Healthy Country

managing the land for healthy waterways

Grower tour investigating European controlled traffic farming

Visiting CTF workshop and related farms

June—July 2009

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Grower tour to European controlled traffic farming workshop and related farms

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FarmFLOW
growth through good practice

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Executive summary

The Australian vegetable industry is increasingly interested in the potential for controlled traffic farming (CTF) in their production systems. While CTF has a long history in grain industries, it is still very new to other agricultural industries like sugar cane and horticulture. The practicalities of implementing CTF in horticulture are not straightforward. This report outlines the findings of a 2009 grower study tour to Denmark, the Netherlands and the United Kingdom to investigate the development of CTF, particularly in vegetable production. It covers the status of CTF in horticultural systems in Europe, the benefits and barriers to adoption and the application to vegetable production in South East Queensland (SEQ).

Currently the extent of implementation of controlled traffic farming in vegetable production in Denmark and the Netherlands is that of Seasonal Controlled Traffic Farming. This involves maintaining wheel tracks for the duration of the crop up to harvest however wheel tracks are not permanent between crops. Currently there is no common wheel spacing across the countries visited where spacings visited vary from 1.5–3.2 m. Organic vegetable production in the Netherlands has the greatest adoption of CTF. These production systems rely on CTF for weed control and, in addition to tractor guidance, the use of implement guidance for increased accuracy is also widespread. CTF is currently less developed in the UK and is primarily limited to grain cropping. Very few of the production systems visited had made serious attempts to incorporate harvest operations into a CTF system. Those producers who carried out their own harvest operations had more success with incorporating harvesting than those that rely on contractors.

Those growers currently implementing Seasonal Controlled Traffic Farming believe that the benefits from this are sufficient to offset the costs of implementation. The initial motivations for moving to a CTF system were to avoid the impacts of soil compaction. The key benefits identified by European producers so far include: reductions in tillage operations resulting in reductions in fuel use and tractor power requirements; improved drainage and filtration; improved uniformity of product; and improved timeliness of operations.

One of the most significant barriers to the implementation of CTF in SEQ is that vegetable growers do not fully appreciate the damage that compaction and intensive tillage does to their soil. Simply 'buying a bigger ripper' should not be the accepted solution in the industry.

Incorporating the harvest operation remains the most significant challenge for those implementing CTF in vegetables because of the diverse range of:

- vegetable crops grown on a farm;
- associated harvest, handling and transport machinery;
- track widths (no common wheel spacing across vegetable production).

Most machinery modifications have taken place ex-factory and without warranty and can be limited by transport logistics of moving machinery on public roads. GPS guidance is considered an essential component of a CTF system in vegetables however, the cost is still a barrier to adoption for many.

Vegetable production in South East Queensland currently relies on intensive tillage, diverse machinery and high inputs. CTF has the potential to provide significant gains to the SEQ vegetable industry through greater resource efficiencies and resilience to climate change but the practicalities of implementation are not simple. Machinery and harvesting configurations will be the most significant issue to address in the adoption of CTF in SEQ, particularly as many growers rely on contracted harvesting. Involving these contractors in the implementation of CTF will be critical. The other key issue will be wheel track spacings. An agreement on common wheel track spacings would assist in developing the critical mass necessary for machinery manufacturers to see the potential for harvest machinery modifications to suit a CTF system.

Tour report

Introduction

The vegetable industry in Australia is showing a growing interest in the benefits that a controlled traffic farming (CTF) system can bring to their operations. The basics of CTF are simple—to maintain the same machinery wheel tracks in cropping paddocks year after year. Soil health and crop productivity improve by eliminating compaction from the crop growth zone and creating permanent compacted wheel lanes that allow more efficient machinery operation. While this seems a very logical approach—plants grow better in soft soil and wheels work better on roads—the realities of implementing CTF are not straight forward. This is particularly so in the vegetable industry where the enormous diversity of crops grown makes achieving equipment commonality one of the great hurdles to the successful implementation of a CTF system.

A grower study tour to Denmark, The Netherlands and UK investigated the state of development of controlled traffic farming in Europe, particularly for vegetables and mixed crops. The group consisted of growers (from Tasmania and Queensland), contractors, private consultants and staff from the Tasmanian Institute of Agricultural Research and the Department of Primary Industries, Parks, Water and Environment.

The status of CTF in horticultural operations in Europe

In Denmark and The Netherlands CTF is being adopted by both organic and conventional vegetable growers, with experience amongst the growers ranging from 3–9 years. At this stage, all vegetable growers are actually using Seasonal Controlled Traffic Farming (SCTF). SCTF is a system in which the location of traffic lanes is maintained for primary tillage and throughout the growing season up to harvest. However, because of a lack of harvest equipment compatible with CTF, or dependence on non-CTF contractors, it is difficult to ensure harvest traffic is restricted to the compacted traffic lanes. In some cases, the traffic lanes are cultivated between seasons, so while the entire field may be cultivated, it is possible to return to the same track location using GPS guidance. This means that, even though the soil has been cultivated, the soil that is compacted for the wheel tracks this season is the same soil that was compacted last season.

Figure 1. The problem with SCTF—when harvest machinery doesn't match, the compacted area of soil increases dramatically.

Track widths used on the farms visited ranged from 3.1–3.2 m, although there are also a number of operators working on narrower track widths, such as 1.5–1.6 m. Tractor modifications to achieve wider track widths include cotton reel extensions and axle replacement. A number of different approaches were observed, most having been arrived at through the process of trial and error, until arriving at a solution that worked. Many of the failures have been centered around the smaller horsepower tractors where axle strength is inherently limited.

The choice of track width in Europe seems to be mostly guided by existing spatial and row configurations, hence a farm on 1.6 m will logically move to 3.2 m under CTF. While this is a 'simple' change in a mathematical sense, it ignores issues surrounding transport and road travel, and also ignores the opportunity to consider alternative crop row spacing arrangements that may offer additional yield improvements in a CTF system. The other advantage of the wider track width is that it is easier to integrate cereal harvest, with cereals being an important component of the vegetable rotation.

The level of adoption of CTF by organic growers in The Netherlands was remarkable. The system seems to provide a fantastic solution to the inevitable weed control issues encountered in the absence of herbicides. Many of the growers have found GPS controlled implement guidance of great interest. It is not sufficient for just the tractor to be guided, it is also important that implements track accurately, allowing much more accurate inter-row weeding. Some experiences suggest that weeds are reducing under CTF, although no clear explanation was given as to why this might be the case.

Figure 2. Tractor on 3.15 m track width with guidance on both the tractor and the implement. (BioTrio Farm, The Netherlands)

CTF in the UK is far less developed and is more common in grain cropping. Of the various vegetable operations visited in the UK, it was quite surprising that only one has made significant moves toward CTF. This operation grows wheat, potatoes and onions, with 7500 t/y of onions being the major crop. The farm is in the process of conversion to CTF and uses ± 2 cm RTK[1]–DGPS[2] for tractor guidance. The CTF system will be based on a 1.83 m track width since the current equipment inventory includes 35 pieces of equipment on that dimension. It is estimated that 65 t of machinery passes over the tracks in the process of establishing an onion crop, highlighting the scale of the potential soil compaction issue.

Some land is prepared with a stone windrower (particularly for potatoes and onions) and the aim is, with guidance and CTF, to not have to repeat that operation in coming seasons. Slopes are a challenge for CTF and implement guidance is judged to be essential, although not yet in place.

None of the farms visited on the tour had, at present, made serious attempts to incorporate harvest operations into their SCTF system. However there was certainly recognition that this was the weak link in the system at the moment and there were varying degrees of effort being made to address this. In general growers who conducted their own harvesting operations were further down the track in this regard, compared to those that relied predominantly on contract harvesting. While there has been significant lobbying of contractors, little headway has been made to date in changes to harvest equipment.

There is a belief among the growers that even if a full collection of compatible machinery is not yet available, the advantages of SCTF are sufficient to warrant the investment. These include observing improved yields, timeliness and labour efficiency, better harvest recovery in some crops and reduced tillage through the use of SCTF.

The on-farm benefits resulting from adoption of CTF

It was evident from the farm visits that there were a multitude of on-farm benefits that a CTF system is able to facilitate.

- All growers reported a reduction in both the number of tillage operations and the time taken to complete these operations. This results in lower fuel usage and the potential for a smaller investment in tractor power and tillage equipment inventory. However, instead of downsizing tractor horsepower, with the lower draught requirement in a CTF system, many of the farms had instead chosen to increase their implement widths.
- Improved drainage, infiltration, aeration and soil porosity. This results in increased water holding capacity, with more efficient capture and storage of rainfall and/or irrigation water in the crop root zone. This has had enormous implications for many of the vegetable farms visited, which are exclusively rainfall reliant. Seeing vegetables growing successfully without any sort of irrigation available was quite incredible.
- Most growers reported a reduction in the level of soil borne diseases which was attributed to better aeration, drainage and soil biology.
- There were generally far fewer clods in hills/beds, leading to improved quality and uniformity and reduced harvest costs for potatoes, carrots and onions
- Research conducted on one farm indicated that over a four (4) year period, average yields of crops increased by 6–10% as a result of SCTF. They believed that, for their operation, an average yield increase of 2.2% would be sufficient to pay the costs of conversion to SCTF.

For many of the growers visited the above benefits were derived from avoiding soil compaction in cropped areas and were the initial motivations for converting to CTF. As their experience with the system grew, another benefit applicable to all vegetable growers emerged:

- Timeliness—'weather proof' wheel tracks and the resultant improved trafficability of paddocks was a major benefit. Timeliness of operations often sets growers apart from each other and is of critical importance where planting schedules are often narrow and/or well defined to ensure consistent market supply.

The major hurdles to CTF adoption and how they are being addressed

Track width standards

CTF operators in Europe use track widths ranging from 1.5–3.2 m for vegetables, while cereals in the UK are based on a mix of dimensions from 2.2–2.8 m. Most tractors have to be modified ex-factory, often without warranty cover, to achieve a track width over 2.2 m. Many EU growers seem well attached to the 3+ m option for track width, despite the obvious transport logistics issues. It appears they require either limited road transport, travel mostly on quiet roads or just accept that their 3+ m wide machinery will get

Fig. 3. New front axle, cotton reel and rear axle modifications to provide 3.2 m track width on tractors (Kjeldahl Farm, Samsø, Denmark)

Figure 4. Some experiences in track width modifications were gained the hard way.

right of way. Some countries, including Australia, legally allow machinery up to 3.5 m total width with various escort requirements, but the logistics of moving such equipment in densely populated areas can be a problem. The limit in other countries is 3 m total overall width, which creates problems for machinery on a 3 m centre-to-centre track width.

Machinery manufacturers are reluctant to move down the path of building equipment specifically for use in CTF until there is a more defined market. Until that happens, individuals will continue to modify equipment to suit their own needs. It was generally agreed that if tractors were grouped into two categories—extendable up to 2.5 m and from 2.5–3.5 m without ex-factory modification—then manufacturers may be able to include those design requirements in a range of models and meet the needs of most people wanting to engage in CTF.

An often overlooked impediment to achieving a standard is the mix of metric and imperial dimensions that arise as a result of North America being the major machinery manufacturing base and market.

Harvest equipment

Management of harvest traffic remains the major hurdle for the adoption of completely integrated CTF systems, particularly in vegetables. Vegetable harvest the world over is characterised by significant materials handling considerations of 50–100 t/ha yields and 15–20 t loads. Harvest machinery is typically expensive, and therefore requires a high number of annual work hours for economic viability. In addition, a diverse range of vegetables grown means a diverse range of harvest machinery. This places considerable economic pressure on the process of converting to CTF as the benefits gained have to be sufficient to offset the costs over a range of crops and harvesters. This is a significant difference to the grain industry where the range of harvesting machines is far fewer.

The challenge of vegetable harvest machinery suited to CTF is one of economics, not technology. There is something of a ‘chicken and

egg' syndrome occurring at present where growers find it difficult to move to a fully integrated CTF system without suitable harvest equipment, and manufacturers are unlikely to provide the necessary equipment while the market is small, unless individuals are able to pay for custom built machines. The inability of the industry to settle on a uniform track spacing further compounds the problem of integrating harvesting gear.

GPS guidance

There was a clear message from all the growers practicing CTF that RTK GPS guidance is considered essential. The pass-to-pass and season-to-season repeatability of 2 cm RTK guidance is the cog which makes the system work. However, like Australia, cost is still a barrier, particularly for many vegetable operations, which compared with most grain operations, are often operating a larger number of smaller tractors, all requiring steering kits, receivers, etc.

Certain parts of Europe and UK are well serviced with GNSS[3] CORS[4] RTK networks[5] which eliminate the need for growers to buy a base station for use with their guidance system. CORS networks deliver correction signals for machine guidance via the internet or mobile phone network to clients operating within range of the network. Accuracy, repeatability and reliability are equal to that obtained with fixed base stations.

Victoria is the most advanced state in Australia in the development of CORS networks, with expansion occurring in New South Wales and Queensland. This has the potential for great benefit to growers and contractors who will be able to operate 2 cm RTK guided equipment in a range of areas without the requirement of a fixed base station.

Applying CTF to horticulture in SEQ

The CTF mindset

It is important that the culture of vegetable growing recognizes the impact of wheel track damage, and therefore the need to both minimize it and confine it to areas where crop is not growing. The traditional solution of 'buy a bigger ripper' should no longer be acceptable.

Continuous vegetable production, as practiced across Australia, is an intensive industry relying on high inputs, excessive tillage and a diverse range of equipment. Adoption of CTF has the capacity to reverse this situation through maintenance of permanent wheel tracks but in order to do so requires a level of management and machinery integration not previously required in the industry.

Many growers recognise the limitations of current farming methods, particularly in relation to maintenance of soil quality and the expense of production practices, including extensive tillage. Few changes to production systems can address the more efficient use of resources and increased resilience in the face of climate change as effectively as CTF.

There is no doubt the Australian vegetable industry stands to gain significantly from the adoption of CTF.

Set up costs

Securing these benefits will not be without an initial cost outlay, as the adoption of fully integrated CTF requires a long-term vision and commitment to change, with implications not only for machinery inventory, but also farm layout, irrigation infrastructure and farm management practices. Some of the changes to crop management can only be postulated at this stage and are likely to require in-field research to refine.

Machinery and harvesting configurations are probably the most significant issues to address in the adoption of CTF. While many tractors, planters and tillage implements may be reasonably easy to reconfigure, harvest equipment remains the dominant problem, particularly in an industry that has a high reliance on contractors, not all of whom will necessarily see the value in investing in new or modified machinery to fit a still-evolving farming system. However I believe for anyone considering CTF, there needs to be a genuine attempt to include the harvesting operation into the system. The process of conversion to CTF requires a great deal of thought and planning and this will take some time to play out.

Pathways to adoption

The Tasmanian vegetable industry is vigorously debating the merits of various track width spacings at present, with the goal of finding a consensus on a standard wheel spacing. A 2 m system looks the most likely at this stage. For most growers, this wheel spacing serves to minimize both transport difficulties and the percentage of paddock wheeled by machinery. This also has the potential to deliver the critical mass required to convince machinery manufacturers to build equipment with CTF firmly in mind, at least locally. The situation with wheel spacings in South East Queensland (SEQ) is certainly similar to the Tasmanian industry, where there is a mix ranging from 1.5 m though to 1.8 m. The majority of spacings are probably at the lower end, around 1.5–1.6m. It would fantastic to think that SEQ growers could follow the Tasmanian lead and settle on a standard spacing, however this would take a great deal of negotiating to achieve.

The inclusion of two major Tasmanian vegetable contractors in the tour party is also likely to lead to changes in operations over coming seasons as they modify and apply what was learnt on the study tour. These changes can potentially have a rapid and significant influence on other growers due to the geographic and industry spread of their contracting operations.

Vegetable production in SEQ differs slightly from the Tasmanian industry in that there is an absence of comparable independent contractors operating in SEQ. This role is often filled by the operators of central packhouses. To ensure consistent throughput of product these operators complete a number of field operations, from ground preparation through to harvest, on behalf of the grower. It will be important for these groups to get on board for CTF to have widespread adoption in the SEQ region.

As discussed earlier, GPS guidance has been pivotal to the success of CTF systems in the UK and Europe, and I believe the

situation is no different in SEQ. Uptake of GPS technology by vegetable growers in SEQ is gradually increasing, with most of the opinion that 2 cm guidance is the only real option for row cropping. The main operational drawback of these high accuracy systems is the requirement of a fixed base station. While the installation of base station networks is quite advanced in broadacre and some cane growing regions, this has so far not occurred in the main vegetable growing areas. This is a significant stumbling block that, if addressed, would rapidly increase the uptake of GPS guidance by SEQ vegetable growers.

My personal experiences and CTF changes

Before I found myself growing vegetables in the Fassifern Valley, I worked as an agronomist for five years in Central Queensland, involved mostly in broadacre grain and irrigated cotton. It was widely recognised in these industries that soil compaction is an important issue across all cropping systems, irrigated and dryland. During this time I gained great appreciation for how well CTF was able to address many of the compaction related issues faced by growers. However transitioning the same principles into vegetable growing has not been as straight forward as I would have liked, given the difficulties of retaining permanent wheel tracks in tillage based production systems. Fortunately, the only real solution to this problem—high accuracy GPS guidance systems—have now become affordable enough to be in the reach of many vegetable growers.

The farm has invested in a 2 cm RTK guidance system which is easily movable between the main tractors. Along with this, we are modifying some ground working and hilling equipment to ensure we are able to retain permanent firm wheeltracks during all ground preparation operations. The system we are working towards with our packing shed aims to get the harvesting equipment running on the same wheel spacings as all tractor operations, however this has proved a little problematic to fully achieve. A large amount of field drainage work has also been completed, with every block having some degree of leveling to ensure effective drainage out of wheeltracks during heavy rain events. This will be critical to ensure the expected improvements in timeliness of operations with CTF are achieved.

While the setup costs so far have been significant, and we are by no means finished, I am very confident that it will be a worthy investment. Early experiences to date have been very encouraging and I firmly believe that the CTF system will greatly increase the reliability of our cropping program while at the same time simplify and trim our production costs.

(Endnotes)

[1]RTK—Real Time Kinematic—a real time signal correction to raw GNSS signals that enables machine guidance with ± 2 cm accuracy

[2]DGPS—Differential Global Positioning System

[3]GNSS—Global Navigation Satellite Systems

[4]CORS—Continually Operating Reference Stations—permanent, accurately located base stations providing RTK correction signals for surveying, machine guidance etc

[5]GNSS CORS RTK network—an integrated network of CORS providing 24/7 RTK signal coverage to a broad area using central processing, standard language protocols and built in redundancy for reliability