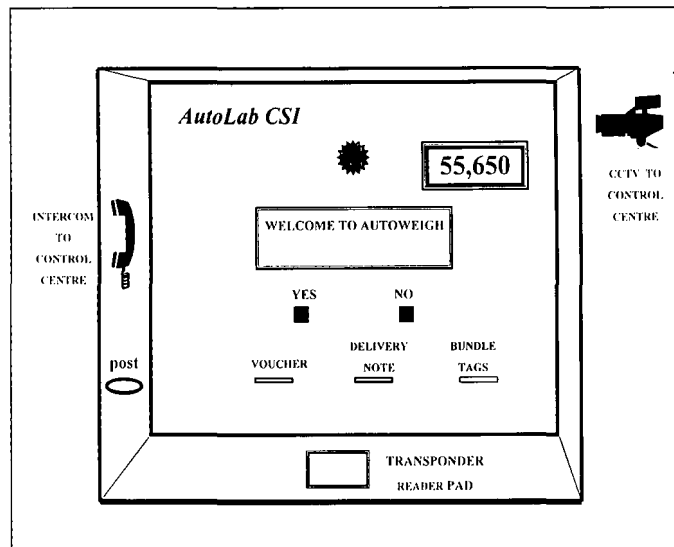


Figure 2. Automatic data capture control panel.

Software

The system is connected to two databases, with the CTS database being considered the 'master' database under normal circumstances. The weighbridge database serves as a back-up to the CTS LAN and also enables the system to operate without the CTS file server when necessary. During normal operation both databases are updated with all transactions. When one or other database is not available, the system has been designed to continue operating on the database that is available.

Should a back up or re-indexing of data be required by CTS, the weighbridge system automatically closes the CTS files and uses the local files exclusively. Once complete, the weighbridge system automatically reopens the CTS files again and updates the CTS database with the transactions that have taken place. This allows deliveries to continue without disruption.

The programs designed for both the gross and tare computers are identical, but operate in either a 'gross' or 'tare' mode. The 'gross' functions control the traffic light system and updating procedures for the CTS database. Should either weighbridge need to be shut down, the programs have been so designed that both gross and tare functions can be performed on one weighbridge.

Basically, the programme loops continuously, checking for:

- Input from a vehicle transponder. When a transponder signal is detected, the programme checks the vehicle file and goes through the necessary cane tare or gross procedures, or, in the case of non-cane vehicles (e.g. molasses), the 'other products' procedure is initiated.

- Requests for back-up/re-indexing from CTS. When such a request is received, the CTS databases are closed and a signal is returned to the CTS file server. After completion of the operation, a signal from the CTS file server prompts the gross computer to open the CTS files and update them.
- The need for additional vehicles in the millyard. Should there be insufficient vehicles in the millyard (the parameters can be set by the user) a traffic light is switched on, the priority of which is calculated by the system. This is based on whether a bundle or spiller vehicle is required and, in the case of a spiller vehicle, whether it should be a Unitrans vehicle or a vehicle from another contractor.
- A change in the day number from CTS. When the day number changes on the CTS system, the weighbridge system carries out the necessary housekeeping functions (clearing and updating of files).

A supervisor's program has been created to make enquiries, set parameters, register transponder codes to vehicles and register consignment note books to grower names and quota numbers.

Printers

Identical dot matrix printers, each with an internal guillotine, are installed behind the control panels of the gross and tare weighbridges. These use 76 mm wide 'tally-roll' type paper to provide the vehicle drivers with receipts and vouchers. A further dot matrix printer is fitted in each control panel to print sequentially numbered bundle tags onto adhesive labels for drivers who deliver their cane in bundles.

Automatic data capture control panels

Control panels for automatic data capture were designed and incorporated into the system to be as 'user friendly' as possible. Each control panel has several features, including:

- a LED digitised mass display window
- a green and a red push button for acknowledgement of messages or procedures (Yes/No)
- a LED instruction/message window
- a transponder reader pad
- two slots from which either receipts or cane delivery vouchers are issued
- a slot for the insertion of the optically marked consignment note
- an intercom telephone that can be used for summoning help when problems arise
- a four-camera closed circuit colour television system linked to the mill control centre, which can monitor operations in each cubicle and around the weighbridge.

Power for the system is sourced from an uninterruptable power supply facility of a nearby installation. A spare document scanner is carried in case of power failure.

Transponders

The transponders used in the capture of vehicle details are of the small, sealed 'credit card' type, using induced power from the reader unit and having a lifetime guarantee. They are less expensive than the more powerful vehicle-powered and mounted type and are easily retrieved should a vehicle be transferred or moved away from the Sezela operational area. To prevent loss, each transponder is sealed into a specially printed, brightly coloured PVC folder. The folders also serve as protection for the OMS card while the cane is in transit from farm to mill.

Optical mark sense cards

One of the main criteria in the design of the system was a highly simplified, optically marked consignment note that supplies the system with the grower's quota number, field number and loading zone number. Because agricultural information such as the variety of cane being delivered was not supplied on the optically marked consignment note, yet was vital to the CTS system, a local database was created on the file server at the weighbridge and on a remote database at the CTS laboratory, that would supply this information when the field was identified from the consignment note.

The creation of the database involved the capture of agricultural data for each field on a grower's farm from the first estimates he submitted to the Mill Group Board. Although initially a time consuming exercise, the menu driven programs were designed to allow data to be updated or amended easily.

The OMS cards were specifically designed to eliminate the need for any written words or numbers. This ensures that even barely literate/numerate zone clerks, if properly trained, can easily capture the necessary agricultural/field information onto the card.

The OMS cards are printed with blocks into which the following information can be marked (Figure 3):

- load point or zone number
- subcontractor number
- total number of bundles in a consignment
- three separate blocks (in alphanumeric format) for cane harvested from different fields and number of bundles per field
- expected deliveries for the next day expressed as a percentage of DRD or allocation
- date/time when the field was burned/harvested.

A bar code and sequential number are printed on the reverse side of the OMS card. The cards are parcelled in books of 100 pages for large scale growers and 50 pages for small scale growers. Each book has tear-off perforations, with the numbered stub being retained by the grower for record purposes. When a book is issued to a grower, the first and last sequential numbers are registered in the system. Even when no delivery data are entered, the load of cane will therefore be credited to the correct grower.

Figure 3. Example of optical mark sense card.

Because of the low volumes involved, the OMS cards cost approximately R2 per book more than the conventional consignment note book supplied by SASA. Should more mills convert to the system, the cost of the OMS consignment notes will be reduced accordingly.

Operation of the system

Three lanes have been demarcated in the vehicle staging area outside the Sezela millyard entrance. These are for the different haulage types delivering cane to Sezela mill, namely 'Unitrans', 'Other Spillers' and 'Bundles'. The volume of deliveries and space limitations preclude setting aside a staging area for vehicles delivering or removing production-related products to the mill. These vehicles merely go to the front of the queues and are processed in the same manner as cane delivery vehicles. Operation of the automatic weighbridge can best be explained

by describing the sequence of events from the time the vehicle arrives in the staging area until it leaves the millyard after being unloaded:

On arrival in the staging area, the vehicle moves into its allocated queue. The driver waits to be called onto the weighbridge by the traffic control lights linked to the system.

When a vacancy exists in the millyard for a particular delivery type (Unitrans, other spiller or bundle), the appropriate traffic light will call the vehicle onto the weighbridge. A siren sounds for a few seconds to bring the light to the driver's attention.

The driver positions his vehicle on the weighbridge by means of the indicator lights. He leaves his vehicle and enters the cubicle where a Waiting for vehicle message is displayed on the control panel screen. The driver then places his transponder on the transponder reader pad mounted in the control panel.

The system reads the transponder and displays the vehicle registration or fleet number on the screen as follows: Vehicle No: NX 12345 OK? If the number is correct, the driver presses the green (Yes) button mounted on the control panel. Should he press the red (No) button, the procedure will end and the screen will return to Waiting for vehicle. The driver can call for help by means of the intercom connected to the mill control centre. Should the driver move onto the weighbridge before being called by the traffic lights, a message Vehicle not needed, try again - OK? will be displayed on the screen. The driver must then either return to the staging area or wait until a similar delivery type vehicle leaves the mill, before access to the millyard will be allowed.

After acknowledging that the registration number is correct by pressing the green button, the weight of the vehicle is displayed on the screen, e.g. Weight: 455 00kg - OK? The driver must compare this weight with the weight displayed on the digitiser screen and, if correct, acknowledge this by pressing the green button. Should the two weights differ, the driver must press the red (NO) button and he will be given the options of taking a second reading or going back to the beginning and starting again.

If there are no discrepancies with the registration number or weight, the screen will display the message Waiting for card. This prompts the driver to insert his consignment note into the card reader slot.

The reader will draw the card into the control panel, scanning it in the process. A message on the screen will tell the driver where to go, e.g. East Tandem (Figure 4).

A receipt is printed and issued to the driver. It shows the grower's name and quota number, time of delivery, gross weight and the allocated off-loading point in the millyard. The system also prints and issues consecutively numbered, self-adhesive labels to drivers of bundle type deliveries. These show the gantry at which the bundles must be unloaded.

After unloading, the vehicle goes to the tare weighbridge and a similar procedure prompts the driver to weigh his vehicle out of the millyard. The driver is issued with a cane delivery voucher that shows the grower details: gross, tare and nett weights of

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** CANE CRUSH VOUCHER **

ILLOVO SUGAR LIMITED SZ
Date /Time : 96 / 01/ 24 12. 16. 41.

Vehicle      : S8169
Serial       : B103247

EAST TANDEM
  
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Figure 4. Example of cane crush voucher.

the delivery; balance of DRD of allocation left to deliver; field numbers and, if supplied, the number of bundles delivered from the field, and the millyard delay in minutes (Figure 5).

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ILLOVO SUGAR COMPANY
** CANE DELIVERY VOUCHER **
Grower Name : ILLOVO SUGAR LIMITED SZ
Grower Code : 772100011A
Date/Time   : 96/01/24 12. 16. 41
Vehicle     : S8169
Serial No   : B103247
Gross      : 55, 300 Kg   S/N : 95455
Tare       : 24, 400 Kg   S/N : 11050
Nett      = 30, 900 Kg
Bundles    : 1
Field     : 410      (0)      (0)
Load Point : 7785
Yard Delay : 17 Min
DRD Alloc : 370
Delivered  : 31
Balance    : 339

STRICTLY D.R.D. UNTIL FURTHER NOTICE
Christmas shut down Weighbridge will close
6 p.m. Monday 23 December and re-open 4 a.m.
Monday 30 December.
HAVE A RESTFUL CHRISTMAS
  
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Figure 5. Example of cane delivery voucher.

Special features of the automated weighbridge system

Some features of the automated system are worth noting:

- The system can print messages on the cane delivery vouchers that will improve productivity to the mill, growers and hauliers during day-to-day operations. Examples of these messages are: to all growers delivering cane to Sezela mill (e.g. Mill will be down for maintenance on Monday 27 January 04h00 to 16h00), Sezela mill growers only (e.g. Estimates due at MGB Office on Friday 24 January @ 12h00), a group of growers (e.g. 100% restriction to all Hibberdene growers Monday 27 January), and an individual grower (e.g. Poor cane quality on the last 4 consignments [low purity avg 72%] If no improvement forthcoming consignment could be rejected).
- The system can enforce adherence to individual/grower group DRDs or allocations. Should a grower exceed his DRD, the transaction will not be accepted at the weighbridge and the driver will be instructed to return to the staging area to await instructions or he will be instructed to return to the farm. Similarly, should the mill be running short of cane, the system can be programmed to accept more than the DRD or allocation.
- Consignment notes have a field showing whether a grower will deliver on the following day. This enables a report to be printed showing expected deliveries, and mill production can be planned accordingly. The system will not accept a delivery that was not shown on the previous day's consignment note.
- The system strictly controls the number and type of vehicles allowed into the millyard according to pre-set parameters.

Discussion

Since the introduction of the system at the start of the 1996-97 season, responses from growers, hauliers and in particular the vehicle drivers have been most favourable.

After approximately 30 minutes of training, vehicle drivers and loading zones clerks were able to complete the OMS consignment notes.

Apart from minor adjustments during the first few weeks of operation, few amendments have been made to the software. A system of pauses was built in to slow the system down, thus giving the driver time to read messages and make appropriate responses.

During the year, frequent 'hanging' problems were experienced with the computer on the gross weighbridge. Although the auto boot facility on the programme brought the system back on line when the PC was re-set, the problem was frustrating and time wasting. It was eventually traced to the mother-board not being able to cope with the continuous looping and causing the keyboard chip to hang (the input from the card reader is via the normal keyboard connection). Inserting a one-second pause in the loop eliminated the problem. The tare work station was

replaced with a 100 MHz machine towards the end of the season to determine whether problems would occur with a faster computer. It has been found to operate perfectly.

Minor problems were also experienced with scanners rejecting consignment notes during wet weather. The problem was traced to the roller feed settings on the scanner, and after adjustment the problem all but disappeared. Similar feed problems were experienced with the printers. This problem was traced to incorrect feeding of the tally-roll paper and was easily remedied.

Advantages of the automated system

- The delay times of vehicles waiting to weigh in and out of the millyard have been reduced significantly. During manual operation, only one clerk was on duty on the weighbridge, and vehicles were delayed while he completed transactions, or performed back-up or re-indexing functions. Weighbridge delay times were reduced from approximately 2,5 minutes when the system was operated manually to approximately 35 seconds on the gross weighbridge and approximately 20 seconds on the tare weighbridge.
- Errors caused by incorrect data capture have been eliminated. Valuable time previously spent by CTS in amending data is saved. Errors are now caused mainly by incorrect data being entered on the consignment notes by the zone clerks.
- Vehicle selection from the staging area outside the millyard is now done on a fair and equitable basis, according to mill performance and DRD or allocation. Queue jumping, a continuous area of conflict between drivers, has been reduced significantly.
- The message facility on the cane delivery voucher that informs growers and hauliers of important dates and mill or grower production related problems has led to significant improvements in communication and productivity.
- As all vehicles that need to be weighed can gain access to the millyard only by means of a registered transponder, risk management and millyard access control have improved.
- As the system instructs the driver on which cane unloading facility to use, millyard management and productivity have improved significantly. Time wasted by drivers queueing at an over-stocked unloading point has been eliminated. Deliberate time wastage by drivers is now easily detectable, allowing corrective action to be taken.
- As millyard supervisors need to spend less time managing traffic flows around the millyard, more time can be allocated to important issues such as cane quality control.
- Capital cost of the automated system amounted to R285 000 in hardware, software and cabling costs. A further R33 000 was spent on ancillaries such as alterations to the weighbridge building, installation of a closed circuit television system and the PVC transponder folders. The total costs of the automated weighbridge system amounted to R318 000, and the project

is expected to have a pay-back period of 2,8 years. There are significant labour cost savings, as data capture clerks are no longer required on the weighbridge.

Disadvantages of the automated weighbridge system

As there was no clerk at the weighbridge to assist drivers when problems were encountered, slight delays were experienced. These problems were limited to the start-up phases of the project when drivers were unfamiliar with the system. As the season progressed, these problems reduced considerably. Millyard supervisors were given training in basic problem solving, thus further reducing delays.

There is a loss of interaction and informal communication between the drivers and data capture clerks regarding deliveries. This interface has been replaced largely by the capture of expected delivery performances from the consignment notes.

Future developments

Growers have the new agricultural data for each field of the farm (field number, age of cane, area, variety, ratoon) captured on the database, and computer links between the Sezela Pest

and Disease Committee, the Sezela Mill Group Board, local SASEX extension services and the system have been established via the Sezela and CTS networks. This allows the downloading or querying of cane delivery data into local files in a spreadsheet format for the preparation of customised reports. Although this phase of the project is still in the developmental phase, the prospect of using this facility as a management tool has much potential.

Conclusion

The automated weighbridge system, a departure from convention, has proved that automated weighing and capture of cane delivery data is not only feasible, but is far more efficient and cost effective than a manual system. With the implementation of the automated weighbridge system, productivity improvements have been realised, not only by the Sezela mill, but by all the stakeholders supplying cane.