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Customised Controlled Traffic Farming systems, instead of standard recommendations. Or "TRAMLINES AIN'T TRAMLINES"

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Some suggestions for Controlled Traffic farming equipment have promoted a standard, modular wheel spacing for all situations. Such 'standard recipes' may be suitable for some farming systems, eg based on raised beds, but can be most inappropriate for other systems, eg broadacre agriculture on compactable sands in WA. This paper tries to encourage customisation of Controlled Traffic Farming systems, based on the physical or operational problem controlled traffic is primarily trying to reduce in a specific farming system and location. Customisation essentially applies principles, not standard formulae, and combines design features generated from the main factors which CTF is trying to control or influence.

If any technical innovation is to prove useful and succeed it must be adaptable to a range of agricultural situations. Crop varieties are bred to match variation in climate, soil and market needs, so too controlled traffic technology should be altered to match similar variation of needs.
The arguments presented in this paper are only a 'first approximation' and a basis for discussion.

Design Factors in Controlled Traffic Farming

It is important to focus on the design factors being used in CTF to reduce the specific problems for each farming situation. A design factor is the expression of a solution to a problem the farming system is trying to minimise, or the means of allowing new technology to be employed in the system. Some of the design factors of a Controlled Traffic Farming System, and associated problems are listed below:-

1. Controlling overland flow to minimise water erosion and poor water entry.
2. Improving topsoil drainage to minimise surface waterlogging.
3. Improving furrow irrigation to maximise irrigation efficiency.
4. Improving traction and flotation to minimise excess fuel use.
5. Confining compaction to minimise recompaction and improve soil macrostructure.
6. Keeping all in-crop wheelings on bare tramlines to minimise crop damage.
7. Reducing overlap and misses to minimise cost of seed, fertiliser and pesticides..
8. Improving crop uniformity and quality by minimising variability of growth and yield.
9. Improving timeliness of operations to minimise sub-optimal agronomy.
10. Increasing opportunities for inter-row operations by improving access to the crop.

These design factors will have more importance in some farming systems and locations than others. Thus the customisation of the CTF system should be strongly influenced by the more important, major, design factors. At one extreme there are systems of irrigated vegetable crops in ridges or beds which demand all wheels in the furrow, to maintain furrows and maximise irrigation efficiency as well as quality in the uniformity of the product; encouraging major design factors 3 and 8, above. At the opposite extreme there are alley farming systems which only require traffic 'control' in the more precise layout of the seeding runs and the reduction of overlap to compensate for the loss of cropped area where the trees are planted; encouraging major design factor 7, above. In these situations wheel location is less important and the guidance methods of CTF are more useful. Table 1 attempts to relate the design factors mentioned above to specific examples of farming systems and identify which are the major design factors for each system. A broad observation from Table 1 is the greater number of design factors easily associated with irrigated summer crops and vegetable farming systems. Thus, it may not be suprising that the longest period of development of controlled traffic systems in Australia has been in irrigated cotton production and irrigated vegetable production; greater needs induced earlier innovation. Controlled traffic has also been most readily associated with irrigated summer crops and vegetable farming systems, even sometimes giving the impression that controlled traffic is confined to such designs. Alley farming is associated with few design factors and has not often been referred to as controlled traffic farming. However, once considered in an analysis of 'customised design' it easily classifies as controlled traffic, because it share the design factor 'overlap' with other CTF systems.

Table 1.
Design Factors (✓) and major Design Factors (✓✓) influencing the choice of controlled traffic for some farming systems.

Design Factor > / Farming System	overland flow 1	topsoil drainage 2	irrigation efficiency 3	traction & flotation 4	compaction 5	crop damage 6	overlap 7	quality 8	timing 9	inter-row operations 10
Irrigated summer crops & vegetables	✓	✓	✓✓	✓	✓✓	✓✓	✓	✓ ✓	✓✓	✓
Rainfed crops in high rainfall intensity climates	✓✓	✓✓		✓✓	✓		✓		✓✓	✓
Bed farming in waterlogging soils	✓✓	✓✓		✓✓	✓		✓		✓✓	
Broadacre rotations with broadleaf crops				✓✓	✓	✓✓	✓	✓	✓	
Broadacre rainfed farming on compactable sands.				✓	✓✓	✓	✓			
Alley farming							✓✓			

We can then consider, from Table 1, a wide range of farming systems where CTF is appropriate, based mainly on the identification of design factors which can minimise primary or secondary problems for current farming methods. The farming systems most likely to benefit from CTF seem to be :-

1. Irrigated summer row crops and vegetables, on ridges or beds.
2. Rainfed row crops in high rainfall intensity climates.
3. Bed farming for reduced waterlogging.
4. Broadacre rainfed rotations, especially including broadleaf crops.
5. Broadacre rainfed farming on compactable sands, especially zero-till.
6. Alley farming.
7. Organic farming using inter-row cultivation or flame weeding for weed control.

Some farming situations or systems where CTF seems less appropriate are:-

1. Small irregular shaped paddocks, with many tree and rock islands. Because the shapes are too difficult to accommodate in a CTF layout.
2. Extensive opportunity cropping in low rainfall areas. Because speed of sowing is more important than other physical factors when suitable rains do occur.
3. Low ground pressure farming systems. Because compaction and crop damage have already been minimized by other vehicle modifications.

Design Features derived from Design factors

When we consider this wide range of farming systems more or less appropriate for controlled traffic farming, there are some common design features which can be related to the design factors in Table 1. For example, the use of bare, unsown tramlines. This may be an essential design feature to enable design factors such as irrigation efficiency and uniformity of vegetable products in irrigated agriculture. Sown tramlines are also a useful design feature in a drainage system of bed farming to slow the rate of flow down the furrows and reduce erosion risk. In broadacre cropping, to reduce compaction and improve access into the crop for spraying and spreading, some tramlines can be left unsown and some sown; depending on the relative widths of equipment and spraying strategy. The location of equipment and vehicle wheels, the use of marker arms and guidance systems and the use of single or dual tyres or tracks, are other design features associated with certain design factors which should influence a customised controlled traffic farming system. Some of these design features are related to various design factors in Table 2.

Table 2. Design features related to design factors for controlled traffic farming systems (✓).

Design Factor > Design Feature V	over-land flow	topsoil drainage	irrigation efficiency	traction & floatation	comp-action	crop damage	over-lap	quality	timing
all bare tramlines	✓		✓					✓	
all sown tramlines		✓							
some bare tramlines						✓			✓
all wheels in tracks	✓	✓	✓	✓				✓	✓
heavy vehicle wheels in tracks					✓				
sprayer and spreader wheels in tracks						✓			✓
guidance system for each pass of seeder							✓		
possible use of duals at seeding				✓	✓				
seeding up and down slope	✓	✓	✓		✓				
seeding across slope	✓				✓				
seeding around paddock					✓				

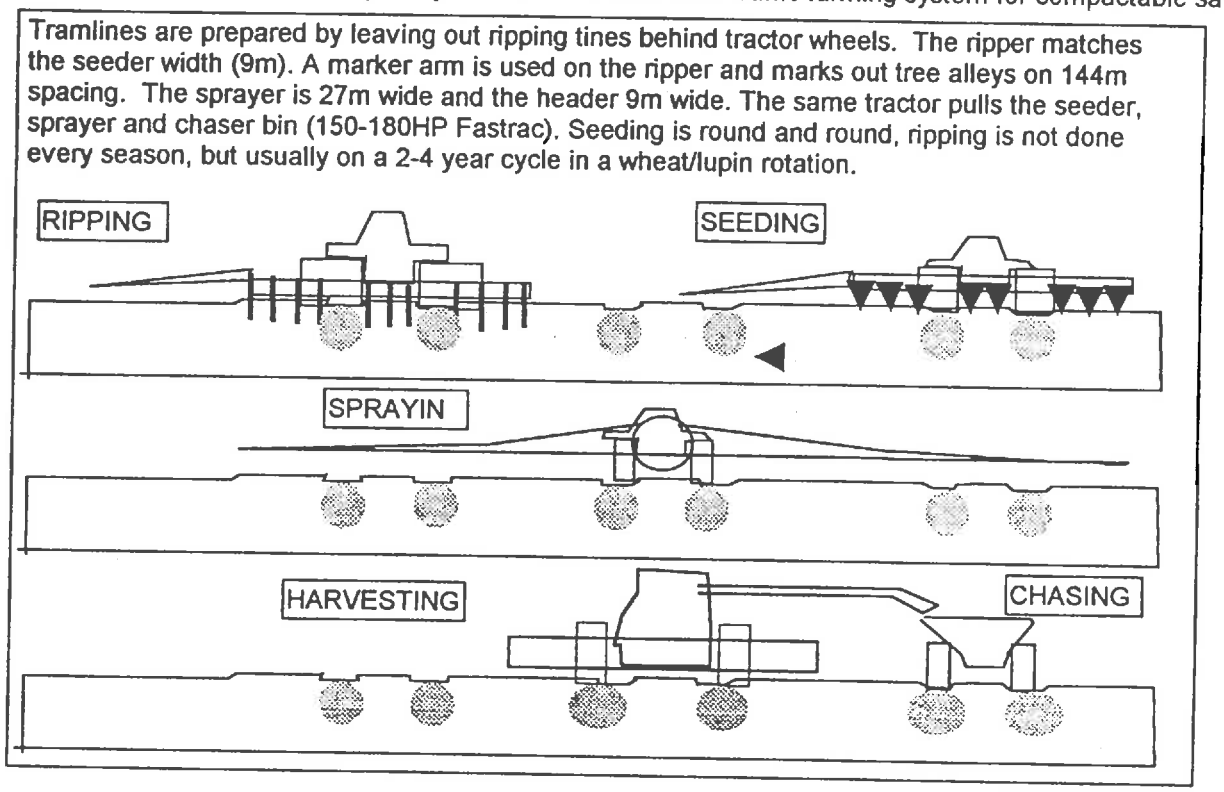
Thus, if compaction and overland flow, as well as crop quality need to be controlled, then beds or furrows up and down or across slope are appropriate with all wheels in furrows. However, if compaction and overlap need to be controlled, then only heavy wheels need to be on tramlines and a guidance system, such as marker arms, is needed. Clearly, there are many possible combinations of design features of controlled traffic systems and some current grain cropping systems are hybrids of random traffic, low pressure traffic and controlled traffic tramlines. E.g. seeding with large 4WD tractors using triple tyres and spraying on tramlines for with tractors using single tyres or tracks.

Some features and factors which are identified as more important to a customised system can be prioritised in the development of a controlled traffic farming system using this analysis. An example would be deciding to base the tramline spacing around the wheeltrack of the header, because it is the least able to be modified and creates the most compaction in wet harvests. Then matching the widths of tractors and self propelled sprayers and seeders to the width of the header wheel track and swath in later financial investments.

Example of a Customised Design

This is being used in a GRDC funded project to demonstrate and evaluate controlled traffic for broadacre grain production in WA. It is in a 170 ha paddock at Wyalong farm near Mullewa.
The customisation of this prototype Controlled Traffic Farming System (illustrated in Figure 1.) has a major design factor of confining compaction. Compaction of these sands can restrict cereal yields by 20-40%, depending on the compactability of the sand, nature of the compaction and the type of growing season. This system tries to confine the heaviest wheelings, from the seeding tractor, sprayer, spreader, header and chaser bin to permanent tramlines.

Figure 1. An illustration of a prototye customised controlled traffic farming system for compactable sands



Therefore major design features are all heavy wheels in permanent tramlines, seeding around the paddock (because there is no need to control overland flow or drainage), possible use of duals at seeding (because there is little risk of knocking down raised beds or ridges) and only the tramlines for the spray traffic are unsown (to minimise yield loss from unsown rows). The tramlines are established at ripping by removing each tine behind the inner tyre of the 450HP 4WD tractor used for ripping. The ripper uses a marker arm to increase the accuracy of layout in the paddock and matches the airseeder width and the sprayer is three times the airseeder width. Thus the tramlines can easily be used by the seeder and the 2nd, 5th etc tramlines are unsown and used by the sprayer. At harvest the header front wheels are about 300mm wider than the tramlines. The chaser bin is pulled by the same tractor used for seeding and spraying and can sit on the adjacent tramline for unloading the header on the move. The unsown tramlines are also visible after harvest for spraying summer weeds. The next stage is to have a spreader bar to top-dress fertiliser from the tramlines on a 27m width.

Conclusions

1. The need for cusomised designs and lateral thinking.

- A customised design based on an analysis of design factors and features can be a flexible approach to tailor a CTF system to the needs of a specific enterprise. An analysis such as that presented here will even showing the steps which could be used to prioritise such a development.
- There are opportunities for lateral thoughts and 'original' ideas when fitting the system together. For example the balance between urgency to harvest a barley crop, at risk of staining in anticipated wet weather, and the later opportunity to 'renovate' harvest compaction by selective deep tillage.
- Adaptation of CTF systems is also important to accommodate complementary innovations, such as inter-row weed control, inter-row fertiliser placement, relay planting between rows of existing crop.
- Some WA farmers are even trying 'one wheel tramlines' i.e. one wheel track is left unsown, not for trick driving on two wheels, but to provide some easy guidance in the absence of automated tramline controllers for airseeders.

2. The need for automatic tramline controllers for airseeders

- Much more versatility of CTF design for airseeders could be achieved if there were commercial products which automatically shut off or opened seeding rows on airseeders which go round and round the paddock.