FARMING WITH COMPACTION

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INTRODUCTION

Retained hills are now a well-established management strategy in the Australian Cotton Industry. They provide the Industry with a unique strategy to control soil compaction, ensure long-term maintenance of the soil resource, and provide lower cost land preparation.

Growers should be aware, however, of several potential management problems inherent in the system, especially as approximately 80% of irrigated cotton is now grown in retained hills.

There are two potential problems: keeping compaction out of retained hills, and ensuring wheel compaction is removed if hills need replacing. The first part of the paper will address this.

The answer to both lies in a working knowledge of wetting/drying cycles, that is the process that controls structure formation in most cotton soils. The second part of the paper will address this.

1. COMPACTION IN HILLS AND REPLACING HILLS

The retained hill system is one form of controlled traffic. Wheels are restricted to the furrows and, in theory, the hills are only cultivated lightly.

The effects on soil structure of the retained hill system are being monitored using soil image analysis in a CRDC funded project. This is a resin-impregnation technique that captures the soil structure on any one occasion and permits statements on soil pores and the shape and size of soil aggregates. Samples for this analysis were taken through the 1990-91 season from an irrigated cotton paddock near Pittsworth, Queensland. The soil is a deep, black cracking clay and hills are on 1 m centres.

Results demonstrate two effects of the retained hill system on soil structure.

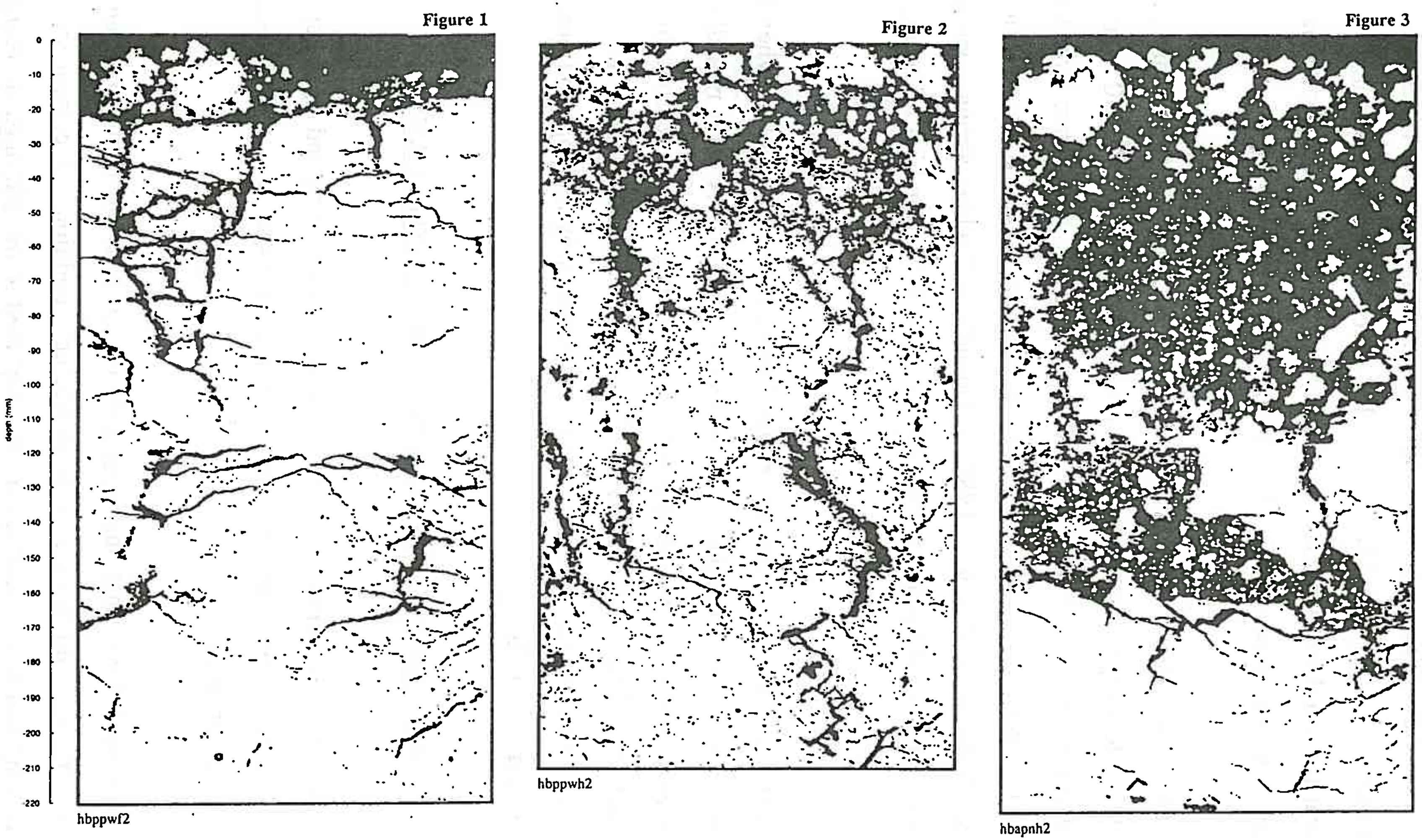
(i) Soil compaction can be restricted to the furrow

Figures 1 and 2 show two images from an immediately adjoining hill and wheel furrow, taken on the one day just before picking in 1991. The hill exhibits good pore space from the surface to depth. There is a loose granular seed bed to 50 mm, then to the bottom of the sample (210 mm) there are wide continuous cracks with porosity between the cracks. The continuous cracks permit good water and root penetration.

In stark contrast, the wheel furrow has virtually no loose topsoil, with plate-like horizontal structure from 20-180 mm. The plates are up to 20 mm thick, and their whiteness (in the image) shows their high density (low porosity).

(ii) Cultivating hills can compact them

Figure 3 shows damage to the cotton hills in the same paddock caused by one pass of a middle-busting tine. The tine was used to "aerate" the hills for the 1992 season. It can be seen that the tine has created a very loose, highly porous topsoil to 100 mm, but from 100-160 mm large, high density (low



Figures 1, 2 and 3. Three digital images of soil structure taken from a cotton paddock, near Pittsworth, Queensland. In all images the soil pores (air spaces) are black and the soil solid is white. Figure 1: a wheel furrow, and Figure 2: the immediately adjoining hill, just before picking (1991). Figure 3: a cotton hill one week after the pass of a middle-busting tine, just before the start of the 1991-2 season.

porosity) soil clods are visible. Below 160 mm the soil has become most dense with evidence of plate-like structure similar to the wheel furrow in Figure 1. Comparing Figures 2 and 3 (taken 3 months apart) it is evident that the good soil structure with many continuous vertical pores has been lost and a hard pan produced in the hill.

The water content profile of the soil in Figure 3 was dry to 150 mm (under 19% gravimetric water content) but was 29% water at 180-240 mm: The plastic limit of this soil is 29% (water content), so the deeper layer would have smeared and compacted under the implement. This links well with the observations of McGarry (1989) at Goondiwindi where strongly smeared, dense layers were found in the centre of retained cotton hills following wet cultivation.

Furrow compaction, between retained hills, is only a problem when hills need replacing, commonly due to poor alignment. A 50% reduction in cotton yield has been recorded by placing new hills over old furrows (McGarry, 1990). The furrows had not been repaired, as the soil was wet when chiselled, and the new hills were underlain by a compacted pan (the old furrow) to 40 cm.

2. REPAIRING COMPACTION IN CRACKING CLAYS

Hill and furrow compaction can be repaired using wetting and drying cycles. This is the natural, in-built process that gives these soils their excellent, inherent structure.

Common belief is that one wetting/drying cycle is sufficient to repair the soil structure and bring it back to original condition. A current study is showing that this is incorrect and that repeated wetting/dryings are required. This section will detail results of this study.

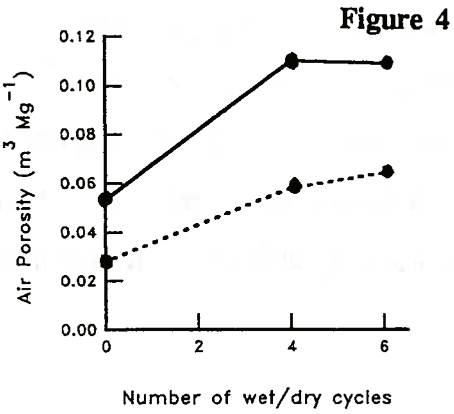
Methods. Large compacted soil blocks (15 cm x 15 cm x 15 cm) were taken from wheel furrows from a paddock of retained hill cotton near Pittsworth, Queensland. The soil is a black cracking clay and the samples were taken one week after pre-irrigation. The samples were coated in latex, leaving only the upper surface of the soil exposed, and buried in sand leaving only the exposed surface open to the environment. These two stages were important to ensure the soil sample responded as if it was still in the paddock.

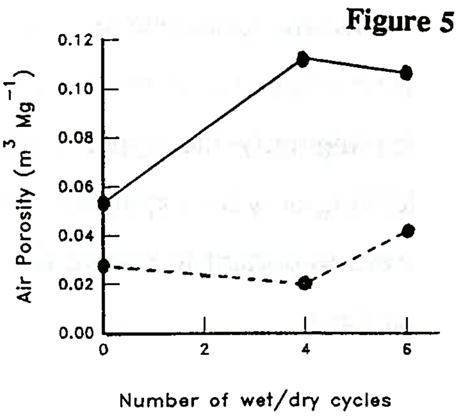
The blocks were allowed to dry, then were wetted. They now have had 6 wet/dry cycles. Wetting of half of the blocks has been by rainfall (using a rainfall simulator at 39 mm an hour), whereas the other half have been flood-wetted, to simulate irrigation.

Before and after every wetting event the soil blocks were weighed to give the amount of water that entered the soil. Clod samples for shrinkage characteristics were taken from the original samples, and after the fourth and sixth wetting/dryings. On each of these occasions the remainder of the block was resin-impregnated for image analysis.

Shrinkage data will be presented as air porosity (in normal shrinkage). Increased air porosity indicates a better soil environment for plant growth as it provides greater water infiltration, oxygen diffusion and easier plant root penetration. The amount of water that entered the soil at each wetting is expressed as the ratio of total water that entered at the first wetting.

Results. Soil aeration dramatically increased with wet/dry cycles. In the top 10 cm, four wet/dry cycles gave a two-fold increase in air porosity (Figures 4 and 5). Rain and flood performed equally in this layer. In the 10-20 cm layer flooding, with a two-fold increase, was better than rain. Six wet/dry cycles gave a further, small increase in the 10-20 cm layer under rain.





Figures 4 and 5. Air porosity (in normal shrinkage) for six wet/dry cycles on soil from compacted wheel furrows; 0-10 cm (——), 10-20 cm (- - -). **Figure 4:** Flood wetting. **Figure 5:** Rain wetting.

So, a minimum of four wet/dry cycles are needed to significantly improve porosity in the top 10 cm, whereas after six cycles air porosity is still improving in the 10-20 cm layer.

Matching the increase in air porosity was an increase in water infiltration into the soil blocks (Figure 6). Three wet/dry cycles achieved a two-fold increase in water infiltration with flood wetting. With rain, infiltration did not improve even after six wet/dry cycles.

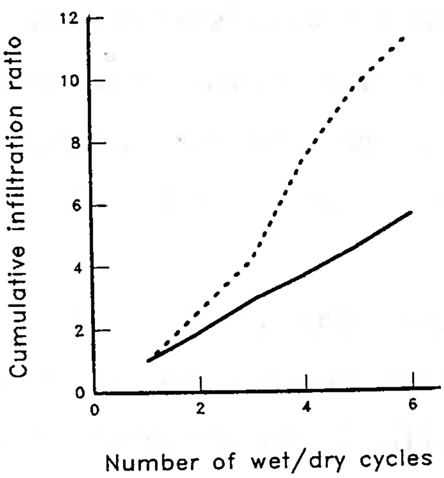


Figure 6. Cumulative infiltration into soil from compacted wheel furrows for six wet/dry cycles, expressed as a ratio of water infiltrated at the first wetting. Flood wetting (- - -), rain wetting (——).

Hence a dramatic increase in profile recharge can be achieved after wet/dry cycles under flood irrigation. A minimum of three cycles are needed but increases are still being recorded after six.

The success of the above experiment has led to a CRDC funded project which has recently begun. The project involves the repair of compaction from commercial cotton farms both in the field and laboratory using wet/dry cycles. This includes drying through crop growth.

REFERENCES

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