Technical meeting, 8 am Thursday 24th May

Tim Chamen welcomed everyone to the meeting whose format had been changed slightly to account for the different cross-section of attendees compared with those anticipated! He said that the International Soil Tillage Research Organisation (ISTRO) CTF working group had been set up at the ISTRO conference in Brisbane in July 2003, more details of which can be found at: http://www.controlledtrafficfarming.com/istro.html

Welcome

Jan Huijsmans welcomed us on behalf of Plant Research International, which he said had a long history of working with controlled traffic systems. This dated back to the 1970s when they were working with 3 m track widths and growing sugar beet, potatoes and onions. Now, they continued to be involved with new work on both SCTF and CTF in the vegetable industry. Jan wished us a fruitful and successful workshop. Jan Huijsmans' presentation

CTF – why, what and a little bit about how

Tim Chamen of CTF Europe Ltd provided an overview of CTF, highlighting the reasons why it was now becoming of interest to so many growers. Stresses in the soil at 40 cm depth caused by horses or machinery had increased from just 0.1 bar in the 1930s to nearly 2.5 bar today. This was causing enormous problems, reducing crop yields, increasing energy demands, increasing costs and resulting in significant environmental damage. Controlled traffic, which is simply a term for the practice of running vehicles in
the same place year in year out, is one way of counteracting these problems. And often a system can be introduced very simply. Tim Chamen's presentation

CTF in the Tasmanian vegetable industry

John McPhee of the Tasmanian Department of Primary Industries and Water gave us an overview of CTF in Australia and the vegetable growing business in particular. The vegetable industry is characterised by a diversity of crops, small farms on expensive but undulating land with widespread use of irrigation and summer cropping. Leased land is also significant as well as the use of contract harvesters. Erosion is significant in the rolling landscape and farm layouts, cut off drains, improved infiltration and crop residue retention are all important, as are alternative irrigation systems. Barriers to CTF adoption include a knowledge and understanding of the benefits, equipment configurations, erosion, field logistics and costs. But, people are starting to discuss CTF and John provided us with an overview of the equipment available and opportunities for fitting it in to the discipline of CTF. Most importantly, people were recognising the damage and limitations caused by existing practice and the potential improvements that CTF offered.

They were now starting on the journey - getting from where they are now to where they want to be with CTF. John McPhee's presentation
Seasonal Controlled Traffic Farming (SCTF)

Bert Vermeulen of Plant Research International introduced the subject of and the research project he had been running on the organic BioTrio farm that was first on the list of our visits. SCTF is a controlled traffic system that uses permanent traffic lanes for all operations other than harvesting and primary tillage. On the BioTrio farm, tractors with a 3.15 m track width were used, mostly with equipment of 6.3 m width. With four years of results from the farm the research had shown that, despite the seasonal return to widespread trafficking, significant benefits had been realised. These included occasionally higher yields (especially in spinach), an increase in workable days, better mechanical weed control, lower power demand, improved soil conditions, lower emissions of N\textsubscript{2}O (nitrous oxide) and a good potential for increased farm profit. Bert Vermeulen's presentation

Visit to farm “BioTrio, de Nieuwe Weg”, Molenweg 17, 4771 RT Langeweg

Short description: The BioTrio farm is an organic farm with an area of about 200 ha, developed from a merger of three organic farms in 2005. The three farms have pioneered SCTF since 1999 and research was carried out to establish the effects of SCTF compared with normal field traffic. The main crops grown are spinach, carrot, onion, green beans, potato and wheat. Since 2002, SCTF has been implemented using a tractor with 3.15 m distance between tracks and equipped with RTK-DGPS and rubber tracks.

Of the trio running the farms, Kees van Beek made the general presentations to the ISTRO group, but both Dianne Schrauwen and Jaap Korteweg were present to talk to us individually.

Kees explained before we went into the field that for organic farming it is extremely important to have good soil preparation. You cannot use inorganic fertilizer, you have to use manure through animals or raise alfalfa etc for nitrogen. Because soil preparation is so important, we started to use a track system. At first it was not very professional, but five years ago we started with a Fendt 916 on tracks and fitted a GPS system. Since then we have prepared most of our land with the system. As of yesterday, we now have a John Deere 8420T tracked tractor on a wide track setting. Our crops are mostly salads with a rotation of 7 years with carrots for human consumption being the most important. After carrots we grow beans, then potatoes (seed and ware) then grass and clover and sell the grass to a livestock farm. After that year we grow onions, then alfalfa for animals and then spinach. We also grow a lot of herbs, but only on a small area. These include thyme, dill, basilicum, oregano and ? The herbs are grown for a company in Belgium where they are dried. Kees then invited us to go out to the field, but questions were invited.

Q. When did you last have rain – I noticed that some of your tracks have water lying in them?

A. Kees commented that the weather had not been their partner this year. They had an unprecedented six weeks without rain and then three weeks ago it started, and especially in their area, where there had been 100 mm. They had also been irrigating some of their land before this, and that together with the rain from heaven, meant that much of their land was completely waterlogged. Further questioned about whether they had experienced any difference in field access as a result of SCTF, Kees replied that it was
better. He believed they had more workable days than when they used low ground pressure tyres.

Q. Before you started growing organic, how long had you been growing these crops?
A. For at least fifty years, but we grew more sugar beet in earlier years.

Q. How do you deal with phytothera (blight) in your potatoes?
A. In organic farming we tend to harvest early, especially if phytothera is a problem. The crop is burnt off and usually lifted by August and that also gives us plenty of time to sow grass and clover. Onions are also harvested early, usually the end of July early August. For phytothera we are not allowed to use any chemicals or copper within the organic standard in the Netherlands. When we get blight the crop is burnt off with a flame weeder using propane and this usually takes two passes.

Q. Are all onions grown from sets?
A. Yes, most of them, although we do grow a few from seed for our own sets, but we tend to have soil borne disease problems.

Q. Are weeds a problem in onions?
A. Yes, but we have 18 people at the moment, mostly from Romania to help with the weeding as well as using mechanical methods.

Questioned about spinach, Kees said they use a lot of manure on this crop, but not on the following carrots because of interaction problems.

On the question of when they spread manure, Kees said that this was often in the spring, if there were an opportunity. As we heard earlier, the contractor who does this for them has his equipment on a 3.15 m track, so there is little or no damage to the cropped area.

**In the field.**

Rik van Bruggen of SBGuidance Innovatie, who manufactured the steering system on the tractor, said it is the third system for this farm and is used extensively, sometimes in excess of 12 hours per day. The base station is at the farm on the top of a barn and reaches around 10 km. Sometimes when they do contract work they take a mobile system to the site they are working at.

The main feature of the system is that it can drive straight and extremely accurately. With this particular tractor that just has tracks and no wheels, the controls are all electronic, no hydraulics are concerned.

Kees said that in this particular field carrots had been harvested in extremely wet conditions, often with standing water. Because of that, it was only now that they were ploughing. The field was receiving a cultivation pass and following some drying and wetting periods, would receive further cultivation before being sown with beans. Because of the greater extremes in weather, we must be prepared to have a lot of rainfall and to use the plough to store a lot of water in the upper layers. And when you don’t drive on it with wide tyres, you can store more water.
It was noted that “green” clods were being brought up, a sure indication of anaerobic conditions. Kees was not surprised considering the very poor conditions under which the carrots were harvested.

The reason for changing to the JD tracked tractor was because the WesTrac tracks on the Fendt tractor had caused them a lot of trouble. The hope is that the John Deere will not break down. They will use other tractors for lighter work. They normally use equipment that is 6.3 m wide and the tracks on the Fendt had proved unreliable with this load. The tracks on the John Deere are around 42 cm wide overall and the gauge between the tracks had been widened from the standard 3.04 m to 3.15, especially for the BioTrio farm. Kees considered that they might reduce individual track widths to around 33 cm, especially if the existing width caused crop damage.

Questioned about the ploughing operation also being undertaken in the field, Kees said they were hoping to buy a bigger plough with six or seven furrows that would plough the whole bed using the new John Deere tractor. This would be far better than their current system which was ploughing in the furrow.

A question was raised about other makes of tracked tractors with a wide gauge. The Challenger and Agco tractors have track widths from 3.2 to 4 m as a standard option. The JD goes from 2.4 to 3 m, or Rik guessed, from 1.8 to 2.4 m.

In the next field we visited, the previous crop had been grass and clover. The soil showed good soil structure with worms, quite different from the previous field but the soil was lighter here.
We then moved to a field in onions which had been in permanent tracks for many years. This year it had received liquid manure using an umbilical system where the manure is pumped through a hose from a tanker on the headland. Kees was asked if they planted in a particular direction to account for wind direction so that it went up the rows rather than across them, the idea to give the crop more ventilation. Kees said this was not something they had tried. Onions are harvested with a 1.5 m machine that leaves the crop to dry on the bed for one or two days before being picked up by a further machine. Mildew in onions is combated partly by using onion sets and partly by immersing the sets in water at around 40 deg C for an hour. This is done in the autumn because when the new sets grown from seed are harvested they have a lot of soil with them and need washing. While they are wet they then receive the hot water treatment and therefore only need drying once. The hot water treatment ensures that there is no mildew on the bulbs when they are planted. When you start with a clean bulb, you may get an extra month before mildew sets in and the crop has to be harvested. They grow the “14-21” sets because they grow quicker but they also use “9-14” which are their home grown sets, but these grow slower due to their smaller size. They also grow “21-25” and these grow really quickly but can suffer from “bolting”. Talking around the 150 hp Fendt tractor Kees said they had been using this for around 5 years. It has a very strong rear axle. Speaking to Rik who visits many farms he said that there was increasing acceptance amongst farmers that driving at random over their fields is not good, and it is particularly
evident in poor seasons. There are now many farmers adopting simple SCTF systems, perhaps just using their standard 1.5 m tracks settings. Bert in response to a question about how long the fields had been in controlled traffic pointed out that when you don’t do the harvesting from the traffic lanes you cannot expect a build up of better soil structure. Every year can be different, but even SCTF brings benefits as we have seen with a 10% increase in yield of onions in one season. Kees said that they grew grass and clover before onions and cannot use chemicals to kill this crop; they must therefore rely on ploughing which they do every year within the 7 year rotation. The organic farmers in his area are thinking about how they can reduce CO₂ emissions through lower inputs, such as less ploughing, but you have to deal with weeds and water storage, and this is being made harder by more extremes of weather. Bert mentioned that someone had observed a compact layer at 20 cm depth, and this he said was inevitable with the current system. Until all traffic could be removed, and particularly the tractor ploughing in the furrow, the soil structure at and below this depth would not improve. Once you can do all operations from the traffic lanes, you can loosen up this lower layer and further improve drainage and infiltration. There were still enormous benefits to be gained. Kees, when questioned about whether he considered that his heavier soils would respond positively and retain structure when traffic was removed completely, thought that they would. He thought ploughing would be far less of a necessity, or at least could be undertaken at perhaps only 5 cm depth, purely to deal with grass and clover and with surface residues. Kees also mentioned that they were developing a root harvester that would span the complete 3 m bed. This would consist of two separate lifters but windrow the crop into the middle. Onion sets were planted at the rate of 25 per linear metre on a row spacing of 0.5 m (6 rows per bed). When inter-row cultivating the onions, some attempt was made to achieve intra-row weed control by throwing soil into the crop row (see photo).

**Back at the farm.**

Kees described the difficulties they had experienced with the WestTrack tracks. The main problem is with the lugs on the inside of the tracks that are used to both drive the tracks and absorb side forces – these shear off. It is also very difficult to line the tracks up when fitting them; the construction is not robust enough. The other problem is with the bearings which have failed frequently. With the John Deere the inner lugs are only used to counteract steering forces while
traction is developed by friction around the drive wheels. The manufacturers of WestTrack are still trying to overcome the problems, but the Fendt is a large tractor. Kees said that they don’t actually need such a powerful tractor, but smaller tractors do not have strong enough axles. They have spent a lot of money and they now need to have solutions.

Visit to the farm “Nieuw Bonaventura”, Boendersweg 38, 3295 LB’s Gravendeel, and hosted by Leen Jan Reedijk

Short description: The Nieuw Bonaventura farm is an organic farm (biodynamic), specializing in growing witloof chicory roots, cold storage of the roots followed by planting the roots in dark forcing chambers to produce the final product of witloof chicory. Other crops grown on the farm are potatoes and wheat. Leen Jan Reedijk purchased a JD 6830 this spring, adapted to 3.20 m distance between tracks by the local John Deere dealer (Stehouwer, Maasdam) and equipped with RTK-DGPS and 54” rear tyres. The main reasons for adopting SCTF on this farm are the expected improvement in soil quality and the better opportunities for high quality mechanical weed control. As Leen Jan was not confident with spoken English, Bert had taken his notes and presented information about his farm on his behalf.

Being an organic farm they do not use any fertilizer or chemicals. With a biodynamic farm you try to produce crops in harmony with nature and this is their first year in SCTF. Leen Jan has contracts with his neighbours to exchange organic wastes from his farm with manures from theirs. However, he does not use these direct on the fields but composts them first.

The farm specializes in growing witloof chicory. Once this crop has gone through the first year growth cycle of a biennial in the field, it is lifted and are then “forced” in a dark room in wooden boxes that are kept moist. Leen Jan showed us the finished product that is separated from the root on a special topping device (photo) and packed for the supermarket. Chicory is a very difficult crop, particularly within an organic regime where sclerotinia can be a major problem because there are no control measures. The root has to be kept very clean and this means that you shouldn’t grow legumes, a key crop within an organic regime. The specialised crop rotation is chicory, wheat or a fallow, then potatoes and then wheat, and then one year of non-leguminous green manure if needed. Manure is chicken and pig and waste from the sugar industry. In organic farming, many more field operations are needed and this exacerbates the compaction problem and is one of the main reasons that Leen Jan made a move to SCTF. The farm is 84 ha and all the chicory is grown on this farm. In the past he has bought the roots in from other organic farms, but he had problems with sclerotinia. He is expecting SCTF to deliver better rootbeds and healthier crops with better competition with weeds. Secondly he expects better mechanical weed control due to more level seedbeds, better timeliness and accuracy. He also expects increased efficiency, allowing him to manage the whole farm with just one person – using the tractor for around 900 hours. The tractor will be used for seedbed preparation in the spring, stale seedbed preparation, sowing, ridge building and weed control and later in the season for spreading potato leaves and sowing green manures. Overall, he hopes to
use the tractor sufficiently to make it profitable. Leen Jan prefers to buy in his equipment rather than make it himself. His new 6830 John Deere has 54” rear wheels and the front axle has been modified by a local company to achieve the required width and has 42” rims. The tractor has only been put to use this spring but following a period when it was too dry, they quickly went into a period when it became too wet, even for the controlled traffic lanes.

The new John Deere 6830 tractor was imported with a US back axle while the front axle modification was arranged by Leen Jan's local John Deere dealer (http://www.jstehouwer.nl/)

Manure application, including the tanker, is from the controlled traffic lanes. Presently they are working in the field making ridges for the chicory in one operation and sowing it in another – both in the same field. (see photos)

Q. What are the three main economic reasons that made you change to CTF?
A.  
1. Labour, difficult to get and expensive
2. To get a vigorous crop, because this is the best method of weed control
3. Improved yield with lower cost and time to do more of the work himself.

Q. How do you harvest chicory?
A. An adapted potato harvester is used by a contractor but as this is Leen Jan Reedijk’s first year in SCTF he still has to go through the harvesting process. The front wheels of the harvester will fit into the traffic lanes and the machine will have low ground pressure tyres at the rear, but the pressure on these will still be around 1.5 bar. In future tracks may be fitted to the rear end of this machine.

Leen Jan commented that he could clearly recognise the places in the field where the potato or chicory harvester had run because of poor performance in the following wheat
crop. And when you can see effects such as this, it generally results in 20-30% reduction in yield on these soils.

Q. What soil type do you have on the farm?
A. A clay soil with about 25% clay. In this part of the Netherlands they do not have a classification for silt, but define a soil as heavy if 30% – 45% of its particles are less than 0.016 mm (16 µm) in diameter. [Author note: The USDA and ISSS systems classify clay as any particle less than 2 µm (0.002 mm) and silt from this size to around 0.05 mm]

In the field,

Rik van Bruggen of “SBGuidance Innovatie” (see later section on their products) provided an overview of the guidance equipment being used. Leen Jan had decided about 2 years ago that he wanted to get into CTF and to make it as simple as possible. He selected a 1.5 m row spacing and he therefore needed GPS. He started with it on 3 tractors which were converted to autosteer. He also bought one side shift system that could be changed between the chicory ridger and the potato planter. The soil is very heavy here and the tractor often drifts off line due to variable subsoil, which is why he has the side shift system. He needs to achieve 1 cm accuracy because the weed control system relies on gradually cutting the ridge away. The chicory planter is also working with a side shift control. Similarly they steer and vary the width of the plough to achieve exactly parallel ploughing and also synchronization of the furrows with the chicory ridges to minimise variability.

The side shift system can move the implement 12 cm in either direction, i.e. a total of 24 cm movement on the cylinder. The tractor is basically driven by eye and the aim is to avoid sudden or excessive steering corrections as the side shift system may not be able to respond quickly enough or to the extent that might be needed to keep the implement in line. The most difficult pass is the first one when there may be no feature that the driver can follow. On the second pass you have the adjacent ridge to follow and the implement can easily adjust to any small errors. Ridge size and weeder accuracy are crucial in minimising manual labour needed for weeding. A wide ridge initially means that a number of passes can be made with the weeder, each one taking away a part of the ridge so that at the end, only 4 cm width remains at the top. This is also important for the harvester because it means it has less of the difficult heavy soil to deal with. The weeder is operated manually from a comfortable seat at the rear (the weeder had obviously been parked under a popular bird perch when we saw it – the amount of guano on the seat would have left a very permanent mark on the backside of the operator!).

The 20 ha of organic chicory on the farm normally needs around 120 labour hours per year for hand weeding, so any saving is very significant. Last year they needed only 80 hours, but this was just one season and natural variability may have accounted for some of the difference. Timing is crucial in terms of weed control and so the more efficient and quicker this is the better.
The chicory is sown at 3 cm spacing in the row. Tops grow to about 0.5 m and are cut by hand before harvesting.

Preparation for the crop following ploughing consisted of a pass with a power harrow followed by another pass that incorporated two power harrows and a ridger (see photo). Questioned about why he ploughed, Leen Jan said it was primarily to improve water infiltration over winter. Further questioned about whether CTF would allow him to avoid ploughing, he replied that this was an unknown. Certainly the potential for a full CTF system to further improve the soil condition was significant, particularly as Leen Jan was forced to plough in the furrow. An “on-land” plough would have to consist of at least 5 furrows and would need a larger tractor but even a larger tractor may have traction problems on his heavy land.

An alternative would be to use a 4 furrow plough to cover half the width of the 3.2 m wide beds, which would place just one wheeling in the centre of the bed. Unfortunately Leen Jan only has a 3 furrow plough, so this is not possible at the moment. This discussion led us to consider BioTrio’s new opportunity with the tracked John Deere tractor which was capable of pulling a plough that would cover the full width of their beds. Bert said that Dutch work in the 1970s had showed that the last furrow could be displaced by a blade that ran across the traffic lane and pushed it into the open furrow in the adjacent bed left by the previous pass (see picture). In this context
the Blaxta\(^1\) plough from Sweden was mentioned. This is capable of turning the furrows without moving them sideways.

Following harvest of the crops Leen Jan often sows green manures, which he does from the permanent traffic lanes. This ensures that there is no further damage to the soil and maximises benefits of the green manure in terms of soil structure.

Questioned about the cost of his John Deere tractor front axle conversion (made locally) he quoted this as €7000, not including the wheels and tyres. The rear axle is a standard US option quoted as capable of carrying 7 t. Asked whether the tractor was still under warranty Leen Jan said “yes – until it broke”! The reality is probably that John Deere would warrant the rear axle but not the front.

**SBGuidance Innovatie**

Rik van Bruggen said that SBG was set up in 2003 by three graduating students from Wageningen University. The company concentrates on precision steering and DGPS and was subsidized initially by the government. Their main customers were in the immediate area and the first systems were sold within 5 km of where they were based. This allowed them to carry out an efficient development programme and they are now selling their systems across the whole of Holland, mainly to the arable sector. Sales to farms have mostly been driven by good economic reasons The company now has 7 employees and they do some design and production work for third parties, but their main business is in guidance.

Range of the RTK systems they offer is around 10 km but depending on the landscape can reach much further, for example 16 km to reach the farm we were on. Most base stations are now fixed, but they do still sell some into mobile applications where they are moved around. With the network available throughout the Netherlands, there is now less need.

Rik gave an example of working with red beet, with a row spacing 37.5 cm. Normally the driver would spend 90% of the time concentrating on steering and 10% to check the operation. With RTK guidance, 100% of the time can now be spent on equipment operation and this has improved product quality and reduced the labour demand in the sorting house.

In equipping tractors with guidance equipment where you are looking for centimetre precision, a judgement has to be made about whether the age of the tractor will limit its performance. Two wheel drive tractors are less stable than four wheel drive and this is also a consideration. Side shift can overcome these problems because the performance of the tractor is no longer an issue. If the system is used with a variable width plough it is possible to adjust the furrow width to 37.5 cm for example, and the crop can then be sown either on top or between the furrows.

In Holland there are two markets for guidance, one at the very cheap end and one at the high precision end. SBG have concentrated on the high accuracy end with delivery of RTK DGPS systems. Because their customers often have many tractors on which they

want to use the system, they have designed it to run from just one terminal that is switched between vehicles. The tractor based system can operate at speeds as low as 50 m/h.

Side shift has advantages in that tractors are often unstable in the field, particularly when they are on low ground pressure tyres. The side shift system applies correction to the most important machine in the operation and the tractor is steered by eye, often needing to stay only within ± 10 cm. [This is obviously not ideal in terms of a CTF system!]

The side shift system can also be used with trailed equipment and with appropriate sensors, integrated into a control system that alters the width of the plough to counteract changes in working width with changes in soil type or condition across a field. This development was requested by growers because it gives them a more even result and can even save one seedbed operation, especially for a crop like sugar beet.

Questioned about whether SBG had a system for on-land ploughs, Rik said that none of his customers had such a plough, mainly because of traction problems.

In line with other systems, SBG have separate A-B lines for each field, but it is possible to use one A-B line for several fields if they are parallel to each other. This means that all working across those fields will be parallel.

Asked whether SBG offer a curve following option, Rik said that they did not at the moment because of little demand.

With fertilizer spreading they have a variable rate control system on one computer that receives a card with the appropriate information. Rik also showed a low speed operation where the tractor had been “modified” by the user to run without a driver – not strictly legal, but inevitable when the driver is faced with practically nothing to do. Stopping the tractor was possible from the towed implement where several people were seated, but the tractor was also equipped with sensors to stop it if a solid object were approached. In this situation SBG work closely with the customer to make the system as safe as possible.

**Technical meeting, 17.30 Thursday 24th May.**

**Application of CTF in Europe using satellite guidance systems.**

With our slightly delayed return from the field we started with the presentation by Hans Henrik Pedersen of the Danish Agricultural Advisory Service. Hans Henrik made the point that for any satellite-based correction signal (for example StarFire2 and OmniStar), CTF is only possible if you can see the tracks you need to follow. Once on the track, the operator manually eliminates any error in the satellite correction and initiates autosteer.

In terms of RTK systems, the correction signal is transmitted on different radio frequencies depending on the provider. Selection may be based on administrative aspects such as governmental restrictions on power and frequency, and John Deere for example have selected to use part of the UHF band that in many countries is available for low power transmissions. This does however limit the range to just a few kilometres.

Some users have networked base stations and introduced repeaters to extend their range. There are some issues with base station and repeater being seen at the same time by the
roving vehicle, but multibase frequency sharing offered by some companies introduces a
delay between one base station (or repeater?) and the next to overcome the problem.
Virtual base stations (VBS) [author note: this is the same as VRS – virtual reference
station used later in this document by another presenter] interact with a server that
calculates a virtual base station from known true positions of an array of fixed base
stations. This system provides stability and rapid initialisation of the RTK signal.
These networks use open standards such as RTCM (Radio Technical Commission for
Maritime Services) or CMR (Compact Measurement Record) and CMR+, both developed
by Trimble. Communication can be through a combination of internet and radio or
mobile phone. Accuracy of these systems is nominally ±10 mm with 1 mm additional
error with every 1 km from the virtual or physical base station.
Denmark now has a network set up in the southern part of the country with delivered
accuracy of around ±2.5 cm from both Leica and Trimble. [Hans Henrik's presentation]

AutoFarm GPS Precision Farming

The presentation was introduced by Jürgen Ackermann who heads Europe wide sales
and marketing for AutoFarm, a subsidiary of Novariant.
AutoFarm is a US company based in “Silicon Valley”. They introduced the first GPS
steering system in 1992 in cooperation with Stanford University and were noted for
landing a Boeing 737 with it in 1995. In 1999 they introduced their first commercial RTK
system through GPSAg in Australia. They first used the system in 2003 for land levelling
and introduced it to Europe in 2005. Claiming to be the world leader in delivery of these
systems, they service them into Denmark, Spain, France, England and the Netherlands. In
NL they are represented by Compufarm.
Arne Rijzebol of Compufarm then continued by saying that RTK and Autosteering are
recommended because they deliver perfect guess rows, day and night and repeatedly in
exactly the same place. A minimum of 4 satellites is required with the signals being
delivered to two antennas, normally positioned on the lateral extremities of the vehicle’s
cabin roof. The two antennas mean that corrections
for slope and heading can be calculated and delivered
in real time. Although no automatic headland turning
is provided at the moment, the system will allow the
next bout to be selected when the vehicle heading is
up to 90 degrees away from it.
In the cab a touchscreen is used for inputting data and
selecting operational parameters. The system is
capable of delivering “circular”, “box”, “fan” and
“parallel” rows as well as a “repeat job” facility and curve tracking. The A-B path master
allows multiple A-B lines within any given field. The screen also offers adjustment of
response rate and a “nudge” function.
Most systems in use are for potato and vegetable planting and for seeding between rows.
AutoFarm also use a directional antenna that provides a more focused signal.
The cost for one tractor on autosteering and one base station was quoted as €35,000. There
was also a price of €4000 quoted for an “installation kit”, but I’m not certain whether this
was in addition to the price quoted above or whether it was for an additional vehicle that
was already equipped with autosteer. The price for an additional vehicle fully equipped as above was €26,000.

**Summing up of the first day**
The overriding conclusion from the day in terms of vegetable production was that we are all stuck at a similar point – not being able to achieve a season to season CTF system, mostly because of harvester designs. It was certainly evident from the soil conditions and from discussions, that the greatest benefits of CTF had yet to be achieved. However, even in the absence of a complete system, it was important to gain the maximum benefits within existing constraints. For example, we must ensure that we do not cultivate or sow the wheelways when there is no need.

**Technical meeting, 8 am Friday 25th May**

**Harvest systems for high value crops – research and development.**

*Bert Vermeulen* spoke to this subject and restated the reasons for wanting a complete cycle of CTF, namely the vastly improved soil conditions and a reduction in the need for tillage. He also listed the technical problems that we were facing and the fact that a complete redesign of harvesters might be needed. It was also the case that financial justification was based on the harvester hours worked per year and because the area under SCTF was presently limited, the costs would outweigh the benefits. Bert went on to look at possible solutions to the harvesting problem, including a 6 m gantry system, a modular harvester and starting with easier crops, all of which are described in his presentation linked below.

As mentioned earlier, Plant Research International is involved in new research projects. One is developing practical guidelines for maximum safe tyre inflation pressure within a CTF system when harvesting. First results suggest that under dry conditions tyre pressure had no effect on successive growth. A second project is comparing SCTF with a true CTF system combined with reduced tillage. Further details are given in Bert’s presentation *Bert Vermeulen’s presentation on harvest systems*.

**Strategies for CTF adoption in vegetable cropping**

John McPhee emphasized that the starting point must be a clear idea of the benefits – this is about a mindset not the technology. It is also important to visit other growers and industries using CTF to learn as much as possible about the various systems already in use. It is also about keeping all high pressure tyres off the land, not cultivating the permanent wheel tracks and making sure the planting equipment works only between the wheel tracks. If possible start with the easier changes and if irrigating, make sure this works in with your CTF plans, particularly in relation to the potential for soil erosion. If feasible, try crop rotations that minimise traffic in the cropping zone from one season to the next. *John McPhee's presentation on CTF strategies for vegetables*.

**Strategies for CTF adoption in arable cropping**

Tim Chamen presented some ideas to dispel the idea that adopting CTF was complicated, costly and required a whole fleet of custom built machinery. CTF can often be achieved simply by considering the options around existing machinery. A tiered approach was
suggested that allowed a simple starting point and gradual progression that achieved a consistent reduction in the percentage area covered by permanent traffic lanes. Four tiers were proposed with the ultimate being Tier 4 and only likely to be delivered by a fundamentally different but highly desirable, efficient and appropriate mechanisation for CTF based on wide track vehicles. Different configurations of conventional machinery that achieved the different tiers were presented and an example based on an existing farm showed how adoption could be achieved with a reduction in machinery investment. Tim Chamen's presentation on CTF adoption strategies for combinable crops

Visit to the SBF farm of Keij-van den Dries, Zwijnsweg 5, 8307 PP Ens

At the farm

Our host, Digni van den Dries introduced his farm before we moved out into the field. This particular farm has 90 ha divided between three separate areas. Digni also works with another farmer on 180 ha, but that is around 80 km away. Zwijnsweg has been organic since 1990 and their goals are to have an ecologically sound system that has inputs that exactly match the outputs. Nitrogen input in the form of manure is around 100 kg/ha.

Other goals are efficiency in the use of labour, particularly as it relates to weed control and the yield and quality of crops. A further goal is to make room for nature.

The rotation on Digni’s 45 ha is seed potatoes, grass seed, chicory for root, summer beet, plus wheat and this year, wheat and beans together. In previous years he has used clover in wheat, but the clover has often not done well. The rotation continues with cabbage and summer wheat.

The principal rotation is root crops followed by fodder crops and each area is self-contained within a season to try and prevent insects spreading from one part of the farm to another.

Digni then showed a home-made a potato harvesting system consisting of a self-propelled box carrier, each box with a volume of 2 m$^3$ and ten boxes in all, with a further two at the rear of the machine. The boxes are filled carefully with a commercially avail system and each of them can be slid out along the length of the machine. They wanted to make two of the machines so that harvesting could be continuous. Each machine is quite long, there being three sets of wheels.

Cost was estimated at between €150,000 and €350,000. At the lower cost, it could be economically viable, but at the upper end, not.

Digni then went on to describe another modular potato harvesting machine that was long but also had an extending conveyor that could reach across to the next bed. The first element of the machine was an elevator that graded out anything less than 40 mm. The machine could also be used for onions, red beet and chicory? [I think! My tape ran out at this point!] The machine had both tracks and wheels.

Digni considered that at the moment the special designs needed by CTF for harvesting would cost more than the return they would get from their limited area. It was in our
interests to promote CTF to increase the volume of need. In the meantime, the best option was to use the permanent tracks where possible and use ultra low ground pressure when the beds had to be run on. For some crops such as carrot and chicory, it may be possible to offload on the headland. Making the equipment as light as possible was a priority for Digni because this would always make things easier.

Regarding operation of the guidance system, Digni said that this was capable of very precise operation, but as with all new things, there have been times when it has not worked. Mostly, he had to admit, this was because they had got something wrong or had not understood something correctly; it was rare that the problem was actually caused by the equipment not working properly.

Digni spoke of 450 ha within their area that had four tractors similar to the ones we had seen on GPS and four that were without it. Liquid manure is applied with an umbilical system and keeps to the same wheel tracks. Solid manure is also applied and I believe this was also achieved from the 3 m wheel tracks. They have 60 ha of cabbage this year and during planting using RTK DGPS guidance, the driver would leave the tractor and join the team on the planting machine. This procedure is also used when sowing carrots and the driver will have a joy stick on the planter from which the tractor can be stopped or the speed changed.

On the 180 ha, 100 ha of carrots and 80 ha of potatoes are grown. Initially they ridge on a 3 m system, but then use a 6 m planter or drill. Weeding following planting with GPS is done by eye.

Questioned about any problems with the machinery, Digni said that after 1400 hours a bearing had failed on the back axle of the tractor. He didn’t know whether this was a “one off” or whether it would fail again in another 1400 hours. They had taken certain precautions to try and reduce the risk, one being to restrict road speed to 25km/h and the other to restrict the lift pressure to around 100 bar on the rear linkage. They had also planned to reduce road work, but with the farms being 8 km apart, this had not always been achieved.

They also have a problem on the front axle with a particular component working loose but he was confident they could overcome this difficulty, particularly as another farmer with exactly the same set up and component had experienced no problem in four years.

The total cost of the tractor conversion to make it wider was €10,000, but to this has to be added the cost of the tyres and the GPS system. Their goals in adopting CTF are:

- achieving sustainable use of their soils;
- realising higher yields;
- realising better quality crops;
- realising more efficient input of labour and machines;
- realising optimal use of the soil;
- more stable yield of the crop;
- more efficient use of nutrients;
- 10% less labour, fuel, depreciation and maintenance;
- less nitrous oxide emissions
In terms of economics, on 50 ha they should achieve a turnover of €250,000 per annum from their crops.

Their expected savings and gains with SCTF include:

- Manure, 15% saving = 90 t (from 600 t/a to around 500 t/a)
- Labour, fuel and maintenance, €9,000 (10% of €90,000)
- Increased yields valued at €12,000

This gives them a net gain of over €20,000 per annum and a total investment potential of around €80,000 per annum. Digni said they were confident they had made the right decision in moving to SCTF.

**In the field.**

Digni said they had chosen their potato harvesting contractor specifically because he was able to harvest from their 3 m tracks. This would be done by two 1.5 m wide lifting webs. The field in which we were standing had been in carrots and had been harvested with random traffic, meaning that practically the whole field had been covered with wheels. Questioned about whether the field would still have been cloddy had there been no traffic on it, Digni said that he really did not know. It was suggested that this was a worthwhile topic for some research. Digni also mentioned that he was planning to stop ploughing and to make ridges in the autumn. He mentioned a German farmer who had devised such a system. Digni said that he was planning to make ridges in the autumn in good conditions that would be left over winter and then “manipulated” in the spring.

The potatoes in the field at the moment would be harvested with a new system that was not Digni’s ideal, but was the best they could do within their financial constraints. The first machine on large low ground pressure tyres would lift all four rows in the 3 m wide beds. The haulm would be discarded to the side and the potatoes windrowed into position on the bed for another machine that would follow within perhaps 10 minutes or up to an hour, depending on the weather conditions and the rate of drying of the crop. This machine, equipped with similar tyre equipment to the first, would run on the same track as the previous machine and pick up the windrowed potatoes. As they were elevated, those potatoes less than 40 mm in diameter would be graded out and conveyed to a separate box. The remainder of the potatoes would then be conveyed laterally to new trailers capable of carrying 8 boxes on similarly wide low ground pressure tyres. These trailers would run in a different spot compared with the other machines and would bring about coverage of the whole area with low ground pressure tyres. Conveying of the potatoes into the boxes was a superb design that minimised the potential for any damage. Once filled, the boxes are able to be slid off the trailer bed within one minute.

Digni said that achieving “on track” harvesting of potatoes was not a technical problem, it was one of economics. He estimated that a complete controlled traffic harvesting
system would cost around €1 million and they just could not afford this with only 100 ha of potatoes. Around 500 ha would be needed to justify this investment. Queried about whether a contractor might be interested in doing this, he reported that a number had shown interest, but not that much interest! Equally however, one contractor said that he would be interested, particularly regarding the machine’s ability to grade out the 40 mm potatoes. He has now imported one of the machines and assured Digni that he would make it available to him.

Digni also expressed the belief that agriculture on these soils should be achievable without irrigation. In his view, within the present norms of the weather, if you do the right thing the crop will emerge and produce an abundant root system that can explore the whole of the profile. In this way it will achieve good production without the need for artificial water. He regularly achieved 40 t/ha and considered that 60 t/ha was equally achievable but blight often prevented them from achieving it. Make the conditions right for growing a crop and you will diminish diseases and you won’t need to irrigate. And yet irrigation is the norm in this area and had become a custom to overcome poor soil and crop management.

We were also shown an interesting experiment where beans and wheat had been sown together. Over the past two years this combination had been grown on 1 ha areas by a number of the farmers, but this year their combined areas had risen to around 30 ha. The quality of wheat harvested from these areas had been so good that their confidence had risen, and if successful this year, the area would be increased again next year, perhaps reaching around 300 ha in the region. Such a crop combination might mean that they could avoid bringing manure onto the farm. At the moment they had to sell the crop as animal feed, but if enough was grown their buyers would separate the two crops in a grading machine, selling the wheat as a high quality organic product. At the moment manual mixing of the two seeds was necessary for them to be sown within the same machine, but this could be mechanised. The varieties of wheat and beans had been chosen carefully to match as closely as possible their seed characteristics, not only for sowing, but also for harvesting that was carried out with a conventional combine harvester. Digni was excited by the fact that this was a true ecological farming system in that it was balancing the P & K inputs and outputs and capturing nitrogen through rhizobia on the beans. When growing 50% forage and 50% cash crops this was a difficult balance to achieve.

Geometius

Dennis Nijland of “Geometius”, who deliver Trimble guidance systems to the Netherlands and Belgium provided us with an overview of their products and services. Geometius sell into agriculture, surveying and the marine environments and also develop and provide the software behind GIS (Geographic Information Systems). Established in 1994, Dennis has 15 colleagues who provide a rental service and also run a service centre
that covers all units in the Netherlands, with expertise that allows them to deal with all
issues “in house”.
In agriculture they have 350 EZ-Guide products in the field and 70 RTK Autopilot
systems, of which 12 operate within either a CTF or a SCTF regime. Trimble was the
first to introduce an RTK AutoPilot system in Europe and this was for a CTF application.
Their standard products delivering 10 – 30 cm accuracy include EZ-Guide Plus and EZ-
Guide 500. These cost €3,000 – €4,000 but can be upgraded to RTK AutoPilot. All the
systems offer auto steering through their EZ-Steer bolt on motor that drives the tractor
steering wheel by contact with its periphery. When installed with RTK, this would only
be expected to deliver ±5 cm accuracy rather than the ±2
cm with “plumbed in” autosteer. The latter (AutoPilot) is
available for all machines including harvesters and when
driven in reverse. Trimble’s RTK system also has a drift
sensor to correct side shift that may occur when pulling
soil working equipment that imposes varying laterals
loads. This works through a steering angle sensor on the
roof equipped with three gyros that detect roll, pitch and
yaw. When using land levelling equipment the receiver and gyros will be placed on the
working implement and precludes the need for a laser. Another implement-based and
recent development is “side shift”. In this case receiving antennae and gyros are placed
on the tractor and the implement, the latter being steered independently through either
steered wheels, a hydraulic cylinder on the tractor (see earlier photo) or if it is a very
heavy machine, through steered coulters. The antenna on the implement is mounted in a
raised position to help ensure satellite reception. In the cabin, both tractor and implement
information is displayed with light bars on one display console. The steering of tractor
and implement can be engaged separately and the system allows curves to be negotiated.
Dennis then went on to AgroSPIN (Agro Service Precision Farming in a Network
Environment). In the Netherlands this is enabled through 27 national base stations
covering the whole country in what might be termed a spider’s web.
Until now, the system has been used for surveying, but Geometius have
negotiated delivery of a correction signal from these stations via GPRS
(General Packet Radio Service – data transfer charged per megabyte
rather than by time) technology from a third party. In effect this means
that anywhere in the Netherlands where you can receive a mobile phone
signal (and this is practically everywhere), you can receive a correction
signal capable of providing ±2 cm accuracy. The correction is measured
in a coordinate system that through satellite scanning of a particular area delivers
“background files” that preclude the need for recalculation. This means that the system
initialisation is 30 s rather than 1 minute for a base station.
The system works by creating a virtual reference station (VRS) from 3 of the 27 national
base stations. These stations look at the satellite array and send the signals via the internet
to a calculation centre. If you are on a tractor, the tractor sends an NMEA string (NMEA,
a communication standard developed by US – based National Marine Electronics
Association) to the calculation centre and this identifies its position. The centre then
calculates a VRS in the close vicinity of the tractor for which correction signals are
calculated and sent back to the tractor. As far as a user is concerned they see no
difference between this and a local physical base station. In the tractor, the only
difference is that there will be a cellular modem (like a mobile phone) with its own GPRS
card, rather than a radio.

Geometius have negotiated a deal with a third party land survey GPRS provider and in
the Netherlands now offer a correction signal for just €995 per annum for 800 hours of
“on line” time. It appears that the “on line” time is not as great as the time the system is
actually in use because the information is sent in “comma separated files”, presumably
meaning that your time is not clocked between one comma and the next!? Dennis quoted
€30 per 100 hours of delivered signal. The modem is €2,000 compared with a radio
costing €2,500 (from Geometius) plus some cabling.

Taking questions, Dennis said that in the case of GPRS signal loss, RTK would also be
lost, but if only for a short time, it would be very quick to re-establish once the signal
returned. Generally, reception in a field is good (compared with in buildings), but if
reception is a permanent problem, the correction signal can be delivered through the
internet and a local radio link. Depending on where you are and what radio frequency the
system works on (the higher the frequency, the less it “bends” round obstructions) and
what power level is allowed by local legislation, it may be possible for a grouping of
farms to get together and establish several transmitters all provided with the same signal
from the internet via an ADSL (broadband) connection. Geometius now also provide a
back-up system for ADSL. If one ADSL provider “goes down”, a second will
automatically be picked up.

Sadly for the rest of us (not in NL) this network system is not likely to be so cheap, but in
any country where there is a land survey network, it doesn’t take much to build a package
for agriculture.

**Conclusion of the workshop**

As with the first day, the overriding message was the need to develop harvesting systems
that are compatible with vegetable crops and CTF. The encouraging further message
from the growers themselves was that this is not a technical problem, it is one of
economics. Individual growers often do not have enough area to justify designing and
developing machines themselves, but in the Netherlands, the number of growers using
SCTF is now approaching the point where a contractor might be encouraged to make that
investment. Certainly, a harvester designed for controlled traffic would still be perfectly
suitable for random traffic systems, so any contractor making such an investment would
have the potential for a new as well as an existing market.

The other positive message is that SCTF is delivering benefits, despite random traffic
being used for harvesting and primary cultivation. It can only be speculated what extra
benefits might be gained from a full CTF system!

It was also noticeable that growers were still pretty much on their own when it came to
the machinery needed for CTF. It is in the interests of all involved in CTF that its benefits
are circulated and growers encouraged to raise the subject of CTF with their machinery
suppliers. Only when there is confidence from the machinery industry that there is a
significant product demand will appropriate machines be designed and built.

The subjects of research, education and extension were well represented by attendees at
the workshop and Jan van den Akker (Secretary General of ISTRO) in closing the
meeting, brought our attention to ISTRO as a key umbrella organisation that could bring
people together from across the world to discuss and address particular aspects of CTF. Research of this nature would provide growers with the management information they needed, particularly in the subject area of soils and to the crop responses arising from the low input systems that were possible with CTF. He was pleased that the ISTRO Controlled Traffic Working Group had provided this focussed event for which there was so much interest and both he and Tim Chamen thanked the organisers most sincerely for a well managed, interesting and enjoyable two days. Particular thanks were due to Bert Vermeulen and his colleagues at Plant Research International, Wageningen under whose umbrella the meeting had been organised. Also very particularly, thanks to the growers who had made it all possible – Kees van Beek, Dianne Schrauwen, Jaap Korteweg, Leen van Reedijk and Digni van den Dries. Sincere thanks similarly to John McPhee, who had come from Australia to share his thoughts and experiences with us and to Hans Henrik Pedersen for his presentation. The presentations from the different satellite guidance providers were also particularly valued and our thanks to them for joining the workshop.

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CTF Europe Ltd
Bert Vermeulen, Secretary, ISTRO CTF Working Group
Plant Research International
5 June 2007
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