

REPORT ON PROJECT CS07C:

DR MAC KIRBY ATTEND 2ND INTERNATIONAL CONFERENCE ON SOIL DYNAMICS AND VISIT LABORATORIES IN THE UNITED KINGDOM

1. SUMMARY REPORT

From this visit I gained:

1. A good overview of the state of agricultural soil mechanics worldwide. I was struck by the lack of direction and novelty in some of the work in this field. I am convinced that the work pursued in Canberra for the CRDC is amongst the best being undertaken anywhere in the world.
2. An appreciation of the shift in emphasis in research in agricultural soil mechanics, which in some respects mirrors the situation in the cotton research - the problems of tillage and compaction have been well studied, and are now of lower priority. Some environmental issues are rising in importance, and much soil mechanics research is now turning in these directions.
3. A detailed appreciation of many particular pieces of research, both through the conference papers and through the visits to research centres. There were a number of papers on compaction and stress measurement at the conference. I presented a paper on the uncertainty in compaction predictions that arises from the variability of soil properties. At the various research centres I saw work on permanent beds, agricultural soil mechanics following my own work, the mechanics of root growth, tillage and soil structural problems. I also discussed the experimental design and progress of work by Bruce Blunden undertaken under project CS06C, and reviewed some of the early results.

2. FULL REPORT

During this visit I attended the 2nd International Conference on Soil Dynamics and visited UK centres in agricultural engineering.

What did I gain from this visit? Three things: a good overview of the state of agricultural soil mechanics worldwide; an impression of some of the big issues facing agricultural soil mechanics; and a detailed appreciation of many particular pieces of research, both through the conference papers and through the visits to research centres. I shall deal with each of these things in turn.

The state of agricultural soil mechanics worldwide.

I was struck by the lack of direction and novelty in some of the work in this field. A lot of work was reported at the conference that merely repeats what has been done before. Some work seemed to be pursued for its own sake - for example there is much work on stress measurement techniques that suffers from a lack of analysis about what is actually being measured. (Note: to measure a stress in the soil it is necessary to introduce a metal transducer, which alters the stresses being measured; analysing the alteration caused by the presence of the transducer is mandatory in my view, but was lacking from most of the papers on the topic.) Some of the research into compaction and basic soil mechanics seemed to suffer most from lack of focus; research into tillage performance seemed more dynamic. I am convinced that the work pursued in Canberra for the CRDC is amongst the best being undertaken anywhere in the world.

On the positive side, I met some newcomers to the field who are pursuing new directions, and did make good contributions.

Some big issues facing agricultural soil mechanics

Many that I spoke to (both at the conference and during visits to research centres) commented on the difficulty of obtaining grants for soil mechanics research, and how it was necessary to dress up proposals to give them an environmental focus. This is causing a shift in emphasis of a number of research groups. Other groups seemed unsure of where to go next and were casting around for ways of using their experience to tackle new problems. There was considerable agreement that an important

direction is the interactions between soil management, structure and hydraulic properties and the consequences for drainage, pollution and so on. This was not reflected in papers at the conference. (In fact, this is an area that I have been pursuing for some time.)

In some respects this mirrors the situation in the cotton research - the straightforward soil mechanics problems of tillage and compaction have been well studied, and are now of lower priority. Some environmental issues are rising in importance.

Details of conference papers and visits to research centres

The 2nd International Conference on Soil Dynamics, Silsoe College

The main themes of the conference were soil strength and deformation, soil stresses in agricultural operations, tillage and compaction. The papers on soil strength and deformation included: the fundamentals of the mechanics of unsaturated soils; several papers on different aspects of critical state soil mechanics; measurement of strength under high speed impact; analyses of fracture and crack development. The papers on stress states included: several on measurement methods; stresses around roots; and the influence of tyre and/or tractor operation characteristics. Tillage papers included: force prediction and design methods; mole ploughing and other drainage plough methods; and a paper on repeated failure patterns which included a challenge by the presenter to develop new methods of analysis for this difficult problem. Compaction papers included a number of papers on constitutive models and some finite element work: my paper went beyond this to look at the uncertainty in finite element predictions that arises from the variability of soil properties.

In addition to the oral and poster paper sessions, there were practical demonstrations of various soil mechanics measurement techniques and tillage and compaction performance in the soil bin at Silsoe college.

Visits to UK centres in agricultural engineering.

1. Scottish Centre for Agricultural Engineering, Edinburgh. I was given a general tour of the SCAE and also had detailed discussions about their work on critical state soil mechanics, which is similar to my own work. In the general tour I was shown their range of interests in compaction and soil management. The controlled traffic system that they have developed for potato cultivation has some similarities with that adopted in cotton cultivation in Australia (both being ridge and furrow systems). There are major differences, however, one of the most striking being that automatic guidance is crucial for the runs of a kilometre or more in Australia, but not in the small fields in Scotland!

In the work in critical state soil mechanics, the soil engineering group has developed a novel triaxial soil strength testing machine which offers new ways of soil strength testing. With this, they have investigated the critical state properties of a range of soils in the UK. We discussed mutual interests in the application of this type of work to problems such as root growth.

2. Scottish Crops Research Institute, Dundee. Two areas of the work of the soil science group at SCRI particularly interested me. One was some pioneering work in modelling soil cracking, using a mechanical analogy that I have developed with Chris Moran to investigate soil structure/deformation interaction. The other work was work into root/soil interactions. I discussed at length with Glyn Bengough how critical state soil mechanics and the measurement techniques of the SCAE might contribute to his work on root growth.

3. Silsoe Research Institute. The centre investigates all aspects of agricultural engineering. Of particular interest to soils are:

- The research in precision crop spraying, which appears to be fairly advanced
- The overseas development work which has parallels with Australian ACIAR projects. The work includes research into crop establishment, soil management and water conservation in areas such as India and Africa.

- The soil science group under Tony Dexter is investigating a range of problems including tillage, soil structure and pollution. There is considerable emphasis on environmental impacts of soil management practices.

4. At the Silsoe College of Agricultural Engineering I spent some time after the conference with Bruce Blunden, who was in my project in Canberra, and spent three months at Silsoe working in their soil bin. We discussed the experimental design and progress of this work and reviewed some of the early results. Some results have now been included in a paper:

Kirby, J.M., Blunden, B.G. & Trein, C. R. 1995. Simulating soil deformation using a critical state model: 2 soil compaction beneath tyres and tracks. For European Journal of Soil Science.