Controlled Traffic- The Potential for Precision

J. R. Murray and J. N. Tullberg
Farm Mechanisation Centre
Department of Plant Production
University of Queensland Gatton College

Introduction

Current reasons for adopting controlled-traffic systems are largely based on the crop, soil, energy and timeliness benefits resulting from optimisation of soil compaction in the crop and traffic zones. In practice, permanent and highly compacted traffic lanes provide good machine mobility, higher tractive efficiency and improved timeliness of operation. Removing traffic induced compaction from the crop zone reduces or eliminates the need for deep tillage, improves the efficiency and effectiveness of necessary tillage, and allows more control over soil conditions affecting crop growth.

Enhanced computability with automated and non-random operations is a relatively unquantified, but potentially significant, additional benefit of control traffic. Fixed traffic lanes provide areas where components of irrigation systems or elements of guidance/mapping systems can be permanently located. In addition, fixed traffic lanes (alone, or in conjunction with other guidance devices) facilitate more precise operation through improvement in machine location, stability and ease of operation.

Precision in machinery operation determines how accurately agronomic inputs can be delivered to cropping systems and has major implications for a wide range of cultural practices. For example, improvement in depth control influences tillage energy requirements and seed placement. Improvement in lateral spatial control influences targeting of crop chemicals and facilitates inter-seeding and inter-row cultivation. Precise spatial and temporal control is a prerequisite for the application of sophisticated 'mapping' techniques for addressing aspects of field spatial variability .

Practical applications made possible under precision controlled traffic systems could include, for example:

- Application of row-crop technology to swath-crops
- Freedom from implications of 'guess-rows', 'overlap' etc.
- Improved flexibility in use of current susceptible/non-compatible crop chemicals
- More efficient and effective utilisation of system inputs and reduction in their environmental impacts.

The commercial exploitation of enhanced precision technology is clearly dependent on the outcome of a cost benefit analysis - the economic balance between the cost of acquiring a given level of precision and the sum total of the agronomic, environmental and management benefits realised.

The cost of acquiring precision will be primarily dependent on the level of technology employed and the commercial implications of supply and demand. Both the level of technology/precision required and the likely commercial implications are clearly dependent upon the assessment of the benefits of enhancement in machine operational precision.

At the University of Queensland Gatton College, funding has been allocated for the establishment of a large scale experiment to investigate controlled traffic effects on machine system performance, management, soil condition and crop yield. Assessment of precision effects on aspects of tillage, planting and crop chemical application are central to this experiment. Although the statistical and logistical requirements are yet to be finalised, the general layout of the experimental area and the methodology to be used to evaluate precision effects are briefly discussed below.

Research Program (Assessment of Precision Effects)

1 The Objectives of the Program

The objectives of the research program are, for both horticultural and grain crop production systems, to:

- Determine the current status of machine operational precision in conventional and controlled traffic cropping systems
- Identify opportunities and benefits of increasing levels of operational precision under controlled traffic conditions
- Assess the economic benefits of increasing operational precision and use this information to identify optimum levels of precision for controlled traffic cropping systems
- Determine the likely economic/agronomic benefit from improved operational precision as a result of a change from conventional cropping systems to an optimally precise controlled traffic system

2 Major Items of Equipment

The major items of equipment to be used and their primary role in respective cropping systems are as follows:

- Dowler Gantry with a 12 m track width.
  In the horticultural crop production system the gantry will be used for all crop chemical spray operations, general tillage and as a harvest aid. In the grain

production system the gantry will be used for crop chemical spray operations and sward crop planting.

- John Deere 4040 tractor on 3 m track width.
  This tractor will be used for track maintenance in both systems and for all tillage and row crop planting in the grain production system.

- Fendt 360 GTH with a 1.5 m track width.
  This tractor will be used for specialist tillage, bed forming and planting in the horticultural crop production system

- Purpose built Sampling Frame.
  Essentially this purpose built frame will be a semi mounted mobile platform compatible with 3 m traffic lanes and incorporating a pto powered carriage with side shift capability. This frame will facilitate soil sampling and be able to perform precise planting and tillage and crop chemical application operations over a 5 m row length. Re-positioning this frame over the bed at subsequent intervals will provide the basis for accurate measurements of plant displacement, tillage disturbance etc.. The frame will be used for these purposes in both cropping systems.

3. Experimental Layout

The experimental layout of the research plots and the traffic lanes within them are shown in Figures 1 and 2 respectively. The 24 m wide plots are compatible with two passes of the gantry and are separated by a lane way to facilitate product removal when the gantry is used as a harvest aid. Each block allows two replications of conventional and controlled traffic treatments and three blocks will be allocated to each of the horticultural and grain cropping systems.

4 Methodology

While the actual methodology is still to be determined it is proposed to investigate the tillage (e.g. depth, weed control vs plant proximity), planting (e.g. depth, inter-seeding) and crop chemical (e.g. fertiliser placement, pesticide application efficiency) benefits as a result of increasing levels of machine operational precision. The levels of precision are to be those resulting from (a) rail guidance of tractor and machine, (b) tractor and implement guided by local features, (c) tractor free and implement guided by local features, and (d) tractor and implement free. In this context (a) and (d) represent the highest and lowest levels of machine operational precision respectively.

Methods of assessing the agronomic/economic benefit are still being determined but are likely to include: specific inputs (chemicals, energy etc); plant establishment, survival, and growth; weed kill and application efficiency etc. as appropriate.

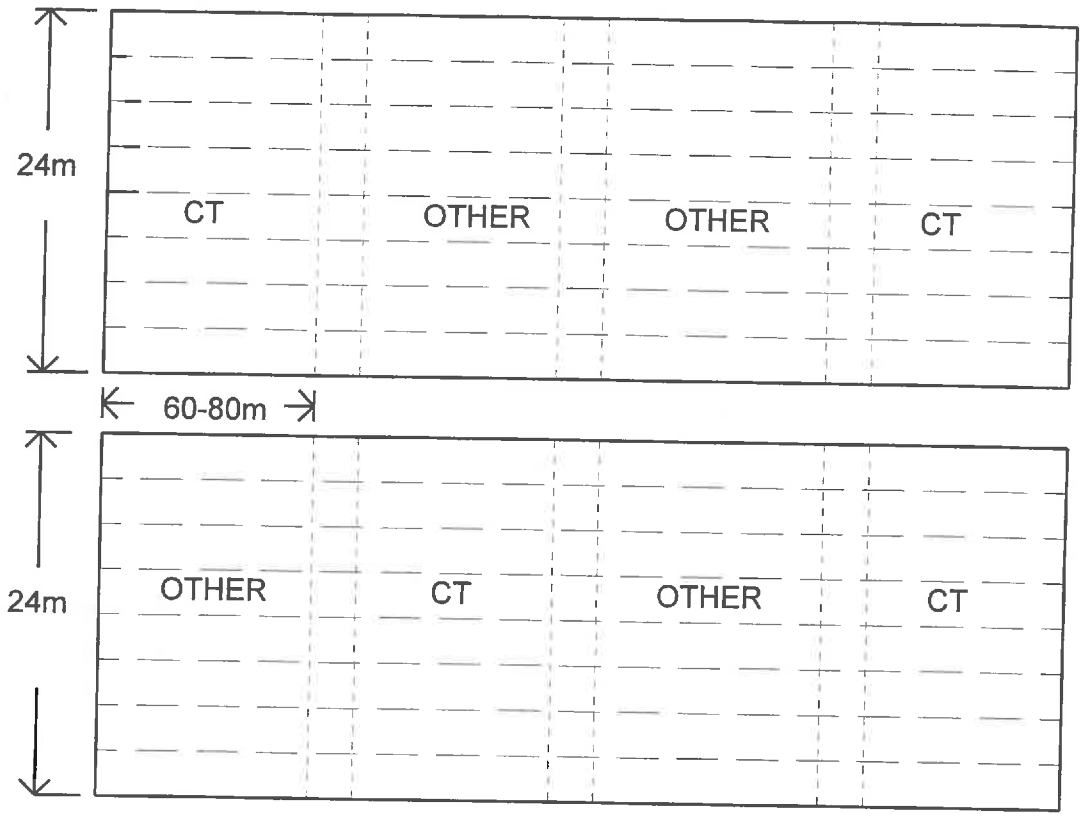

Figure 1. General layout of experimental area

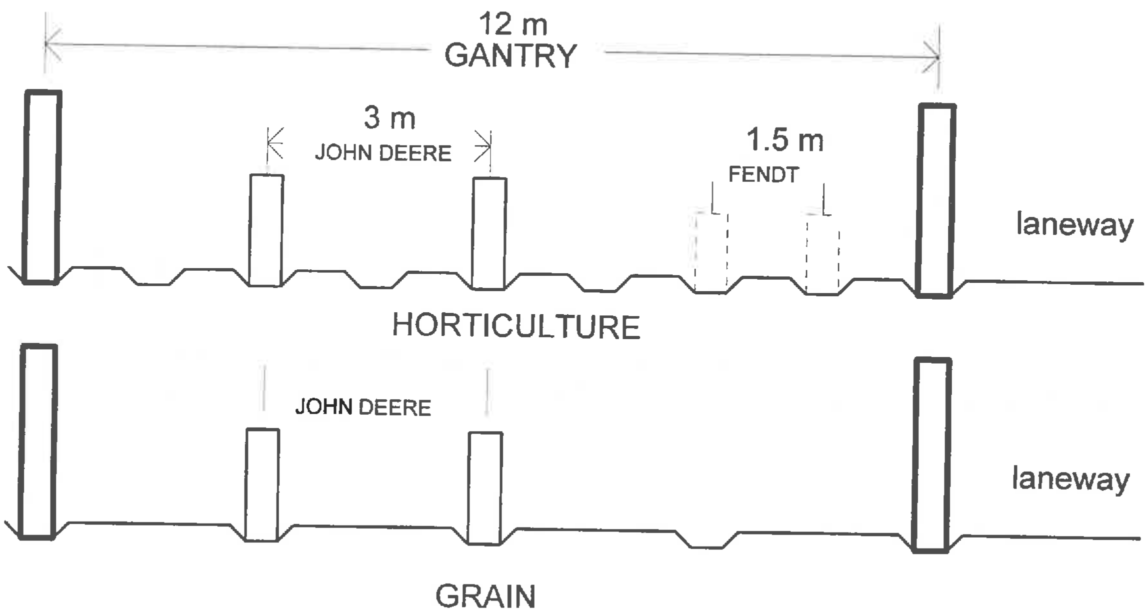

Figure 2. Traffic lane layout within horticultural and grain cropping systems