Managing Soil to Avoid Compaction Problems in Cotton Growing

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Introduction

This paper provides an overview of the Cotton Research and Development Corporation project DDI 1L, which is in its final year at the University of Southern Queensland. The main aim of the project is to develop a suitable management system for cotton growers that will minimize tillage requirements and avoid current problems with soil compaction caused by heavy machinery. The project is based on a controlled traffic approach that maintains compacted lanes for machinery and a compaction free plant environment.

The overall aim is being met in three parts by separate project teams including staff from U.S.Q. (Engineering School), the Qld. Dept. of Primary Industries (Land Management Res. Brnch), and C.S.I.R.O. (Div Soils). The first team is using regular measurements of various soil physical and thermal properties to assess seedbed conditions under controlled traffic farming conditions. The information obtained on the dynamic nature of these properties is being used to develop a computer management model. On completion, the model will provide guidance on the tillage requirements of a cotton crop in a controlled bed environment. The second team is developing guide-lines to install, operate and maintain a suitable system of compacted laneways for cotton growing. The third team is working to develop suitable automatic guidance equipment to allow farm equipment to be operated accurately on the compacted laneways over several years, thus maintaining a compaction free plant environment.

The results from Project DDI 1L will establish a sound, practical basis for cultivating cotton in Australia with existing heavy equipment in a way that will reduce soil compaction problems and reduce energy usage. Potential savings to the farmer include greater control of his soil resource, avoidance of yield depression and a potential halving of tillage costs.

Progress made in each of the three subprojects is summarized below.

Modelling subproject.

The main field programme to collect data for this subproject is now completed, and

development of the tilled soil model is in progress. Parameters measured include:

- **meteorological** variables: rainfall, radiation, wind, wet and dry bulb temperatures,
- **soil** variables: surface- roughness, sorptivity, infiltration characteristics; topsoil- gravimetric water content & potential, bulk density, structure, temperature, penetrometer; subsoil- volumetric water profile, temperature profile,
- **crop** variables: emergence date, canopy growth, flowering and boll counts, yield, and
- **management** variables: machinery type, wheel size, working dates, irrigation dates.

The collected data is being assembled into an accessible database for further analyses. Initial analyses of the temperature data have established relationships between air and surface temperatures that might hold for much of eastern Australia. Such a finding, once confirmed, will greatly assist in temperature modelling throughout the main cropping regions of this country.

Soil structure is being monitored using the SOLICON system of image analysis. Over 130 resin impregnated sample blocks have been collected during the project and these are now being analysed. The preliminary findings from this work clearly show a difference in structure between the soil in the tilled hills and that under the furrows and laneways. Project member Dr Des McGarry will describe these findings in more detail in his presentation to this conference entitled "Farming with Compaction".

The structure data are being supplement by disc permeameter readings, and rainfall simulator experiments to establish the soil's hydraulic behaviour. Other soil properties measured reflect the seedling and plant root environment.

The Ozcot cotton growth model was provided for use in Project DDI 1L by Dr Brian Hearn of Narrabri. This model is being used to simulate the growth of cotton crops as influenced by the measured soil parameters.

Laneway subproject.

The laneway project team has the novel task of determining the best way to compact a soil and to maintain it in a compacted condition. To do this, they have developed new methods and equipment to monitor soil-wheel interactions in the field and to

reproduce the observed behaviour in the laboratory. Various techniques for constructing laneways have been developed and some of these are now being evaluated in field tests.

Work in this subproject has included:

- quantifying the dynamic effect (stresses) of wheels on field soils through field and laboratory studies
- establishing the soil response to wheel stresses under a range of initial conditions, and with several strength additives
- proposing several alternative laneway geometries and construction techniques, based on analyses of measured stresses
- constructing controlled traffic laneways for field evaluation, using a purpose-built laneway building machine

The prototype laneway building machine was designed by project staff and constructed in the U.S.Q. workshop. It was successfully used to install a range of trial laneway types on the cooperating farm. Field trials of possible laneways are continuing, and the results from these trials will be used to develop the proposed guide-lines for cotton growing.

The guidelines will be based on the measured compactive responses of the soil to actual field applied stresses, the tests with different additives to improve soil strength and the field trials currently in progress. They will also address the issue of preferred lane profiles (raised, sunken or intermediate) and placement with respect to irrigation furrows. Soil structural implications of the laneways in different bed sizes will be drawn from the findings of the modelling subproject.

Guidance subproject.

The presentation to this conference entitled "Controlled Traffic and Guidance Systems" by this author outlines the work being done by this project team

Prototype guidance units based on leader cable and ultrasonic technology were designed, constructed and tested as part of this project. The limiting capabilities of both systems were investigated in laboratory tests.

Current work by the guidance project team is concentrating on the evaluation of high speed optical guidance system, under the direction of mechatronics specialist Dr John Billingslie. Future work is being planned around a more sophisticated and

expensive total positioning system.

Overall Project Status.

Project DDI 1L is proceeding to schedule, and will be completed in 1992.

Some preliminary results from the project were disseminated at the Engineering and Soils Research Workshop, held at the U.S.Q. under C.R.D.C. sponsorship in February 1991, and also in the May edition of *the Australian Cottongrower* magazine.

The U.S.Q./C.R.D.C. Workshop also established.a priority listing for future soils and engineering research as reported in the February 1991 issue of the *the AustralianCottongrower* magazine.