Machinery Needs for Controlled Traffic Farming on Dryland Grain farms.

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The ongoing resource based benefits of Controlled Traffic Farming (CTF) are well documented in these proceedings, therefore this paper will only provide a summary. They are:-

- decreased soil erosion
- decreased soil compaction
- increased water infiltration
- increased root growth
- increased water stored
- increased surface cover
- improved soil physical fertility

Likewise, the innovations and opportunities for management allowed by CTF are:-

- planting
  - directed planting
  - furrow planting
  - relay planting
  - improved timeliness
- spraying
  - trafficability
  - timeliness
  - night operations
  - directed spraying
- operational efficiencies
  - no overlap
  - no misses
  - no double spraying
  - no double planting
  - low draft
  - high tractive efficiency
- agronomic manipulation
  - side dressed fertiliser - summer and winter crops
  - increase population beside wheeltracks
  - variable row spacing - for wheeltrack identification-summer/winter
  - directed tillage -inter-row or under-row cultivation
    - weed control
    - promote secondary root development in corn and sorghum

There are opportunities, yet to be tested in the field, to manipulate stubble and plant phenology to achieve more reliable crops and planting opportunities. Certainly, there are many possibilities afforded by this system to be explored and refined.

GLOSSARY

Operational width	- the width of a harvester platform, spray boom or planter.
Wheel Centres	- the distance, left to right, from the centre of one tyre or track to the centre of the other tyre or track.
Wheeltrack width	- the width left unplanted for a tyre or track to run on.
Controlled Traffic Farming	- a crop production system where the paddock is divided into crop zones and wheel zones on a permanent basis with zones orientated to provide drainage of surface water to a safe disposal point.
Guess Row	- the row created between subsequent passes of an implement, should equal row spacing.

CURRENT SYSTEMS

Grouping systems by wheel centres results in three basic scenarios.

60"(1.52m) - 4WD ute used for spraying, often in conjunction with 15"(381mm) row spacing. Harvest equipment not included in system, although operational widths may be the same.

~80" (2.03m) - Truck, tractor or 4WD ute used for spraying. Harvest equipment not included in system, although operational widths may be the same.

120"(3.048m) - Tractor or specialist high clearance sprayer used for spraying. Harvester in system up to operational widths of 30 ft (9.144m).

Major areas of concern in these systems are:-

1. Incompatible wheel centres between spray rig, tractor and harvester.
2. Incompatible operating width between harvester and planter.
3. Implement depth wheels not standardised.
4. Many of the benefits depend on accuracy of operations.

Which of these basic systems best suit CTF?

By definition, no wheels should run on the crop zones. It is also expedient to minimise the total number of wheel zones in a paddock. This implies major modifications would be needed to the harvester and ancillary equipment, chaser bins etc., before they could be used in a either a 60" (1.52m) or 80" (2.03m) system. Similarly, truck and 4WD spray systems are unsuitable in a 120" (3.048m) system, however alternatives do exist. The 120" (3.048m) system with variable operating widths, appears to offer the only practical solution at this stage. Modules of 160" (4.064m) have been promoted in the past, but require modification to both tractor and harvester as well as limiting road transport options.

The future of CTF depends on overcoming the lack of standardisation of wheel centres, increasing the operating width of the harvester and the development of an efficient and effective guidance system. The incorporation of crops, such as dryland cotton, which require specialist harvest equipment, pose an additional challenge.

How then, can we make a good system better?

The Way Forward

1. Wheel Centres

Tractors

Tractor manufacturers have been quick to respond to incompatibilities between tractors and harvesters, with almost all offering tractors on 120" (3.048m) centres, albeit with some provisos. Commercial systems are now available allowing farmers to match harvester, tractor, air seeder cart and spray rig on 120" (3.048m) centres provided they:-

- use either a high clearance, self propelled sprayer
- or a tractor mounted or drawn trailing unit
- and do not exceed 30 ft (9.144m) operational width
- for the harvester.

While platforms are available to 42 ft (12.8m), they are offset to the right, making them unsuitable for CTF. In expansive broadacre areas, operational widths of 30 ft (9.144m) or less has limited appeal. What opportunities exist to overcome these difficulties?

One solution uses 60 ft (18.28m) or 90 ft (27.432m) as an operational width for spraying and planting and a 30 ft (9.144m) harvester running on it's own permanent wheeltracks. However, this results in ~18% of the paddock under wheeltracks, compared to ~9% if we increase the harvest operating width to match the planter.

Spray Technology
Truck and 4WD based spray systems will not suit a 120" (3.048m) system. It may be possible to extend the axles on a truck to cater for the wider centres. A company in Sydney does axle modifications for oil and gas exploration vehicles, however it may be difficult to register as a road going vehicle.
Spraying choice within a 120" (3.048m) system is therefore limited to either high clearance machines or tractor based units. High clearance spray rigs have the disadvantage of high capital cost per unit, although this is offset by higher work rates, better operator environment and the ability to apply pre-harvest sprays. The use of tractors offers some extra utilisation of capital, although this is negated if a second tractor was needed to cover the area. Castor (1998) recommends one tractor and 80 ft (24.384m) boom spray to 4000 acs (1618ha) of cultivation. However, there are many growers farming areas greater than this with only one tractor. Without suspension, tractor spray speeds are limited to about 10 mph. (16kph) and in Queensland at least, the opportunities to extend the operational width past 80 ft (24.384m) are limited. Given the importance of timeliness to spray efficacy, additional capacity, in the form of a contractor or alternative sprayers appears necessary.

The challenge, indeed the opportunity, is before the Australian manufacturing industry to develop a low cost, high clearance spraying system for 120" (3.048m) CTF system.

2. Operating Width
Grain platforms could be made wider, especially the draper types. The use of multiple ~ 20 ft (6.096m) sections would substantially improve ground following ability and reduce harvest losses in undulating terrain. This may allow operating widths up to 60 ft. (18.288m) Grain could be moved from the harvester to transport by unloading to either the front or rear of the harvester. The benefits from increasing the operating width of the harvester are:-

1. The harvester can operate at design capacity in light crops without excessive speed.
2. The number of wheeltracks in a paddock is reduced.
3. Timeliness of harvest is improved through improved trafficability. (One grower was able to harvest on the wheeltracks two weeks earlier than the rest of the paddock.)

Swathing or windrowing prior to harvest is a technique being evaluated for CTF. Early investigations of swathing in QLD yielded mixed results and were limited by the short duration of the study. (Tullberg & Rogers, 1982) Later reports indicate the technique is widely used in southern and western regions, particularly for canola. (Greenslade, 1993)
The attractions of such a system involves faster dry down, less lodging, decrease in losses due to wind, rain, hail & insects. It promotes even ripening and allows earlier starts and later finishes to the harvesting day. (Greenslade, 1993)
With these benefits, how can we make it work under our conditions?
The main difficulty reported by Tullberg & Rogers was the inability of the stubble of light crops to support the windrow. However, target plant populations for cereals have increased significantly since 1980 - 81, as has row spacing. What is the effect of this interaction in a CTF system?
CTF is based on zonal management, it is therefore possible, to create a zone of narrow rows specifically to support a windrow, between the wheel tracks. This is necessary because:-

1. Row spacing up to 18" (45.7cm) are common in CTF systems. This has been influenced by:-
   a) the high capital cost of zero till planting equipment (>$1,000 / row.) and
   b) stubble handling capacity.
2. Windrows need <10" (250mm) row spacing for support.(T. Greenslade, pers. comm.)

The benefits of swathing to CTF are:-

- only the narrow rows need specialist trash equipment therefore lower capital cost.
- allows harvester to match the operating width
- facilitates use of PTO harvesters with pick up (less capital investment)
- allows better utilisation of horsepower and capital (main tractor used for swathing and harvest)

Winter cereals and all legumes appear to suit the system. Summer crops grown in the region, corn, sorghum and sunflowers present more difficulty. There are anecdotal reports of sorghum being swathed in the Orion district (CQ) in 1995 to prevent losses due to lodging. If sorghum could be swathed successfully, it would provide significant management options with regard to pre-harvest spraying and lodging avoidance.
With corn, cotton and sunflowers requiring some form of specialised harvesting, there appears little option at this stage, other than continued direct harvesting with the harvester not necessarily following CTF wheel tracks.
Swathers are available up to 60 ft (18.28m) and one company is assessing a 72 ft. (21.9m) model, allowing the harvester to have an operational width compatible with most CTF systems. The expectation is that modern harvesters have sufficient capacity to cope with the increased crop flow, given throughput is usually limited by forward speed, rather than processing capacity.

3. Implement wheels
Implement wheel spacing does need to be standardised across the industry. Implement wheels can fit between rows without modification to plant spacing, whereas this is not possible with tractor and harvester tyres or tracks. Ideally, gauge wheels should run on their own permanent wheeltracks with scrapers or spray nozzles for weed control. As a compromise, vertically adjustable tynes behind wheels could be used or placed in front of the tyre(s). This enables the majority of tillage to be carried out at optimum depth and avoids the draft penalty associated with setting the whole machine to dig weeds from its own wheel tracks. All equipment, whether trailed or mounted, should run the outside wheel in the guess row.
The placement of wheels across an implement could vary with the operating width. Large trailing machines may need wing modules widths of either 120"(3.048m), 160"(4.064m) or 200"(5.08m) to achieve stability and various transport needs.

4. Accuracy of Operations
Many of the innovations and opportunities occur because CTF is a system allowing operations to be carried out in close proximity to plants or in relationship to previous or future operations. In practical terms, this implies a high degree of skill on the part of the operator to carry out such operations repeatedly and accurately for the duration of his or her shift. Current systems are predominantly based on the use of marker arms for initial marking and following the wheeltracks for subsequent operations. Depending on the operator, accuracy's in the order of $\pm$10" (250mm) are possible. Various organisations and individuals have funded the development of guidance systems in an attempt to provide a higher degree of accuracy to every operation, regardless of the skill level of the operator. The advent of dGPS and automatic tractor steering systems, in conjunction with existing technology, are signs of light at the end of the tunnel. However, much remains to be done before the humble marker arm is consigned the way of the foam marker, to the dump!

Conclusion
CTF is a farming system which delivers enormous benefits in terms of resource sustainability, improved agronomy and efficient use of labour and capital. The continued development of machinery systems to adequately service those opportunities is the challenge before us today.

References
Castor, M. (1998) GRDC Adviser Updates, Dalby,.
Tullberg, J.N. and Rodgers, I.L. (1982) "Time Costs in Extensive Agriculture" *Proceedings of Agricultural Engineering Conference* pp57-62. Institute of Engineers, Australia. No. 82/8
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