

7/92 - 6/93

**COTTON RESEARCH AND DEVELOPMENT
CORPORATION**

**SOIL COMPACTION CONTROL AND REPAIR
PRACTICES FOR CROPPING LANDS IN SUB-TROPICS:
DRYLAND CONTROLLED TRAFFIC SYSTEMS**

Project No: DAQ62C

Research Organisation: Queensland Department of Primary Industries.

**Principal Researcher: Dr D F Yule
Principal Soil Scientist
PO Box 6014
Rockhampton Mail Centre Qld 4702**

Telephone: (079) 360 211 Fax: (079) 361 484

**Administration Contact: Mr P Cronin
Field Crops Sub-Program
Agricultural Production Group
GPO Box 46
Brisbane Qld 4001
Telephone: (07) 239 3501 Fax: (07) 239 3379**

*A final report prepared for the Cotton Research and Development
Corporation.*

Cotton Research and Development Corporation

Summarised Report

Project DAQ 62C: Soil compaction control and repair practices for cropping lands in the sub-tropics: dryland controlled traffic systems

Improved land management practices should include control of soil compaction, runoff and erosion; provision for efficient farm layouts and machinery use; timeliness, flexibility and trafficability; and optimum crop production. Research into these components has defined processes and indicated options but not within a farming system suitable for broadacre, large machinery areas. Research for the irrigated cotton industry has shown soil and efficiency benefits from controlled traffic (CT), and growers have readily adopted CT. Research in dryland areas has shown the benefits of stubble retention and reduced tillage to increase infiltration, and decrease runoff and erosion.

This Project was a preliminary study to develop an R&D program into CT based farming systems for the dryland cotton industry. This Project was closely linked to a LWRRDC / GRDC funded project which studies soil compaction and repair processes and CT for the dryland grain industry. Two specific issues were identified; (a) could efficient CT systems and field layouts be developed for broadacre, large machinery farms, and; (b) could farm layouts include effective soil erosion control.

Several farm visits and farmer meetings were held to discuss these concepts and their potential application on-farm; a workshop was held to consider the soil erosion implications and suggest layouts, for example paddocks; and a detailed proposal was developed.

Generally growers were enthusiastic about CT, but for a variety of reasons. Some wanted to control soil compaction, some saw CT as an effective way to zero till, dryland cotton growers wanted improved trafficability, targeted spraying and to incorporate rotation crops. Major concerns were practical field layouts, infiltration effects, and soil erosion and contour banks.

At the Workshop, the technical issues relating to soil erosion were not resolved due to lack of suitable analytical tools and applicable experience. wheeltracks and furrows will control runoff while runoff is confined within the furrows, and compacted, uncultivated wheeltracks should erode less. However, design criteria could not be established and subsequent analyses with the KINCON model (Geoff Titmarsh and Mark Sallaway) suggested a 3 m furrow / wheeltrack spacing. Furrow capacity was the main limitation. Parameters for the model are poorly defined. CT layouts in paddocks with contour banks create many difficulties. With non-parallel banks CT lines will cross banks which is difficult with current machinery and destructive to the banks. Contour channels reduce the benefits of CT in terms of trafficability, timeliness and flexibility. More waterways may be required.

When growers joined the Workshop, practical issues such as sun glare and wind direction were also raised, but runoff and erosion were the main concerns. Mostyn Fletcher, an irrigated cotton grower at Emerald, detailed over 15 years experience with downslope furrow irrigation and stated that serious erosion had only occurred when furrows overtopped and cross-furrow flow occurred. He was also very positive about permanent beds.

The outcomes of the Workshop and other discussions were: CT systems have enormous potential; on-farm R&D is needed to identify and resolve applied problems; research is needed to develop design criteria for non-erosive farm layouts; and future experience, machinery development and innovative approaches will change current farming systems.

Cotton Research and Development Corporation

Abstract

Project DAQ 62C: Soil compaction control and repair practices for cropping lands in the sub-tropics: dryland controlled traffic systems.

Improved land management practices should include control of soil compaction, runoff and erosion; provision for efficient farm layouts and machinery use; timeliness, flexibility and trafficability; and optimum crop production. The irrigated cotton industry has rapidly adopted controlled traffic (permanent beds) and this project was a preliminary investigation of CT application to dryland cotton where erosion, soil water storage and crop rotation are major issues.

The outcomes of farm visits, a Workshop and model simulations were: CT systems have enormous potential; on-farm R&D is needed to identify and resolve practical problems; research is needed to develop design criteria for non-erosive farm layouts; and future experience, machinery development and innovative approaches will change current farming systems.

Cotton Research and Development Corporation

Final Report

Project DAQ 62C: Soil compaction control and repair practices for cropping lands in the sub-tropics: dryland controlled traffic systems.

Introduction

Soil compaction, soil erosion and water availability have been identified as constraints to the dryland cotton industry at R&D Reviews and QDPI farmer meetings. Past and current research has shown that controlled traffic can reduce the area of compacted soil and increase farm efficiency. Other research is measuring hydrological responses of flow channels in parallel field layouts. However, this research is focussed on the irrigated cotton industry. In dryland areas, surface management research has quantified the benefits of residue retention and minimum tillage for runoff reduction (increased infiltration) and erosion control. However, these results have not been incorporated into effective and efficient land management systems. In the longer term, we seek to develop improved land management systems that incorporate controlled traffic for soil compaction control and farm efficiency, and stubble retention / minimum tillage for increased infiltration and erosion control, for broadacre areas and typical large farm machinery. Other key elements in the dryland cotton systems include crop rotation, runoff control and trafficability. Erosion risk is a major concern with dryland cotton due to low cover levels and interrow cultivation.

Preliminary analyses indicated that controlled traffic could provide the basis for futuristic farming systems. In addition to soil compaction control, permanent wheel tracks reduce fuel usage, tractor wear and tear and capital investment; improve trafficability; allow targeted spraying with reduced chemical costs and environmental impact; and allow inter-row cultivation and side dressed fertiliser. While crop husbandry was improved, the impact on runoff control and soil erosion was unknown. Controlled traffic will direct runoff down the plant rows and the wheel tracks and concentration of runoff could lead to serious erosion. However, analyses indicated that runoff velocities could be non-erosive provided the wheel tracks and furrows did not over-top and carried runoff to a safe disposal site (contour bank or waterway). Possibly fewer contour banks would be needed with further improvement in on-farm efficiency, and drained wheel tracks would provide earlier access after rain and improved trafficability.

This Project was part of a larger program funded by LWRRDC and GRDC which aimed to study soil compaction and repair processes and to develop controlled traffic systems for broadacre grain applications. This Project aimed to extend the program to dryland cotton systems and involved the preliminary stages of grower discussions, collaborator selection and detailed proposal preparation.

Objectives

1. To select farm layout options and possible collaborators.
2. To prepare a detailed proposal for the 1993 - 95 program.

Results

A survey of dryland cotton growers, past and present, was conducted in the Orion and Clermont districts with Agricultural Engineers (Jeff Tullberg and Peter Walsh) to examine the farm machinery for compatibility of wheel spacings and versatility of the equipment. Typical machinery is a four wheel drive articulated tractor and trailed equipment. Most dryland cotton operations use the same traffic lanes except picking, but picker wheel tracks will occur in defined positions in the field. Most growers are capable of controlled traffic during fallow operations and some could plant sorghum using the cotton traffic lanes by using the same tool bar. Wheat is more difficult and wheat planters are generally much wider than the cotton planters. Grain harvesters could fit the tractor wheel tracks reasonably well but the comb width is not the same as the cotton planter. With compromise and inconvenience to the grower it is possible to establish some areas of controlled traffic using all three crops.

Growers consider that rows should be straight so that cultivators etc will follow better and should not be East / West (to avoid sun glare). Growers are concerned that runoff channelled down wheel tracks will cause excessive erosion. Their approach to this is to shallow cultivate the wheel tracks. This may not decrease runoff much but would increase erosion if runoff occurs.

A pilot study was established on Lyle Swaffer's property near Clermont. A topographic survey was conducted on one paddock that included areas of up to 2% slope and one contour bank. In consultation with the grower, a layout was agreed upon which was efficient to farm and provided surface drainage. The layout was imposed at planting and this demonstrated the difficulties of driving straight over long distances and of obtaining uniform guess rows. From this and other experiences it is clear that controlled traffic lines should be established prior to planting as a specific operation or within an operation that is less demanding than planting. Poor tracking has also been identified of both the tractor but particularly the implements. Irrigated growers suggest that furrows make the best tracks but dryland growers are concerned at a perceived erosion risk. Field examinations at the site have identified structural degradation and previous wheeltracks but a technique is needed to rapidly provide a large spatial assessment of soil structure so that relationships can be established with prior cultivations, crop growth, root morphology, etc.

Another small study was established in a dryland area of Mostyn Fletchers farm in the Emerald Irrigation Area. This aims to compare fallow management options after wheat and in particular down slope cultivation and wheel tracks. Treatments are in place but little rain has been received.

A workshop was held in March 1993, to examine the soil erosion issue and to suggest options for non-erosive runoff disposal. A technical session was held with QDPI Soil Conservation Officers to establish design criteria, to examine various configurations, and to develop layouts for example paddocks. In two paddocks we had done detailed topographic surveys and other paddocks had been surveyed for installation of contour banks. Mr Geoff Titmarsh (QDPI, Toowoomba) presented a paper outlining the preliminary results of his Project DAQ 56C (Field Efficient Soil Conservation Layouts). The outputs from this session were then discussed with a group of growers (potential collaborators) to consider questions of on-farm practicality and efficiency.

The outputs from the technical session were confusing. Analytical methods used to design soil conservation layouts were considered unsuitable for the designs that we were proposing and no-one had experience of these designs. The meeting accepted the arguments that frequent downslope furrows would carry low volumes of runoff because of the small

catchment area, but the erosion impact was uncertain. Also, runoff movement in uncultivated wheeltracks was an unknown quantity although sediment concentration would be reduced by the lack of cultivation. The conclusions were that we should research these issues and that we should attempt to model some designs with Geoff Titmarsh and Mark Sallaway. Each example paddock had several options for layout and it was obvious that grower attitudes were also a dominant consideration, ie. layouts were not a paper exercise. Technically there was a need to incorporate controlled traffic with contour banks and the likelihood that more waterways may be required where change in slope occurred.

At the meeting with growers, the major constraints to farm production raised were soil erosion and soil compaction. Issues relevant to controlled traffic were: how does it fit with contour banks; the traffic lines should be as long as possible and preferably straight; sun glare and predominant wind direction should be considered; and increased runoff from downslope wheeltracks leading to loss of water (no temporary surface storage as with contour cultivation) and increased rilling. Some of these concerns were allayed by Mostyn Fletcher, an irrigated cotton grower. Mostyn detailed his 15 year experience with downslope furrow irrigation and stated that serious erosion only occurred when furrows overtopped and caused cross furrow flow. He was also very positive about the benefits of permanent beds.

The meeting endorsed the need for a research program to develop non-erosive layouts and establish practical ways to achieve this high potential, new technology. Several collaborators were confirmed but the on-farm program should address the practical on-farm issues rather than the technical erosion questions. Another experiment was proposed to study long, downslope layouts. The basic design criteria were to retain all runoff within the furrow or wheeltrack where it originated, ie. overtopping must be prevented and each wheeltrack or furrow must convey the runoff to a safe disposal area (contour bank or waterway).

Subsequently we met with Geoff Titmarsh and Mark Sallaway and used the KINCON model to examine various options. The results indicated that a sunken downslope wheeltrack or a furrow every 3 m or less across the slope would be satisfactory for 1,000 m long, 2% slopes. The model predicted that fewer furrows (larger catchment areas) would have insufficient capacity to carry the design storm peak runoff, and therefore would overtop. However, there were doubts about the parameter values used in the analysis and this model does not specifically simulate erosion effects. Based on this modelling and the availability of machinery, we decided to propose for study a 2 m bed system.

Discussion

This preliminary project highlighted the need for efficient and effective farming systems for dryland cotton on sloping lands, the potential of controlled traffic to provide the basis for these systems, the innovation of our concepts for farm layouts and land management (as evidenced by the inability to predict the outcomes), and the clearly identified need for systems research. While many components of improved land and crop management systems have been resolved through research, an efficient and effective system to incorporate these components has not been developed, and consequently adoption has been reduced, crop production reduced and resource degradation increased. For example, contour banks control paddock erosion but not interbank erosion, and decrease field efficiencies by up to 30%; and herbicide technology is available for effective weed control but marking systems are a major limitation.

The major technical constraint is runoff control and consequent soil erosion. Continuing collaboration with Geoff Titmarsh's program should resolve issues and develop design

criteria. Our goal should be to incorporate mechanical design criteria into stubble retention and reduced tillage systems. This should reduce the impact of design failures by reducing the soil erodibility.

Controlled traffic will control soil compaction and, with appropriate layouts, soil erosion and the benefits for improved soil and crop management will support early adoption. Several growers see CT as the only way they can zero till effectively. Spraying efficiency is improved, spraying at night is easy, directed sprays are easy, and the overlap is controlled. Inter-row cultivation or spraying, targeted insecticide spraying, planting between stubble rows, side dressed fertilisers and furrow planting are seen as high potential benefits. CT provides a basis to a farming system that facilitates a wide range of improved practices.

Conclusions, Recommendations and Application to Industry

- Controlled traffic systems have potential to be conservative, productive, flexible, innovative and efficient for broadacre, dryland applications.
- On-farm research is needed to identify and resolve applied problems.
- Detailed research is needed to develop design criteria for non-erosive farm layouts.
- Future experience, machinery development and innovative approaches will change dryland farming systems.

Communication of Results

The output from this Project is the proposal for the R & D program outlined above. This project will be successful if further funding is approved by CRDC.

Appendix

Budget: Total funds contributed by CRDC were \$14,360.

Project QPI14 "Soil Compaction and Repair" is supported by \$180,000 from LWRRDC and \$35,000 from GRDC per year. Total salaries and overheads from contributing organisations (QDPI, CSIRO, UQ, USQ) is estimated at \$516,000 per year.