# Controlled Traffic: a perspective from the sugar industry

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## Introduction

The sugar industry practices a pseudo form of controlled traffic, in that all harvesting traffic occurs in approximately the same position for a crop cycle (plant crop and 4 ratoons). This process is then repeated for the next crop cycle unless a conscious decision is made to relocate the positions of the previous rows and inter-rows. Generally, this entails swapping the row and inter-row positions.

There is, however, a mismatch between the current row spacings used by the industry (1.5 – 1.65 m) and the track widths of harvesting and haulout equipment (1.83 m). This results in harvesting traffic occurring close to the row and quite often directly over the row. As a result, soil degradation occurs in the plant growth zone and the traffic zone encroaches onto the plant growth zone.

Recently there has been a gradual move towards high density planting strategies, whereby dual rows 0.5 m apart are planted on 1.8 m centres. This fits the concept of controlled traffic since the row spacing matches equipment track widths. The impetus for this is to increase productivity rather than to adopt the concept of controlled traffic per se.

This work was undertaken to determine the effect of matching crop row spacing and harvesting equipment track widths on the longevity and yield of ratoon crops planted in dual rows.

## Materials and Methods

### *Trials details*

Field trials were established at Tully and Ingham in 1993 and 1992, respectively. Single rows spaced at 1.5 m were compared with dual rows (0.3 m apart) at 1.8 m spacing. Dual rows were planted to achieve the same plant population as the single rows, since there would be fewer rows per unit area. Both treatments were fertilised at the same rate on an aerial basis.

Two varieties were trialed at each site, Q117 and Q138 at Tully and Q115 and Q124 at Ingham. The experimental layout was a randomised block design with four replicates at Tully and five replicates at Ingham. Plots consisted of four rows, with the two central rows being the datum rows. Results were analysed by ANOVA using the Statistix® statistical package.

### *Soil measurements*

Soil bulk density (BD) and saturated hydraulic conductivity (Ks) were measured on undisturbed cores (0.075 m dia, 0.05 m high) collected before, and then after each harvest, to a depth of 0.3 m from the row and a near-row position.

Soil cone resistance was also measured before and then after each harvest to a depth of 0.6 m using a recording penetrometer (30° included cone, 12.5 mm dia. cone).

### *Crop measurements*

Crop yields were assessed by weighing the two central rows in each plot at harvest. The plots were mechanically harvested.

## Results

Data for the row position is presented, since this is where the crop grows and to determine whether traffic encroachment into the row was occurring.

### *Soil properties*

Bulk density in the row was uniform with depth at the Tully site with no significant difference between the single and dual rows (Fig 1). There was a small increase in the immediate surface under the single rows compared with the under dual rows.

There was a significant increase in bulk density under the narrow single rows compared with the wider dual rows at Ingham (Fig 1). Density also tended to increase with depth at Ingham.

Saturated hydraulic conductivity was only significantly higher in the immediate surface under the wide dual rows compared with the narrow single rows at Tully (Fig 2). The conductivities tended to be higher under the wider dual rows than under the narrow single rows. At Ingham saturated conductivities were significantly higher under the wider dual rows than the narrow single rows at the 0.15 and 0.2 m depths only (Fig 2). There was a strong tendency for saturated conductivities to be higher at the wider row spacing compared with the narrow row spacing.

There was no significant difference between the wider and narrow rows in soil strength at Tully, except at the 0.6 m depth where the wider rows were stronger than the narrow rows (Fig 3). The single rows were significantly stronger than the wider dual rows in the 0.05 to 0.25 m depth at Ingham (Fig 3).

### *Crop response*

Crop yield was variable between sites, with the narrow single rows yielding higher than the wider dual rows at Tully (Table 1). However, the reverse was the case at Ingham (Table 1). There were few significant differences between treatments for the yield parameters measured at both sites. The exceptions were first and second ratoon tonnes cane per hectare for Q138 and plant and second ratoon tonnes sugar per hectare for Q138 at Tully. At Ingham, the exceptions were third ratoon tonnes can per hectare and ccs for third and fourth ratoon for Q115, and third ratoon tonnes sugar per hectare for third ratoon Q124.

## Discussion

There is some evidence of soil degradation in the row under narrow single rows compared with wider dual rows at one site, namely Ingham. Soil bulk density has increased, soil strength has increased and saturated hydraulic conductivity has decreased in the narrow single rows compared with the wider dual rows. However, at Tully both the narrow single rows and wider dual rows have similar soil physical properties. This suggests that traffic is encroaching the rows under both systems. It was observed that during harvesting operations, traffic did occur near and over the row in some instance in the dual row plots. This was due in part to the inexperience of operators and the fact that the elevator on the harvester was short which resulted in the haulout travelling closer to the row to fill the bin. If the sugar industry is to adapt controlled traffic, there will be a need for some equipment modification to fit the system, such as increasing the elevator length on the harvester, and the development of guidance systems to ensure accurate tracking of harvesters and haulouts to reduce the spread of traffic zones into the plant growth area.

Crop yield was variable, with narrow single rows yielding less than the wider dual rows at Tully for the plant and 1st and 2nd ratoons, however, yields for the third ratoon crop were greater for the wider dual rows than for the narrow single rows. The wider dual rows produced greater yields than the narrow single rows at Ingham, with the exception of the second ratoon crop for Q115 where the reverse occurred. There were few significant differences between yield parameters at both sites. Yield differences between the two row spacings at Tully are due to the fact that the wider dual row plots lodged early in the season resulting in yield loss. For the third ratoon crop, the dual row plots did not lodge and as a result produced slightly higher yields than the narrow single row plots. Consideration needs to be given to selecting varieties to suit soil conditions and the environment (A Hurney, personal communication 1998).

Results for Ingham suggest that there is some benefit in adopting a controlled traffic system for sugarcane. Yields although not significant, tended to be greater where traffic occurred further from the crop row. This trial was harvested by more experienced operators, so harvesting traffic was restricted to the inter-row area. Yields tended to be maintained at similar levels to the narrow single rows, but soil conditions in the wider rows were not as degraded compared with the narrow single rows.

Other workers have measured little or no improvement in crop yield due to the instigation of a system of controlled traffic (Braunack *et al* 1995; Gerik *et al* 1985). In instances where yield increases have been measured a physical impediment to plant growth was removed (Tisdall and Adem, 1988) and controlled traffic restricted the redevelopment of the problem (Taylor, 1986).

It is speculated that the benefits of controlled traffic may not occur in the short term in the sugar industry, but will occur with time. The fact that sugarcane is a long growing crop (12 – 18 mths) means that there is opportunity for the crop to grow through a compacted layer when rainfall occurs or irrigation is applied.

It is thought that controlled traffic in conjunction with minimum tillage planting strategies, where only the row is disturbed, the advantages of controlled traffic may be further realised. This will result in a system where distinct traffic and plant growth zones are developed. Compaction will be further restricted and structural degradation minimised through less soil disturbance.

There are many benefits to be gained from the adoption of controlled traffic by the sugar industry. The between row spacing of 0.3 m may not be the optimum spacing as other trials with dual rows at 0.5 m on 1.8 m centres have resulted in yield increases of up to 50% over current single row spacings. However, soil properties have not been assessed in these trials. The fact that yields have not significantly increased suggests that benefit in the short term may not be immediately evident or that a constraint has not been effectively removed. Also, the selection of variety for soil type and environment needs to be considered.

Commercial cane varieties have been selected growing in a system of single rows at a certain row spacing and this may not translate into benefits when the agronomic environment changes to dual rows at a wider row spacing.

Long term benefits, if adopted with minimum tillage planting, are perceived to be less soil degradation in the row due to restricting soil compaction to the inter-row area and wet weather access may be improved due to the maintenance of the compacted inter-row areas. This would ensure continuity of cane supply to the mills during wet weather.

## References

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Taylor, J.H. 1986. Controlled traffic: a soil compaction management concept. Soc. Auto. Engrs. Tech. Paper 860731, 9pp.

Tisdall, J.M. and Adem, H.H. 1988. An example of custom prescribed tillage in South-eastern Australia. J. aging. enging. Res., 40:23-32.

## Acknowledgement

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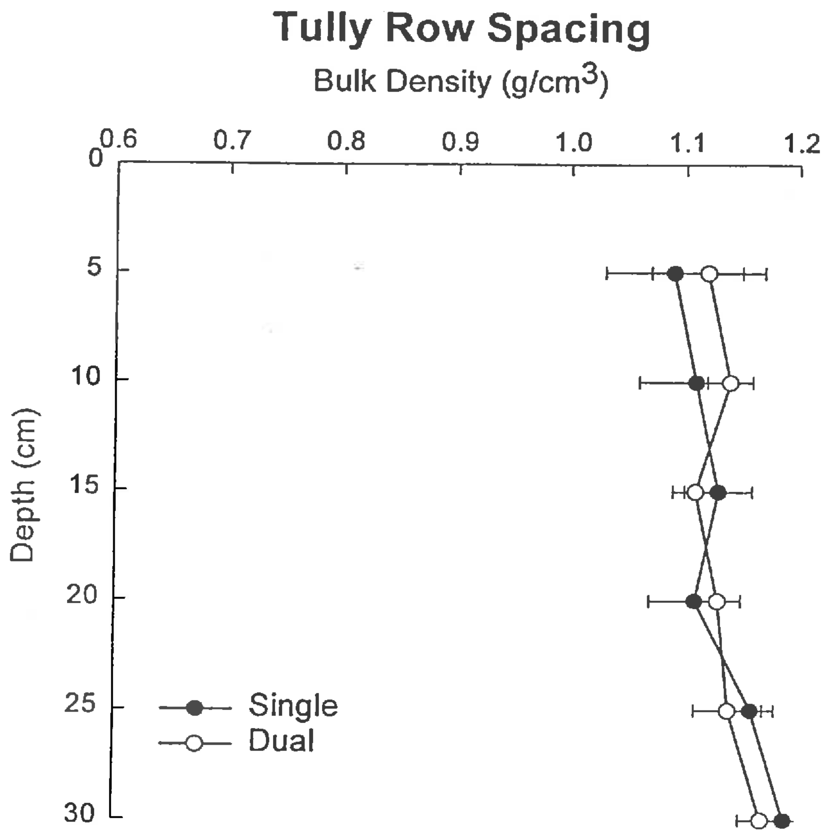
**Figure 1 Change in soil bulk density at the two row spacings**



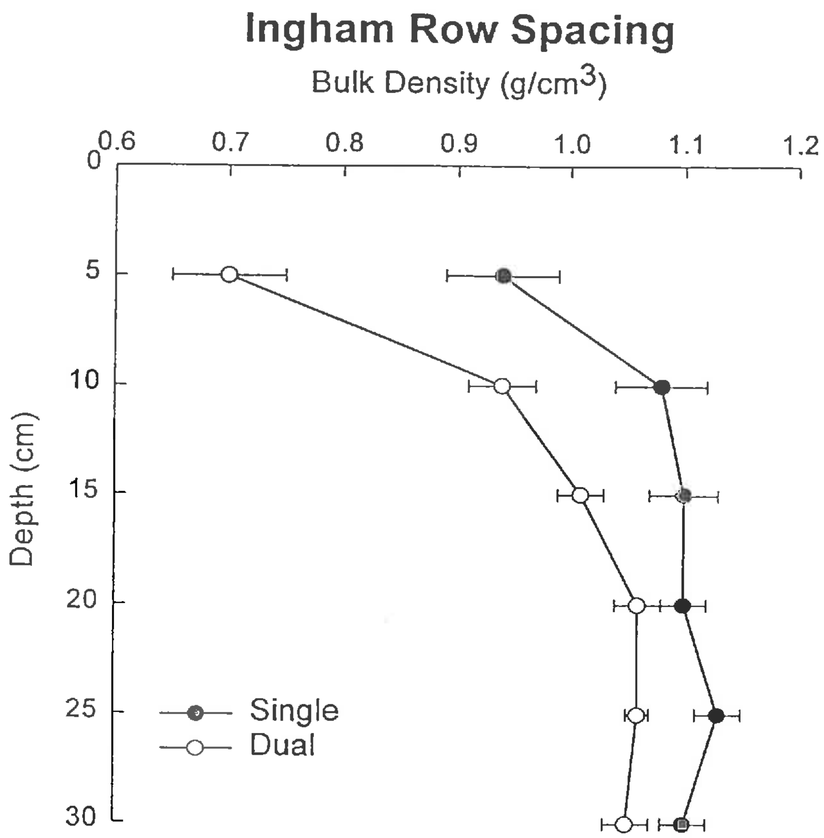
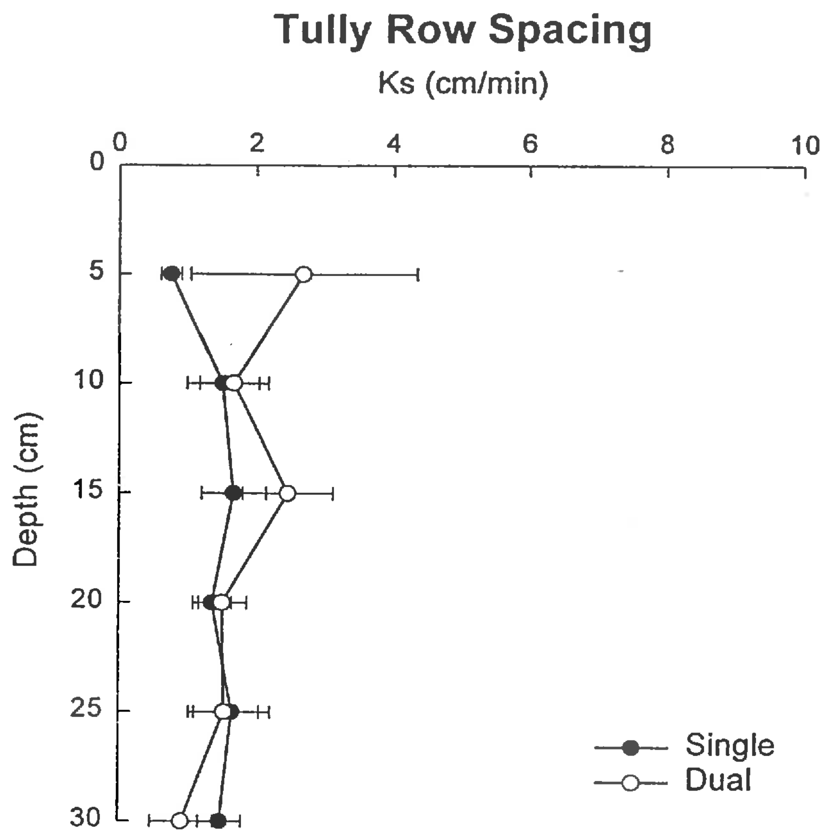



**Figure 2 Saturated hydraulic conductivity under the two row spacings**



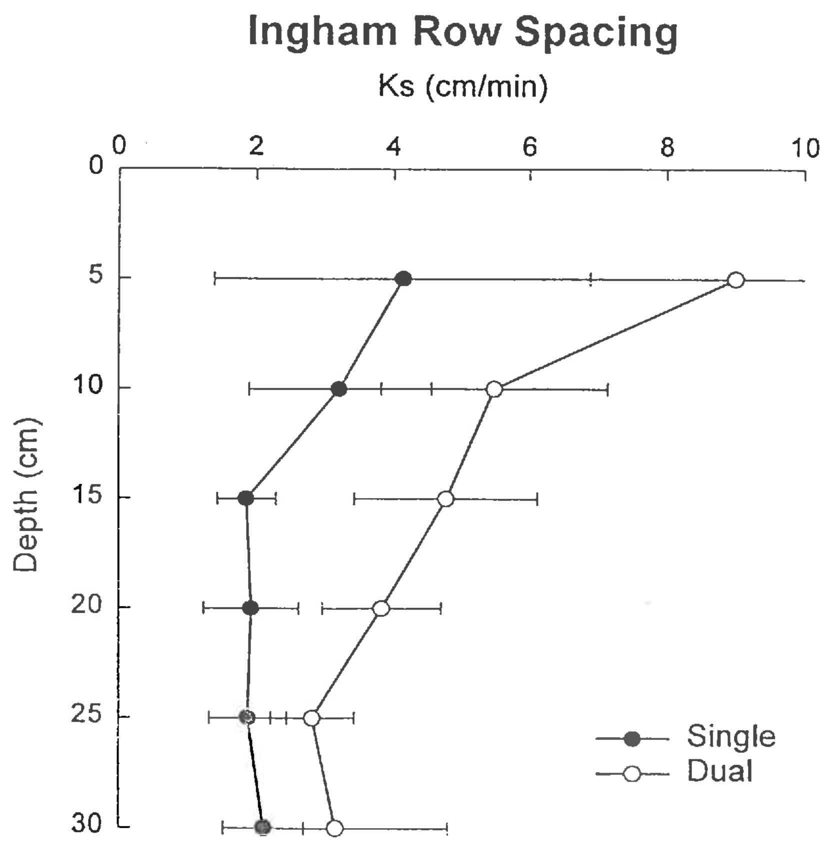
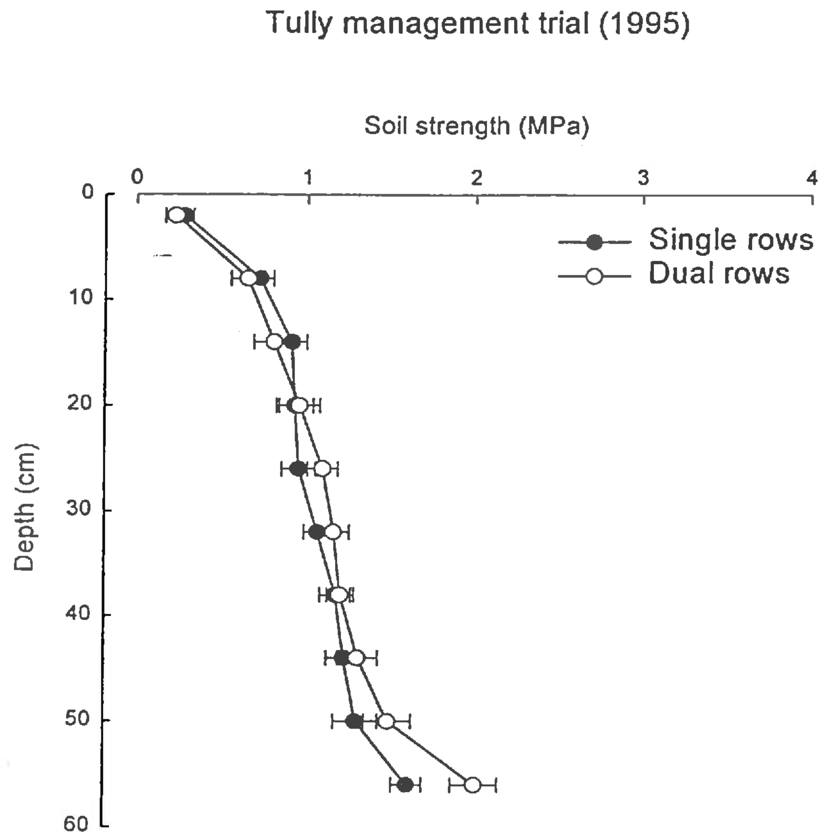



**Figure 3 Soil strength under the two row spacings**



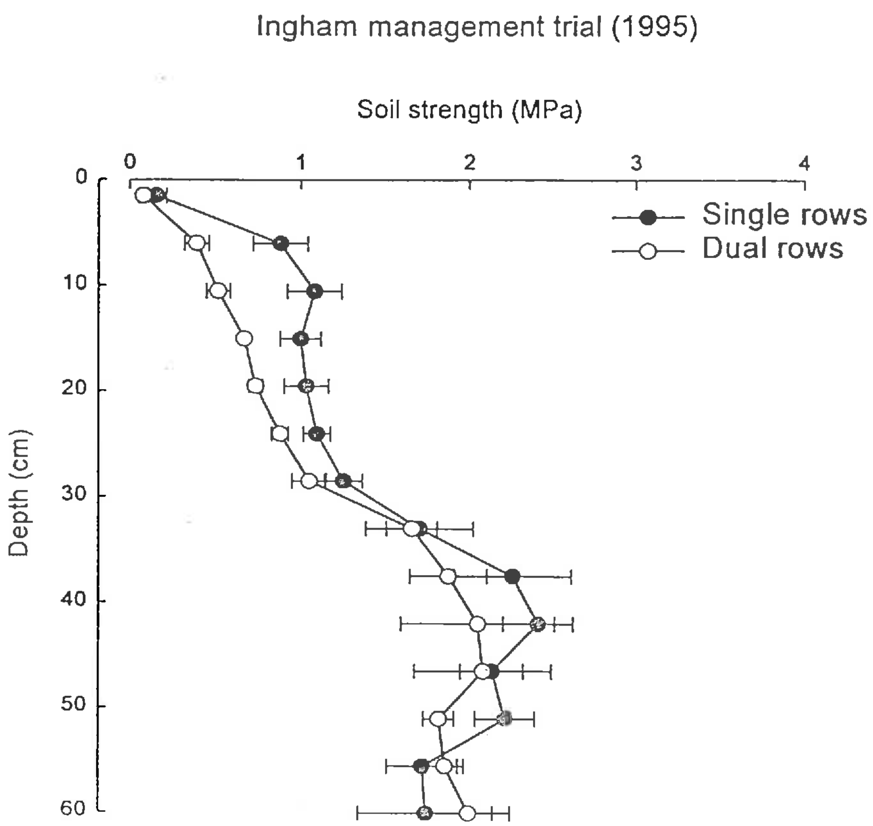



Table 1 Effect of matching crop row spacing with equipment track width on crop yield ( t/ha cane, sugar and ccs)

| Site | Variety | Crop class | Treatment | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1.5m Singles | | | 1.8m Duals | | | LSD (P<0.05) | | |
| | | | TCPH | TSPH | ccs | TCPH | TSPH | ccs | TCPH | TSPH | ccs |
| Tully | Q117 | P | 89.7 | 13.1 | 14.6 | 97.7 | 13.9 | 14.2 | | | |
| | | 1R | 94.1 | 10.7 | 11.4 | 92.3 | 10.1 | 10.9 | | | |
| | | 2R | 127.3 | 15.5 | 12.1 | 106.5 | 13.0 | 12.1 | | | |
| | | 3R | 86.4 | 12.5 | 14.4 | 96.4 | 13.9 | 14.4 | | | |
| | Q138 | P | 111.6 | 15.7 | 14.1 | 102.4 | 13.9 | 13.6 | 13.0 | 1.3 | 0.6 |
| | | 1R | 129.4 | 11.1 | 8.6 | 101.1 | 9.4 | 9.3 | 17.5 | 2.7 | 1.2 |
| | | 2R | 169.3 | 18.4 | 10.9 | 125.6 | 13.7 | 10.9 | 25.9 | 3.7 | 1.6 |
| | | 3R | 115.4 | 15.5 | 13.4 | 124.4 | 17.9 | 14.4 | 20.2 | 3.3 | 1.3 |
| Ingham | Q115 | P | 87.1 | 13.6 | 15.7 | 91.6 | 14.9 | 16.3 | | | |
| | | 1R | 81.6 | 13.8 | 16.9 | 84.7 | 14.9 | 17.7 | | | |
| | | 2R | 120.3 | 19.0 | 15.8 | 119.9 | 17.3 | 14.4 | | | |
| | | 3R | 75.3 | 11.1 | 14.8 | 88.6 | 11.5 | 12.9 | | | |
| | | 4R | 85.5 | 13.4 | 15.7 | 86.7 | 12.3 | 14.2 | | | |
| | Q124 | P | 109.4 | 18.5 | 16.9 | 113.9 | 18.8 | 16.5 | 13.3 | 2.1 | 0.6 |
| | | 1R | 97.9 | 16.9 | 17.3 | 101.6 | 17.6 | 17.2 | 6.2 | 1.3 | 0.6 |
| | | 2R | 119.0 | 16.9 | 14.2 | 124.6 | 18.4 | 14.7 | 9.6 | 3.2 | 1.8 |
| | | 3R | 85.3 | 11.5 | 13.5 | 94.0 | 12.8 | 13.6 | 8.7 | 1.3 | 1.2 |
| | | 4R | 104.8 | 16.4 | 15.7 | 111.2 | 17.3 | 15.5 | 11.3 | 1.6 | 0.6 |

LSD values refer to comparisons ( between treatments and varieties) within the appropriate ratoon for the indicated yield parameter