PRECISION AGRICULTURE IN **RICE** PRODUCTION

GPS & GNSS technology in layouts and levelling

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RURAL INDUSTRIES
Research & Development Corporation

GNSS and GPS

GNSS AND GPS

GNSS stands for Global Navigation Satellite System. GNSS is used to pinpoint the geographic location of a user's receiver anywhere in the world through the use of satellites.

There are four constellations used by GNSS:

- GPS (Global Positioning System)–USA;
- GLONASS–Russia;
- Galileo–Europe; and
- Beidou/Compass–Chinese systems.

GPS was develop by the US Department of Defence and is maintained by the United States government. The term GNSS is being used more than GPS as time goes on.

GNSS applications include:

- navigation–location, speed, direction, altitude/height, points of interest, and auto-steering;
- surveying and mapping;
- construction and engineering;
- remote sensing (EM38, NDVI, imagery)
- mining; and
- agriculture (cropping, horticulture, livestock).

Developments in the agricultural use of GNSS a began with steering machinery; initially as a visual display to aid the driver, then for auto-steering. Harvesters with yield monitors now use GNSS to create maps of yield (sometimes also grain protein and moisture) across the paddock.

More recently, blades and buckets of earth moving equipment are being controlled automatically with GNSS-based machine guidance systems.

Data derived from farm operations (i.e. harvesting, remote sensing) can be used to implement variable rate applications of farm inputs (seed, fertiliser, lime, gypsum).

The use of GNSS in agriculture has yielded tremendous benefits in terms of controlled traffic farming (CTF), row crop operations, spraying, more effective use of inputs, and greater precision in land grading, during both the survey and levelling stages.

IMPROVING RICE LAYOUTS AND LEVELLING WITH GNSS/GPS TECHNOLOGY

There is significant opportunity to use existing GNSS technology for field survey, re-design of layouts, and implementation of re-levelling. GNSS accuracy is now good enough to replace laser guided systems, and offers additional benefits compared to traditional techniques (*see page 8*).

FIELD DESIGN

Operational efficiency can be increased by matching bay widths with implement widths in order to avoid half-runs and ensure the start and finish of a bay is at the same end of the paddock. These efficiency gains are maximised under a controlled traffic farming (CTF) system. The simplest system uses a sprayer and spreader width three times the width of the seeder (for example 9 m seeder with a 27 m sprayer and 27 m spreader).

The harvester matches the width of the seeder. Wheel spacings are also matched, typically 3 m spacing to match the header.

Science has proven the soil benefits of minimising wheel compaction effects and rice farmers who have implemented CTF systems have reported operational efficiency gains. Many CTF farmers are now using GNSS to develop field designs as they set up new paddocks, but few go back and redesign existing layouts. This highlights the fact that the benefits may not immediately out-weigh the cost of a redesign. For further information on layout design see farmer case study 'Nathan Pate, Tocumwal' in *Precision Agriculture in Rice Production: grower experience and insights*.

Cab clutter is the inevitable result of implementing GNSS technologies.

CTF is also helpful for monitoring and assessing on-farm trials as every pass of the seeder is followed perfectly with the harvester. These trials are hugely valuable for farmers who are looking to test ideas or products and want some hard data and to develop an accurate understanding of the return on their investment.

FIELD SURVEYING

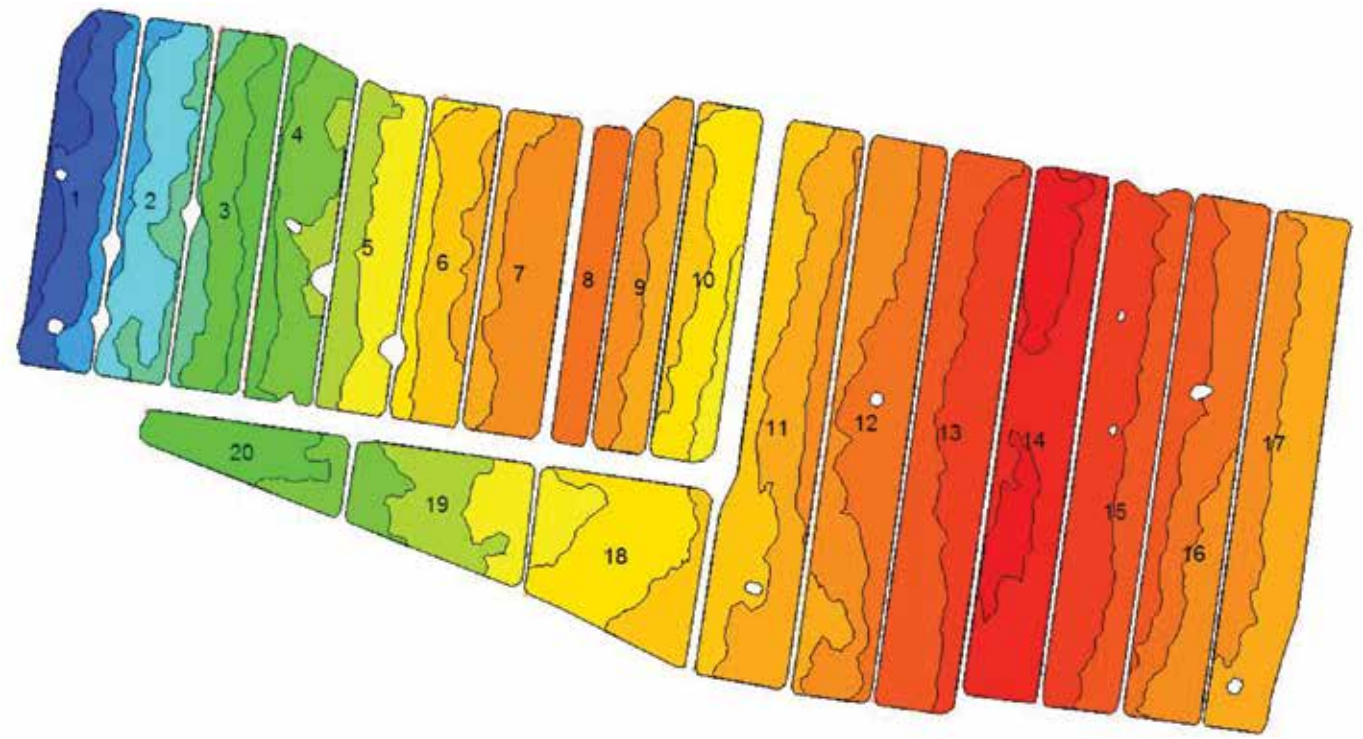
Elevation data can be collected during routine operations (ideally seeding) utilising existing systems when auto-steering (using Real Time Kinematic 'RTK' GPS), enabling the monitoring of bay levels and assisting in the prioritisation of individual bays for re-levelling. However it is recommended to conduct a survey specifically for land levelling, as close as possible to the time when the work is to be carried out. Care needs to be taken to avoid deep wheel tracks or rutting caused by previous passes across the field.

Never use elevation data from a harvester as the readings are influenced by the weight of grain in the header box. A full box of grain will affect the total mass of the header and increase the potential to sink into the soil and compress tyres, which will alter GPS recorded elevation.

Most auto-steer displays have the ability to log elevation data and many do it without the farmer even knowing. In some cases you may need to check the settings of the display to ensure the data is being logged at a desirable density.

Cotton-reel spacers are used to spread the front axle of tractors to 3m centres. The image on the left is a John Deere spacer which is warranted. The one on the right shows a locally engineered retrofitted version.

FIELD SURVEY



A digital elevation model of a rice paddock using 5 cm contour lines.

(Some systems default to the maximum time/ distance between data points to prevent the display from blocking up with data). Ideally you want to collect a data point every one to three seconds or five to ten metres. The data is linked to a job and is stored within the display as an application map.

Extracting data from the display varies for each brand but essentially the process involves transferring the data onto a USB stick or simply copying the data from the storage card. There are several software programs available which can read the specific files from most displays (i.e. Trimble = Track3D, JD = fdd, Agleader = agdata,

A poorly levelled rice bay can result in significant weed burdens and yield losses.

The components of a GNSS levelling system.

Autofarm = sqlite) including Trimble Farmworks and Agleader SMS. Once the data has been collected a Digital Elevation Model (DEM) can be created.

FIELD LEVELLING

It is very important to use a full GNSS receiver on the levelling bucket or blade. Farmers and contractors are starting to invest in these systems.

ACCURACY IN LAND-FORMING

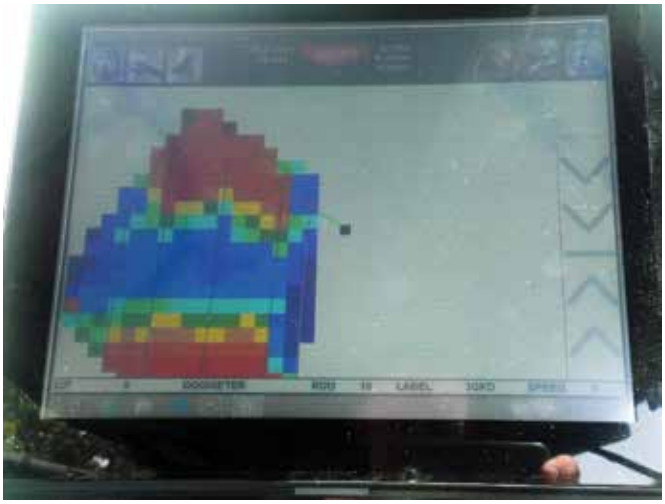
Land-forming requires the highest possible level of elevation (and position) accuracy to achieve fine vertical adjustments. It is highly recommended that only GNSS receivers be used on the levelling machinery, as GPS alone will not provide the required accuracy.

SYSTEMS

There are two types of systems.

Real Time Kinematic (RTK) is a system used to enhance the precision of satellite based positioning systems by using a ground based single reference/base station to provide real-time corrections and enable centimetre-level accuracy. It is highly recommended that the base station be within two kilometres of the levelling operation to be effective, especially in the vertical plane.

Network Real Time Kinematic (nRTK) is a system that also offers centimetre accuracy in real time but without the need for an



In-cab screen displaying design file and grade controls.

operators reference/base station, as it uses GPS raw carrier phase observations gathered from a network of Continuously Operating Reference Stations (CORS). The coverage of any nRTK GNSS service is only limited by the number of available CORS and the quality of the wireless data link used to transmit the correction to the users (i.e. mobile phone networks capable of allowing data – such as NextG). nRTK should only be used when the system is operating on full network corrections; using nearest base (NB) connections is likely to lead to errors as the distance between the base and receiver can be tens of kilometres.

SYSTEMS

COMMERCIALLY AVAILABLE SYSTEMS

A number of hardware and software systems are available on the market, each with a range of features and compatibilities. A brief outline of each of the main players in the market today is included here. The information supplied has been taken from the individual company's promotional material, and readers should make their own enquiries to obtain details of functionality and suitability. Further advice regarding types of systems and suitability to grower requirements should be sourced from your local Precision Agriculture consultant.

BRAND	Farmscan AG
SOFTWARE NAME	LevelGuide
SUMMARY SPECS	LevelGuide is an Australian software program integrated within the wider AgGuide mapping and guidance program that offers auto-steer, implement guidance, variable rate control and spray control, including boom section switching. Used with existing GPS units as long as vertical accuracy and reliability is satisfactory. Can use full multi-plane cut-fill designs, single plane designs or be setup simply like a laser by setting grades in the PC or using single, double or triple reference points.
WEBSITE	www.farmscanag.com/products/levelguide

BRAND	Topcon
SOFTWARE NAME	AgForm-3D
SUMMARY SPECS	This system uses the X30 control console with dual frequency, dual constellation GNSS antennas, a MC-R3 receiver and HiPer AG RTK base station. Applications include field levelling, contours, tiles and ditching.
WEBSITE	ag.topconpositioning.com/ag-products/gps-landlevelingsurveying/agform-3d-software

BRAND	Davco OptiSurface Pty Ltd.
SOFTWARE NAME	OptiSurface™
SUMMARY SPECS	Optisurface™ software, developed in Queensland, operates independently of hardware and offers massive reductions in soil moved (in some cases up to 90%) by working with the natural topography of the land. You can conduct a survey using Trimble, AGPS, or John Deere systems, then import that into Optisurface™ to create different designs depending on user requirements. The final design can be loaded back in these systems for automatic control of the bucket.
WEBSITE	www.optisurface.com

BRAND	Trimble®
SOFTWARE NAME	Field Level™ II
SUMMARY SPECS	Using a FmX/FM1000 Monitor and Antenna/Rover (one on the tractor and one on the implement), applications include the survey, design and installation for field levelling, contouring, levees, tiles and ditches. Levelling models include: point and slope; multi-plane; flat-plane; and contour. Field Level II also accepts Optisurface™ design files. Trimble also offers water management software through Farmworks™, however this is primarily focused on sub-surface and surface drains, not levelling.
WEBSITE	www.trimble.com/Agriculture/field-level.aspx

BRAND	AgLeader®
SOFTWARE NAME	Intellislope®
SUMMARY SPECS	The Intellislope® system uses an Integra monitor for field survey, design and tile installation only (it does not have field levelling features). Intellislope® software features include: drainage analysis mapping, tile installation designs, plan the depth and grade of the tile, control the installation and capture topography data during tile installation.
WEBSITE	www.agleader.com/products/intellislope/

BRAND	John Deere® and PCT
SOFTWARE NAME	iGrade™ and TerraCutta
SUMMARY SPECS	iGrade™ uses a GreenStar™ 3 (GS3) (recommended) or Greenstar 2 (GS2) monitor with a John Deere 450/900 RTK station and a StarFire3000 or iTC™ Antenna/Rover Model for levelling, ditching, grading and plane generation. The system uses Surface Water Pro Plus software for automation ditches, tiles and contours, and TerraCutta for multi-fit application including cut/fill by plugging in a laptop or tablet to the JD controller via a serial port cable. iGrade™ activation works with many of the different John Deere Ag Management Solutions. As the system is connected to the tractor additional functions are possible such as load limiting–where by the scraper will be automatically raised when engine speed and/or slip thresholds have been exceeded. However the load limiting system is disabled when using TerraCutta software.
WEBSITE	www.deere.com.au/en_AU/products/equipment/agricultural_management_solutions/field_and_crop_solutions/igrade/igrade.page

GPS versus LASER

GPS/GNSS VERSUS LASER LEVELLING

BENEFITS AND CHALLENGES OF USING GPS

- GPS is not affected by atmospheric issues (drift with temp changes) enabling the potential for around the clock capability.
- Land-forming designs can be pre-loaded onto GPS displays, providing an opportunity for the farmer to review and change the design.
- Using multiple grading tractors and buckets, the job can be loaded into each machine. Laser requires each machine to be set up individually.
- GPS levelling enables the ability to work across the entire paddock (approximately three kilometre radius of base station for base cuts, and approximately one kilometre for final grade), whereas laser levelling requires working within smaller zones. This reduces time, fuel and compaction.
- GPS can operate 24/7 with the use of auto steer and guidance to aid driver ability.
- Tractors are coming steer- and level-ready via CAN Bus and hydraulic systems.
- GPS follows curvature of the earth, laser is a straight line. Curvature of earth is approximately 20 cm vertical over 1.6 km horizontal.
- Satellite constellation issues can arise at certain times of the day and periods of the year (i.e. poor around December). Less of an issue in time as more satellites become available.
- Sunspots play havoc with GPS signal.
- Vertical Dilution of Precision (VDOP) is critical for accuracy (0.7 to 1.2 is good, greater than 2.4 there is too much error in the VDOP). VDOP is related to appropriate satellite coverage.
- Laser transmitter requires maintenance calibration.
- Older laser systems are being phased out, spare parts expensive.
- Manufacturers moving to GPS based systems.
- Laser accuracy can be affected by dust particles, physical interferences and heat shift.

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