UPDATE ON RIPPING

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The shattering truth about deep tillage

Ripping (deep soil working) can give conflicting responses. Sometimes it increases cotton yields and other times it decreases cotton yields. The aim of this paper is to summarize the position on ripping and to draw basic principles from the information we have. Some basic principles are discussed below as 'rules for ripping'.

Rule 1. Rip only dry soil.

Preparation of land for cotton when the soil is moist or wet has been shown to alter the fabric of a clay soil and to depress cotton growth (McGarry, 1987); to degrade the structure of a clay soil (McGarry & Daniells, 1987); and to decrease lint yield by 30% (Daniells, *in review*). Of course, preparation of land involves many operations besides ripping, but those results raise a caution about any tillage when the soil is not dry.

More pertinent to this paper, an experiment was carried out at Narrabri on ripping soil at different water contents. Soil was ripped to 50 cm in two directions at four different water contents before growing cotton. Table 1 shows the soil water contents at two depths (0.15 m and 0.45 m) when ripped. For comparison, a non-ripped control (Treatment E) was included. Lint yields are shown in Table 1.

Table 1. Lint yields of cotton grown after ripping soil at different water contents.

Treatment	Soil water content kg/kg		Lint kg/ha	Lint % of control
	0.15 m	0.45 m		
A permanent wilting point	0.21	0.21	1749	112
B moist	0.26	0.28	1088	70
C moister	0.29	0.29	1273	82
D wet (just trafficable)	0.32	0.30	1119	72
E control (not ripped)	0.22	0.21	1556	100

Relative to the non-ripped control (Treatment E) ripping soil which was dry (permanent wilting point to depth, Treatment A) increased lint yield by 12% (not statistically significant). Ripping soil which was not dry (Treatments B, C and D) decreased lint yield by 18 to 30% relative to the non-ripped control. Statistically, Treatments B, C and D yielded less than Treatment A (ripped dry) and Treatment E (not ripped). There was no statistical difference between Treatments B, C and D: the variation between 'moist', 'moister' and 'wet' meant little. Thus all soil water contents except permanent wilting point were unsafe for ripping. Add the cost of the ripping operation and this makes Treatments B, C and D an expensive way of decreasing yield!

A further word is warranted on the 'safe' soil water content for ripping (or any tillage). Kirby (1988) draws our attention to the lower plastic limit as the water content above which soil smears rather than shatters when tilled. In the Narrabri grey clay of this experiment, the lower plastic limit is 0.278 kg kg^{-1} (Daniells, *in review*). Treatments B,C and D were all wetter than the lower plastic limit when ripped (Table 1) and would therefore have been smeared. Treatment A was drier than the lower plastic limit and would have shattered when ripped. For practical purposes, it may be easier to use permanent wilting point, 0.19 kg kg^{-1} (Chan and Hodgson, 1981) as the safe water content for tillage.

McKenzie *et al.* (1983) working on a grey clay at Warren found positive responses (economically profitable) to ripping in most years. See Rule 3 below for an explanation of why ripping was not beneficial in all years.

Rule 2. Know why you are ripping.

There are two reasons that I can see for ripping:

(a) to shatter a compacted layer;

(b) to increase water intake to a dry subsoil.

Taking point (a) first, ripping is called for if a soil has a compaction layer and if the subsoil is dry enough to benefit from ripping (rule 1 takes precedence: if the soil is not dry, don't rip even if there is a compaction layer).

Taking point (b), ripping can help rewet a too-dry subsoil. Chan and Hodgson (1981) found that one furrow irrigation failed to completely rewet a subsoil dried out by an extremely moisture-stressed cotton crop. A similar warning is given by Abbott (reference Daniells and Abbott, 1988) in connection with extreme drying by dryland rotation crops. It appears that slaking of a dry soil on rapid wetting can seal off cracks and prevent deep recharge of soil water. Ripping can increase soil water intake (McKenzie *et al.*, 1983) at least for the early part of the cotton season. This effect was short-lived but was enough to increase cotton yield in some seasons.

Given time, rainfall on bare fallow will recharge a subsoil with water. Thus, if time is not a constraint, there is no need to rip to increase water intake to the subsoil.

Hulme *et al*. (1986) working with a brown clay at Warren found that the soil absorbed more water after ripping than after direct listing. Cotton on the ripped treatment suffered less moisture stress before irrigation. However, the cotton was not able to exploit the better soil conditions in the ripped plots: direct listing produced higher yields.

Hulme explained these findings as follows. All plots were watered together and the decision to water was based on the available water in the direct list treatment. Thus the ripped plots were watered too frequently for maximum growth. Had it been possible to water each plot individually, the ripped treatment may well have performed better. Thus management can influence the response to tillage treatment.

Rule 3. Have a crystal ball on next season's weather.

One of the reasons for the variable response to ripping is that the weather during the subsequent cotton crop plays a part. McKenzie found that ripping increased profits in dry years. The ripped treatment had improved subsoil water storage, higher air-filled porosity in the 20-30 cm depth and lower soil resistance to root growth, compared with shallow-tilled treatments. In wet years (even though the ripping was done in dry soil) the improved water intake after ripping was of no benefit to the subsequent cotton crop; in fact the ripped plots yielded slightly less than the shallow-tilled plots. Thus wet cotton seasons enabled the cotton on the non-ripped plots to get by very well without good storage of subsoil water. Increased waterlogging may explain the yield decline on the ripped plots.

This effect confirms Hulme's conclusion that his ripped treatment should have been irrigated less frequently for maximum response.

What does ripping do?

When the soil is dry to depth, ripping shatters the soil, decreases bulk density, improves water intake and reduces soil resistance to root penetration. When the climate and management allow the cotton crop to exploit the improved soil conditions, ripping will increase yield.

Increased water intake and increased yield after ripping has been demonstrated only for some Macquarie soils: soils in other areas may not respond this way. An experiment at Narrabri (Daniells, *in review*) compared ripping and no ripping, with and without a rotation crop of wheat. The aim was to see if either the rotation crop or the ripping (or both) would remove the effects of dry, moist and wet tillage in previous years.

These 'restoration' treatments (wheat and ripping) which were designed to restore damaged soil structure and improve cotton yield, actually depressed yield. Firstly, the growing of wheat depressed cotton yield through a reduction in nitrogen uptake. A higher rate of nitrogen fertilizer should have been applied after wheat. Secondly, deep tillage after wheat decreased clod bulk density but this improvement in soil structure was not accompanied by increased yield. Instead, yield was depressed, particularly on those areas which previously had intermediate or poor soil structural condition. The season (1985/86) was not a wet one and so the season can not be called upon to explain the yield decrease. This result leads to the speculation that deep tillage had a small beneficial effect on well-structured soil at a water content close to permanent wilting point, and a detrimental effect on poorly-structured soil at any water content. This throws some doubt on the use of deep tillage to ameliorate degraded soil.

CONCLUSION

The main conclusion is that ripping is a doubtful proposition. You should give a lot of attention to a decision on whether or not to rip. Ripping is expensive, it may not be needed and it can damage soil structure - not improve it - if done in wet soil. Such a decision would deserve a full diagnosis of soil condition, especially an examination of the soil profile in a back-hoe pit.

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