SOIL DAMAGE AND THE "BIG WET"

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Introduction

It rained a lot, and much cotton was picked on wet soil - but how much damage was, or will be, done to the soil?

It is worth bearing in mind the description given in the handbook on Soil Management by Davies et al. (1977 - see ch. 8, Traffic and Soil Damage). The following is a slightly abridged quotation.

> Dry soil is difficult to compact. As moisture content increases, soil becomes more easily compactible up to a certain optimum point. Above the optimum moisture content the compaction obtainable declines because the pores are water filled and therefore less able to reduce in volume. The situation is shown in Fig.1. It will be noted that the optimum moisture content tends to be at or just below the plastic limit and is near a moisture content generally considered favourable for ploughing.
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> Although soil may not compact further once the optimum is reached the strength of the soil continues to decline as moisture increases further. Then wheelslip tends to increase with attendant puddling and smearing, the bearing strength of the soil declines to give increased sinkage, with increased rolling resistance and again greater puddling and smearing. *The result is inefficient operation and the likelihood of severe soil damage* (my italics).

Is this what is happening to the soil after the big wet? I took some soil samples in the Gunnedah and Moree areas following the big wet, but after the cotton picking had restarted. Compression and shear strength measurements on these samples give information on both the likely volume changes (i.e. compaction), and the bearing strength, under traffic. Thus we may examine whether compaction would be expected, or whether the soil was in the state where the bearing strength was inadequate and puddling and smearing (also called shear damage by Kirby 1988) would be expected. This will be discussed with reference to samples taken from 5-15 cm and 30-40 cm at two locations, one near Gunnedah and one near Moree.

Moisture content and plastic limit.

The moisture content at the time of sampling and plastic limits are shown in Table 1. Obviously, the soils are considerably wetter than the plastic limit.

Compaction characteristics.

The change in density of the soils (at the field moisture contents) with increasing load was measured in the laboratory with a lever arm loader and is shown in Fig. 2. The figure shows two things. Firstly, all the soils did compact with increasing pressure, but the change in density is relatively small for three of the four samples tested. The reason for this is that the soils were nearly saturated, and could not compact much. The fourth sample was the 5-15 cm sample from Moree and was the driest of the four samples (Table 1); presumably this soil had time to dry out at the surface before it was sampled.

The second feature of Fig. 2 is that the three less compressible samples all became saturated at pressures that are well within the range applied by vehicles used in the cotton industry. Once saturated, there is no further compaction; indeed testing soils in this condition is difficult because further pressure application tends to cause them to extrude from the testing apparatus. This is evidence of their weak condition. The drier sample was able to withstand a higher pressure before this happened.

Bearing strength.

The strength of the soil samples was measured in the laboratory using a shear box apparatus, and from the results their capacity to bear traffic was estimated. A soil can bear a certain load with little sinkage and little shear damage (puddling and smearing in the words of Davies et al.). At higher loads a point is reached at which there is catastrophic sinkage in which a vehicle becomes bogged and further progress is impossible. Damage is very extensive at this stage. The ability of the soil to bear this load is called the bearing strength. Up to about 40 % of the bearing strength there is little damage to soil structure. As noted by Davies et al., wheelslip reduces the bearing strength of a soil and increases damage, and thus excessive wheelslip should be avoided.

The bearing strength of all four soil samples was about the same at around 160 kPa. Damage will start at ground pressures in excess of about 65 kPa (i.e. 40 % of 160 kPa) which is near to the lowest ground pressures exerted by farm vehicles, and thus some shear damage is almost inevitable with any traffic. The bearing strength is in the middle of the range of vehicle pressures. Some vehicles would therefore have difficulty in trafficking these soils at these moisture contents. These observations of damage and difficulty in trafficking the ground agree with those of Davies et al. (1977) and Kirby (1988).

So some damage appears inevitable, but how deep will it go. Kirby (1988) showed that, if a tyre exerts a ground pressure equal to the bearing strength, then the shear damage could go as deep as the tyre is wide. However, trafficability is very difficult at this stage, and usually the ground pressure and hence depth of damage would be somewhat less. Nevertheless, damage to depths approaching the width of a tyre can be expected. The actual depth depends on the tyre, therefore.

Minimising damage and options for amelioration.

Davies et al. give several means of minimising damage. Spoor (1987) also gives helpful hints to reduce compaction following a wet cereal harvest in the UK in 1987. The advice given includes:-

a. Avoiding moist and loose soil as far as possible.
b. Cut down traffic to the minimum necessary.
c. Operate at higher forward speeds and lower wheelslips.
d. In extreme cases resort to bed systems of cultivation.

Obviously, much damage cannot be avoided, and consideration must be given to means of amelioration. Some attention has recently been given to various options such as deep ripping and minimum tillage; various articles are to be found in recent issues of the Australian Cotton Grower. I will not repeat these discussions here.

However, in relation to the big wet it is worth noting that Davies et al. suggest that ploughing is best at or just below the plastic limit. Similar findings have been reported by Daniells (1984) and others for land preparation in the cotton industry. The soils discussed here are much wetter than the plastic limit, and are unlikely to dry out over the winter unless a crop is grown. Therefore, careful management of the soil will be required over the next year or so, in order to undo the damage resulting from the big wet. Spoor also emphasises the need for soil investigation and detective work in the spring/early summer following the wet harvest, to identify tbe best management strategy.

References.

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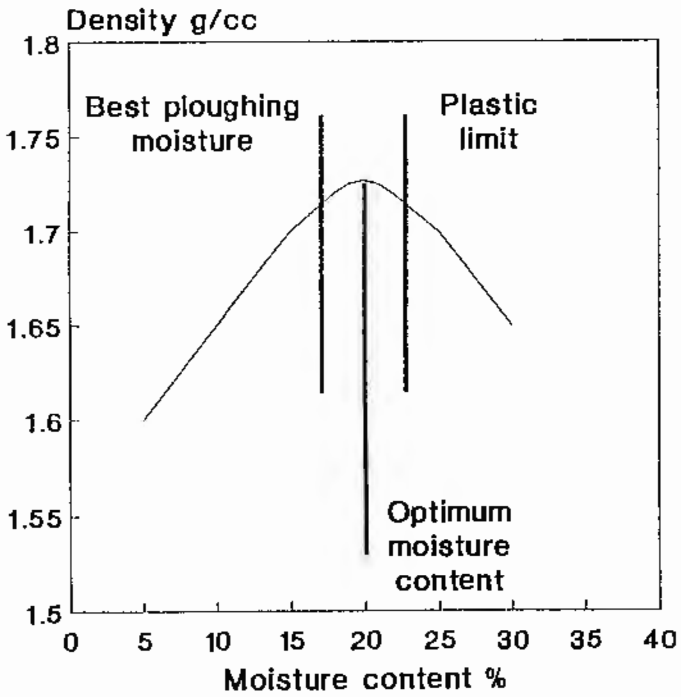
Table 1 Moisture contents and plastic limits of the soil samples.

Sample		Moisture content %	Moisture content at the Plastic limit %
Gunnedah	5-15 cm	44	32
	30-40 cm	48	31
Moree	5-15 cm	31	21
	30-40 cm	36	22

Fig. 1 Compaction of soil with impact load at a range of moisture contents



After Davies et al. (1977)

Fig.2 Density vs pressure Compaction test