Aspects of precision Farming: Guidance and Autosteer

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Potential cropping applications for GPS

- Guidance
- Swath logging
- Yield mapping
- Variable rate control

Levels of machine guidance

Driver assistance

Machine guidance

Fully Robotic

- There are three categories of machine guidance.
- One, driver assistance, in this case the driver is still in control of the vehicle but follows directions from a lightbar which is placed in front of them. GPS is used to generate an initial A-B line. The system then generates parallel lines at the appropriate bout width for the driver to follow. As the driver moves to the next bout the system will guide them to the correct width and then using a system of lights will keep them on track. If the driver deviates off the track then red warning lights will show, when the driver is on track on the green lights will show. There are a number of systems available on the market, most will allow round and round and driving patterns as well as fallowing straight lines. The types of application of these systems are fertiliser spreading and sprayer guidance.
- Two, machine guidance, is where the tractor is automatically steered by the GPS controlled computer system. Once the driver has initiated the system they should not touch the steering wheel until they reach the other end of the paddock. These systems are much more expensive but have a number of advantages in terms of output and quality of work. They are more accurate than human driver.
- Three, fully robotic, this is a fully automated system that has no driver, most will either travel along predetermined path or have a vision system that will guide them. As with machine guidance they will use a highly accurate GPS system as the basis for the control system.

Levels of machine guidance

Driver assistance

- GPS used with in-cab screens, lightbars to guide driver along swath lines
- Driver still has **full control**

Machine guidance

- GPS guidance system linked to hydraulics.
- **Hands-free** driving, leaving operator to concentrate on machinery performance.
- Precision operations can be carried out day or night.
- Level of accuracy provided by GPS depends on requirements and budget!

- Driver assistance helps to improve driver accuracy for the placement of fertiliser and chemical sprays. It has also been shown that these systems can improve output as driver confidence is improved and slow speeds can be maintained for longer periods. There is very little setup time compared to other systems such as the use of foam markers. Even experienced drivers to find the system useful as it cuts down fatigue when driving for long hours.

- Machine guidance tends to be used for a work that requires greater accuracy such as the formation of vegetable beds where crops need to be planted in regular beds, the straighter and more consistent the bed then the easier it is to perform all subsequent operations such as harvesting. These systems are much more expensive than driver assistance as they use RTKDDGPS. Although expensive they have been proven to be economic to vegetable growers in New Zealand. The most common system in New Zealand is the Trimble Autosteer. Details can be viewed on Trimble's web site: http://trimble.com/agriculture.shtml

Automatic Guidance : No Hands Driving

- The auto steer system is more accurate than human drivers can achieve, here's an example where the system is matching exactly between runs of bed formation. This could not be attempted with a human driver. The Autosteer system is accurate to within a few millimetres. It uses a combination of highly accurate RTKDGPS and inertial navigation techniques to maintain a very accurate course.

- The only work that the driver has to do is to position the machine at the beginning of a run, once the system is activated then it will take over until the machine reaches the other end. Users have found large gains in productivity, speed of work is higher, quality of work is higher and the system can be used for longer hours with less skilled workers. It can be used at night for example where previously without such a system quality of work would diminish when visibility became limited.

Benefits from GPS guidance in cropping

Guidance

- Can show most immediate benefits

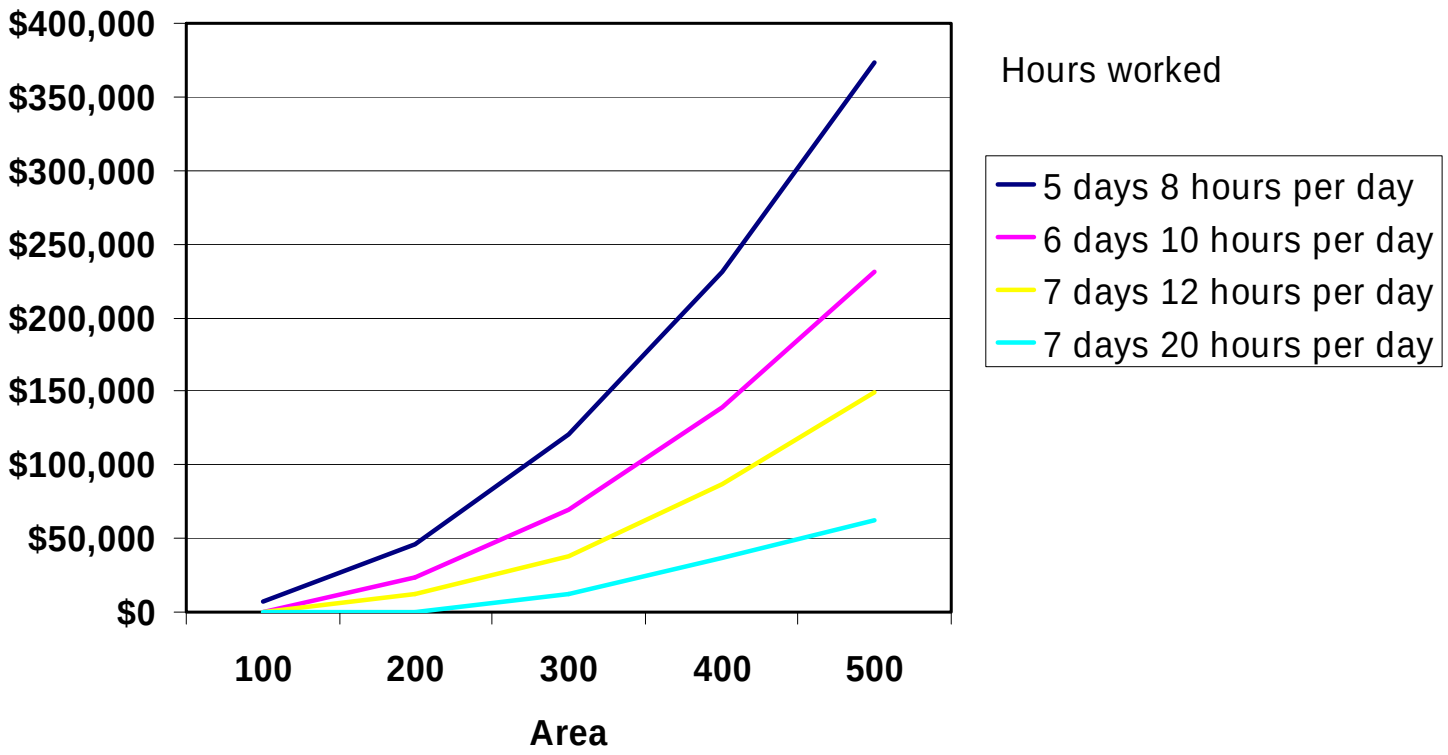
Direct benefits

- Higher operating speed
- Improved field efficiency
- Longer operating hours
- Labour productivity

Indirect benefits

- Reduced operator stress (?!)
- Improved accuracy (planting, weeding, fertiliser placement, increased timeliness)
- QA and traceability (requires field computer)

Financial loss from late sowing of Maize



Assumptions: 8 row planter, 8 km per hour, 80% field efficiency, 5% loss per week for late sowing. 25 tonne DM crop, 20 cents per kg. Soil workable 70% of the time.

- Being able to ensure that jobs are completed on time have direct financial implications for farmers and growers. It is estimated that as the season moves on a yield loss of 5% per week is suffered in maize. Clearly we need to match machine capacity with the area that needs to be completed and the time available to complete the work. The slide shows the effect of being able to work for longer hours per day and more hours per week, this is one method that we can use to reduce losses. It is easy to see why contract which often work long hours at peak periods. Using systems such as machine guidance can allow operators to operate the longer while maintaining the quality of work, with less variability between operators. A number of contractors are now using these guidance systems in their own maize production systems.

Potential for application for strip cropping

- Need around 10 cm accuracy
- RTK GPS only applicable system
- Possible sensor-based system?

- It has also feasible to use the systems for mechanical weeding as the level of accuracy means the crop damage will be minimised. This is important for organic producers who do not have the option of using herbicides. A further example of using Autosteer is a system called controlled traffic, this system seeks put all traffic on certain lanes in the field and leave the rest of the paddock with no wheel marks. This reduces soil compaction damage from machinery and assists in maintaining good soil health. Again it would be very difficult to use these systems if you are purely relying on human drivers.

David Clark

Clark Farming Group

Gisborne

- This is a conference presentation David Clarke gave to the Landwise Conference in Palmerston North on the 9th of May 2007.
- The purpose of including it, is to illustrate how technology can be used to bring about other goals: in this the desire to use a system called “Controlled Traffic”.
- The soils on the farm have been difficult to deal with using conventional cultivation methods. Work overseas has shown that if traffic is strictly controlled onto lanes then although these tracks do not have crop there is a significant benefit from keeping the wheels off the land.
- Using this system eliminated this the risk of soil compaction and as a result the soil becomes work easier to work reducing the overall power demand as well as providing an improved environment for the plants. It is particularly suited to systems where the soil has to be regularly worked. The other major objective was to reduce tillage by introducing “Strip Tillage” this again has a number of benefits the main ones being, reduction in soil erosion through the ability to maintain cover on significant areas of soil in drier spring periods when seedlings are establishing. The second benefit is reduced tillage costs. Again this methodology would be difficult to achieve without the use of the Autosteer technology used.

Opou Station

- 400 ha
- Clay loam soils on a flood plain
- 2006/2007
  - 100% maize
  - Maize for:
    - Food industry
    - Feed(early season contracts-Feb harvest)
    - Maize seed production

Opou Station

- Average paddock size:
  - 26 ha (range from 10 ha to 44 ha)

- All groundwork, planting and maize harvesting done by ourselves

Machinery

- JD 8300 (250hp)
- JD 8520 (300hp)
- JD 2450 (80hp)
- JD 9500 harvester (300hp)

Total hp 930

=0.93 hp/acre – (0.63 hp/acre excludes harvester)
=2.32 hp/ha – (1.57 hp/ha excludes harvester)

In a number of systems in Europe for example the target for power per hectare is around 1. In this case it is 1.17kW per ha. One of the important differences is that all land is going into one crop and so workload peak are likely to be more extreme leading to an increased power requirement. One of the objectives of the system is to maximise the sunshine hours the crop receives by getting it sown early, that benefit would not be realised if the farmer did not have adequate machinery. One of the successes of this system has been early establishment of the crop into good quality seedbeds. Maize is a crop that does not tolerate wet poorly drain seedbeds especially at plant emergence and when the plants are young.

Conversion to Controlled Traffic with RTK GPS
Spring 2003

Reasons to convert:

- Heavy clay soils do not like being worked
- Reduce compaction
- Increase soil organic matter
- Improve soil structure
- Reduce passes
- Encourage worms through reduced cultivation
- Reduce labour requirement
- Save fuel
- Early planting
- Get away from pto driven machinery eg. power harrow

The Conversion Process

- Establish wheel track width:
  - 3m – 10ft harvester
  - Duals came off – 20"-22"
  - Spacers/cotton reels on JD 8300 & JD 8520
  - 20" wide tyres on harvester
- All vehicles had to be put on the same wheel track and standard sized tyres.

JD 8300 Front Axle Extension

Changing to controlled traffic mean that all the wheel tracks of all tractors, harvesting and spraying machinery had to be put out to exactly 3m.

JD 8520 Cotton Reel Extension

- Convert 8300 & 8520 to RTK GPS and self steer
- Install base station
- Operating width increased to 12 x 30" rows (30ft or 9.09m)
- Chose to commit all machinery to 30ft width (exc JD disc ripper)
- Three tractors sold – 500hp
- One new tractor – 300hp

Existing machinery was extended:

- Soil Finisher 28 to 30 feet
- Buffalo Cultivator 8 to 12 rows

New Machinery:

- Kinze 12 Row Planter
- Simplicity 4.5t Fertiliser Wagon
- DMI Strip Till 12 Row
- 30ft Alloway Mulcher
- 12 Row Head for Harvester
- 28m Sprayer

All machinery had to be matched so that the controlled traffic system could be established.

Mulcher

Mulching important to the overall management of the soil.

Strip Till

Only strips of the soil are cultivated. Autosteer means that the tractor can be positioned exactly for subsequent operations.

Strip Till

Strip Till

Strip Till

Strip Till

Planter and Simplicity

Autosteer is used for the planter.

Sprayer

And sprayer

Buffalo Cultivator

Inter row cultivation can be done using autosteer. It is more accurate than a human driver, therefore less risk of damage to the plants. Can be used day or night, in peak periods and can also be used for a longer periods of the growing cycle.
For organic production mechanical weeding could be used with Autosteer.

Buffalo Cultivator

Harvester runs on the same tracks as the tractors. 12 rows maize header presents certain difficulties in terms of weight. Extension to unloading auger to allow bin to be driven in the next track so no fresh ground is touched by a tyre.

It is important to be extremely careful around harvest time as there is huge potential for problems with very heavy machinery and sometimes wet soils.

It is most important to try not to track wet soils as they are very weak and easily compacted. Compaction damage can last many years and be transferred deep into the soil.

Autosteer in action drilling into a maize stubble

Maize following Maize

- Harvesting on tramlines
- Jockey bin following tramlines
- Mulching on tramlines

Challenges

- Strip till following harvest
- Accuracy of RTK means we have ability to move 3-4 inches off old row
- Why do we need to cultivate to depth if we are not travelling all over paddock?
- Headlands may need extra work depending on soil conditions and traffic
- Ensure there are no pans or compaction

AUTO-STEER on Waitatapai

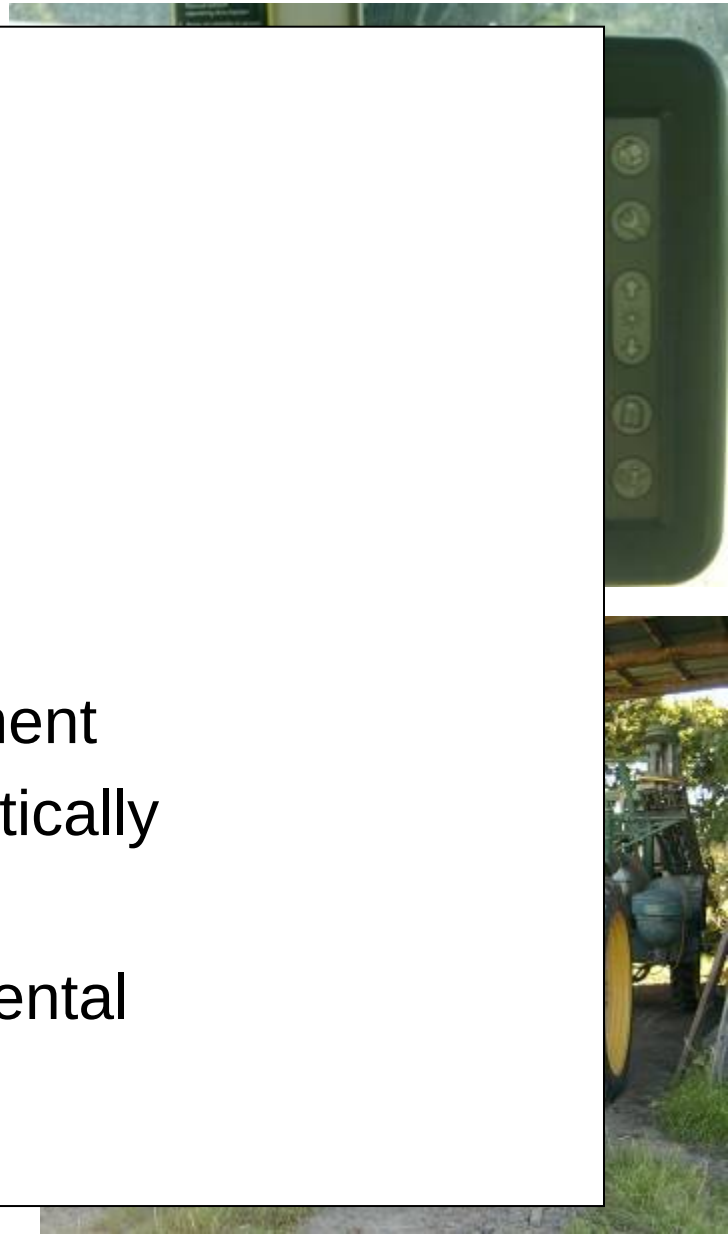
Waitatapia is large mixed farm near Bulls in the Manawatu. The farmer is also using an RTKDGPS based Autosteer system

Waitatapia is already showing a 12% reduction in fuel and tractor hours per ha.

Self steering is allowing the easy adaption of strip tillage with varying width equipment, the potential reduction in soil compaction and the opportunity to undertake CTF (control traffic farming).

Self steering benefits-RTK (2cm accuracy)

- Controlled traffic
- Match variable width implements
- Strip spraying
- Night spraying
- Inter row weeding (maize & squash)
- Buried drip irrigation
- More efficient labour use
- Land contouring and drain development and maintenance (2cm accuracy vertically as well as horizontally)
- Assists to conforming with environmental expectations (accurate placement)



Power harrow strip-till 3 days after spraying

CHOOSE THE SPACING

30 inch/75cm rows

60 inch/1.5mtr rows

SUBSOILING

- 7 rows immediately followed by an 8 row maize planter.

Last pass before planting