The development of the round baler cotton picker has contributed to reduced costs and increased field efficiency. But its adoption has also increased the risk of soil compaction, particularly in the subsoil, due to high axle loads (overall machine weight over 32 tonnes). The effects of subsoil compaction are often persistent, and its alleviation through tillage is energy-demanding and transient. Cotton is relatively sensitive to compaction and research suggests that root growth is significantly affected when soil mechanical strength is higher than approximately two MPa. Above this threshold, water and nutrient uptake by the plant is significantly affected, which compromises crop yield.

From the machine-soil perspective, compaction is influenced by:

- Axle load;
- Wheel slip;
- Contact area; and,
- Tyre deflection.

In particular, contact area can be manipulated, depending upon soil moisture conditions, by changing the tyre inflation pressure so as to minimise compaction. Controlled traffic farming (CTF) systems are also an effective means to manage compaction by confining all load-bearing wheels to the least possible area of permanent traffic lanes. This reduces tillage and energy requirements for crop establishment but requires the mechanisation system to be organised by matching track gauges and implement widths, respectively.

Early studies in the US showed that subsoiling every year was not required to maintain productivity of cotton within a CTF system that was designed to operate with commercially-available equipment. Some farmers in southern Queensland have also reported multiple benefits of CTF in cotton, albeit with CTF-compatible machines. Despite this, several barriers restrict adoption of CTF in cotton-based systems, including incompatibility between tyre configuration (dual tyres on the
front axle) and track widths, crop row spacing, cost of conversion and loss of machine's warranty.

The contact pressure at the tyre-soil interface can be reduced by operating the tyres at low inflation pressure, which also provides improved tractive performance and reduced soil deformation beneath the tyre. This is because the average soil contact pressure under the tyre is approximately equal to the inflation pressure plus the pressure caused by tyre carcass stiffness.

This approach has primarily been used for low to medium weight agricultural vehicles. Given machine/crop-related incompatibilities within cotton systems, an alternative solution to CTF may be the use of low ground pressure (LGP) tyre systems.

LGP systems can operate at about 40–50 per cent lower inflation pressure than conventional tyres thereby reducing contact pressures significantly. This study was conducted to gather preliminary information about the effectiveness of these systems in reducing soil stresses and therefore compaction from cotton pickers, but using conventional tyres at lower than the manufacturer’s recommended inflation pressure.

**Experimental**

A field experiment was established where soil was wetted-up using an irrigation grid to achieve near-uniform moisture content (field capacity to 75 per cent of FC) throughout the profile...
to a depth of 80 cm. Subsequently, the soil was trafficked using a JD7760 cotton picker (unladen) fitted with 520/85R42-R1 and 520/85R34-R1 for standard dual (front) and rear axles, respectively. Tyres were inflated to the manufacturer’s recommended inflation pressure (front: 0.25 MPa, rear: 0.32 MPa) and 50 per cent lower, respectively, to represent an LGP system. Soil bulk density (SBD) measurements were performed to the full depth (80 cm) before and after traffic (centrline of tyre) to determine how the depth of compaction was affected by tyre inflation pressure.

Results

On average, a single pass of the picker increased SBD by approximately eight and two per cent when tyres were operated at the recommended and reduced inflation pressures, respectively (Figure 1). Overall, changes in SBD after traffic were only significant in the 0–25 and 0–50 cm depth intervals for the reduced and standard pressure tyres, respectively. The inner tyre of the dual configuration, operated at the recommended inflation pressure, induced a significant increase in SBD to 80 cm deep compared to that prior to traffic. It was also observed that because of high load on the rear axle, the rear tyre operated at lower than the recommended pressure caused significant additional compaction to the leading (inner) tyre at reduced inflation pressure.

This effect was not observed when the leading inner tyre was operated at the recommended inflation pressure because the compaction caused by this tyre was relatively higher and therefore prevented the rear tyre from causing additional damage. Despite this, overall compaction caused by the (inner) tyre at reduced inflation pressure was lower compared with tyres at standard pressure. For the outer tyre, reduced inflation pressure significantly reduced the depth of compaction to approximately the top 20 cm of the soil profile.

The implication of this observation is the additional tillage energy (draught) that would be required to remove deeper compaction prior to establishing the following crop when tyres are operated at relatively higher inflation pressure. Draught (horizontal force) increases significantly with an increase in tillage depth (that is, by approximately to the power of three of the depth), so it is important that subsoil compaction is minimised.

Further research

LGP systems used in conjunction with shallow tillage techniques may be a cost-effective alternative to CTF systems managed under minimum tillage. For cotton, this may be a practical engineering solution to manage compaction given the incompatibilities that exist between crop row/rotation and machine configurations, which may create a barrier to adoption of CTF.

Further work needs to be undertaken to assess the feasibility and practicalities of using LGP systems in cotton.

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