CHANGE IN SOIL STRUCTURAL FORM ASSOCIATED WITH CONTROLLED TRAFFIC ON A CRACKING CLAY.

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Introduction

Sustainable land use practices must, over the long term, maintain soil structure which is optimum for a range of processes related to crop production and environmental quality. Soil structure is a major influence on the ability of the soil to receive, store and transmit water, to cycle carbon and nutrients, to support and enhance root development, to resist erosion and the dispersal of agricultural chemicals (Kay *et. al.*, 1994). A number of authors have described optimal soil growing conditions for plant growth and linked the various aspects of soil structure to the processes influencing plant growth (Russell, 1977; Russell, 1973). Yet, there are very few mechanised cultural practices that actually optimise soil conditions for long term sustainability and food production. Better than average climactic conditions and or expensive soil amendments have often masked the short comings of a poorly structured soil (Amir, 1994; Gibbs and Reid, 1988). Controlled traffic farming systems (CTFS) appear likely to optimise soil structural characteristics by enhancing form, stability, resilience and by decreasing vulnerability to stress.

Definitions:

- Structural form: The arrangement of solid and void space. Characterised by total porosity, pore size distribution and pore continuity, which determine the availability of water and oxygen and resistance of soil to root penetration.
- Structural Stability: The ability of the soil to retain its arrangement of solid and void space, when exposed to stresses.
- Structural resilience: The ability of the soil to recover its structural form through natural processes when the applied stresses are removed or reduced.
- Structural vulnerability: The inability of the soil to cope with stress.

Structural stability and resilience relate to the dynamic nature of structural form. A structural form that changes in response to stress and natural processes implies a concept of temporal dependence. A cracking clay therefore, given time, may improve its structural form under optimal conditions and seasonal crop growth (Probert *et. al.* 1987; Kay *et. al.* 1994; Pillai-McGarry, U. and McGarry, D., 1996.).

Objective

The objective of this study is to quantify the changes of structural form of a cracking clay after the implementation of a CTFS in a dryland area, previously cropped conventionally for 50 years.

Methodology

The main objective will be achieved by studying;

- The zonal influence and persistence of single and multiple wheeled permanent tracks.
- The change in soil structural form after each planting within each treatment.
- Contrasts between soil structure at implementation of CTFS, at subsequent plantings and in a long term non-trafficked area.

The study is being conducted on two 80m by 12 m blocks. Each block is divided into four beds by permanent tracks at 3m centres. The measurements are taken on the inner two beds while the outer beds act as guards. The soil is a black cracking clay, classified as a vertisol, which is typical of this area and the Darling Downs.

The soils structural form is assessed by; hydraulic conductivity, pore size distribution, bulk density, porosity and soil moisture retention characteristics. Soil data was collected at th implementation of CTFS and after each subsequent planting of a continuous cereal/legume rotation. Measurements are also being collected from a small fenced area of the same soil type, which has not been trafficked since 1979.

The measurements are taken at depths of 100, 200 and 300 mm, in 3 locations, in track, beside the track and in the centre of the bed. The different treatments are simply the number of wheelings in the tracks. That is, 1 wheeling is applied during both harvesting and planting and subsequent wheelings, 2 and 3, are applied to simulate other operations during the growing season.

Results

The results to date are encouraging, in the sense that the soil structure appeared to be uniformly poor at the outset of this study in terms of visual evidence, and it has visibly improved in this qualitative sense. In terms of quantifiable differences however, the results are less encouraging. Figure one indicates a slight trend towar structural regeneration but the results to date are not conclusive. The data in Figure 1 is averaged over the profile depth, however the change in pores/m^2 at 300 mm is more significant when individual depths are compared over time. The trends are similar at all depths and positions, yet there is no discernible difference between treatments. Although the current available data does not provide conclusive results, the effect can be clearly seen. The first two excavations of the Summer of 96 and the Winter of 97, revealed a soil which was virtually structureless and easily smeared. The Summer of 97 pits were a complete contrast, the soil was not as susceptible to smearing and digging was much easier. Roots had penetrated to 300–400 mm, where they had created failure zones, causing the once massive soil to form angular clods. The clods broke away from the pit floor with ease. This makes a most refreshing change to the preparation time of the measuring surfaces of the pit

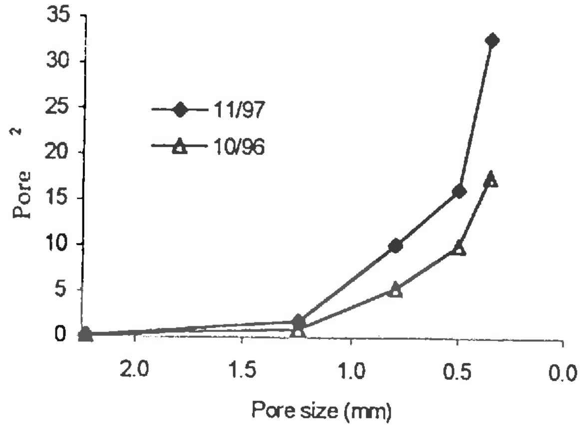

Figure 1. The change in average pore size class distribution to 300mm depth from October 1996 to November 1997

floor. A task, that in the beginning, was measured in days now only takes few hours. The tracks however have remained massive and hard, which is easily discerned in the excavated profile. As expected, large singular, longitudinal cracks form in the tracks, in marked contrast to the fine multiple cracks in the beds. The zonal influence of the track is readily observed in the pit wall, expanding laterally in a bulge under the beds.

Discussion

It is visually apparent that the soil profile is demonstrating its resilience and regaining some structural form. The process, as reported by previous workers, is long term and dependant on a large number of variables such as; climate, biological drilling and shrink swell cycles. (Bridge, *et al.* 1983; Cotching, 1995) It is hoped that this last data set to be taken in September and October 1998 will clearly and quantitatively confirm the direction and extent of the soil regeneration processes over the last 3 years.

In the first two years of the study there were few wetting and drying cycles at depth, much of the self mulching activity was restricted to the surface. This was attributed to unseasonal rain maintaining a full profile and poor soil drainage. Also the roots of the Barley, Wheat and Lab Lab apparently failed to access the moisture in the profile. Since last Summer the rain has been more seasonal, forcing the Lab Lab to forage further. The roots have extended to a depth of 400 mm, leading the way for the soil to recover its structural form.

Conclusion

Given the right climactic conditions a CTFS will allow a cracking clay soil to regain some structural form in a relative short time. Complete regeneration to an optimum state, so that soil processes function efficiently, will take many years, depending on the start point, the amendments used at implementation of CTFS, crop type, soil type and climactic conditions. The act of allowing the soil, plants and animals to live undisturbed, without seasonal destruction of the soil habitat, can save farmers substantially in time and money. The short term gains of reduced inputs are a rewarding step on the way to the long term gain of sustainability.

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