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FREE FUNCTIONALITY:
- Digital farm mapping
- Paddock record keeping and future planning
- Grain storage record keeping
- Operation templates for repetitive data entry
- Comprehensive operation, input and grain storage reporting
- Receive recommendations from your connected adviser

SUBSCRIPTION TOOLS:
- APSIM yield simulations every 10 days
- Climatic events affecting crop development
- Biomass NDVI tracking of crops
- Soil moisture status
- Farm drought monitor
- Paddock gross margins

ADVISER TOOLS:
- Dashboard of all managed farms
- Connect to or register new grower accounts
- Recommendation and observation reporting
- Customisable report setup
- Access grower APSIM yield simulations
- View all grower available tools

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COMING SOON!
From the president

As an independent membership organisation, SPAA aims to promote the development and adoption of precision technologies across the agricultural sectors.

SPAA does this through its Expos, projects and publications. In these activities and publications, we share the journey of farmers who have adopted PA.

However, we are aware of differences in the rate of adoption of PA by sector, region and type of technology.

So what is causing lack of uptake? SPAA is not the only one asking this question. Many in industry who have developed PA tools and techniques are wondering why uptake has not been greater.

The introduction of PA into our business, Bulla Burra has been in many small steps over several years. We asked, we looked, we tested on small areas. In this way we could analyse the productivity and profitability gains and make small mistakes before we rolled it out across our business.

An early decision was to have one PA platform across all machines, which makes it so much easier for training staff, record keeping and management.

As a SPAA member, it is most likely that you have already started using PA technologies. What helped you take that step?

To help SPAA increase adoption of PA across the agricultural sectors, we need to better understand what helped you take the first step into PA and what is stopping your neighbours who have yet to start.

Please share your thoughts and experience with us directly or via SPAA’s Facebook and Twitter accounts.

We hope to see you at our events and encourage you to invite a friend or neighbour who is not currently using PA.

Robin Schaefer
@RobinMSchaefer
Since the last issue, Dimity Hunter, SPAA’s development officer, and I have been organising regional PA Expos. With support from our wonderful sponsors, we have delivered programs tailored to the needs of cane growers in the Burdekin (see page 6), vegetable and horticultural growers in Queensland’s Atherton Tablelands, and are now concentrating on activities for grain growers in Western Australia.

Between August and October, three more events will be held in Victoria and New South Wales (see Diary Dates page 5). All these specialist events are designed to help farmers in these regions:

- learn more about the benefits of adopting PA technologies;
- discuss specific PA issues with experienced farmers and PA specialists; and
- hear about the latest innovations from our speakers and sponsors.

Several of the events will include half day hands-on session to address equipment and software issues.

We enjoy meeting members at these events and they are also a great place for non-members to experience the value that an association with SPAA offers.

We encourage members to attend these events and to bring neighbours and friends to help them gain confidence in adopting PA management on their farms.

I am delighted to report that the SA Grains Industry Trust (SAGIT) is to sponsor farmer representation on the programs at some PA Expos and at the PA Symposium over the next three years.

Farmer case studies are popular and well received as they provide honest candid accounts of their PA journeys and are great opportunities to learn and share with experienced PA farmers.

Full details of all SPAA events can be found on the SPAA website Events page.

**RINPAS**

When it comes to investing in PA research, it is important that farmers have the opportunity to influence its direction to help ensure it offers practical outcomes.

SPAA is helping to achieve this as one of the members of the steering committee for the development of the Research and Innovation Network for Precision Agriculture Systems (RINPAS).

RINPAS (www.rinpas.org.au) brings together 15 organisations including research providers, Research and Development Corporations, industry and state government primary industry departments to establish and drive the implementation of a national agenda for precision agriculture.

The group will then apply for funding from the National Primary Industries Research Development and Extension Strategy for Precision Agriculture Systems.

At the meeting in June, SPAA committee member Frank D’Emden, Precision Agronomics Australia represented SPAA. The topic for discussion was ‘Data for Decisions – Big Data and Data Communities’. Frank presented results from the SAGIT factsheet survey, previous PA adoption studies conducted by CSIRO and anecdotal remarks from
farmers regarding the problems they face in making full use of the precision ag data that is generated on-farm. Ideas on data accessibility and sharing, governance, privacy and ownership and current and potential data initiatives in the agricultural sector were discussed. Results from the workshop will be published on the RINPAS website in due course. SPAA's involvement is another example of how important it is for members to share their PA wants and needs with committee members and the executive to help ensure SPAA's input is as representative as possible.

If you have any specific thoughts about PA research required to increase on-farm profitability in any production sector, please contact myself, Robin (President) or our RINPAS representative and SPAA past-president Neale Postlethwaite (0407 547 848).

**New project**

I look forward to working with the Riverina Local Land Services which through the National Landcare program have funded SPAA to generate a virtual bus tour of PA farm visits in the catchment. To achieve this, we will produce YouTube videos showcasing farmers' use of PA tools and systems in four important agricultural sectors in the region; grain, cotton, rice, and horticulture.

**Join SPAA in Toowoomba for the PA Symposium.**

The 19th Precision Agriculture Symposium will be held on the 12 and 13th September at Toowoomba City Golf Club. The symposium is a great opportunity for PA enthusiasts to ‘learn, share, connect and be inspired’.

Presenters from research, development and leading farmers will report on their work from the breadth of agricultural sectors. This year's international keynote speaker is Lisa Prassack. Lisa is an agrifood innovation expert and data strategy consultant who has her roots in farming. She has presented at major PA events in the US and Canada on evolving PA technology, data security and what the future holds for agriculture. We look forward to hearing from her at the PA symposium.

On Wednesday 14th there will be a full day tour visiting farms and research facilities to see the latest PA applications in grains and horticulture.

The symposium dinner on the Monday night is always a great social event. This year delegates can even enjoy a round of golf at the venue. Registration is now open and more details can be found on the SPAA website Events page.

**Membership due**

Yes, it is that time again when membership is due – don’t forget that only members receive Precision Ag News and all PA factsheets in the post. Another benefit of membership is priority registration at the annual PA Symposium.

Current members were emailed a membership renewal and new members can join at SPAA events or download a membership form from the website.

**Diary Dates**

**SPAA Expos and events**

- 28th July - Three Springs, WA
- 1st August – Temora, NSW
- 2nd Sept - Gunnedah, NSW
- Early October - Horsham, Vic
- 12th -13th Sept - PA Symposium, Toowoomba, Qld.

**International**

- 31st July-3rd August - 13th International Conference on Precision Agriculture (ICPA), St Louis, Missouri, USA
- 16-20 July 2017 - 11th European Conference on Precision Agriculture (ECPA), Edinburgh, Scotland.

**info@paanz.co.nz**

**Stay connected with SPAA on twitter (@SPAA_EO), Facebook and YouTube**
SPAA was delighted with the response to its first PA Expo for cane growers. This was held in the Burdekin region of Queensland and supported by Sugar Research Australia. The PA Expo attracted over 40 local cane growers and industry support personnel to learn from a packed program of speakers.

While the morning was filled with technical presentations, the afternoon consisted of hands-on training to help growers gain the most from the GPS and PA equipment they already have in their machines.

Brothers Bryan (left) and Terry Granshaw (centre) both use PA technologies to help improve cane productivity. They are pictured with local farm manager Walter Marcheini.

Bryan Granshaw, BMS Lasersat, presented the latest in soil surveying. The Soil Information System (SIS) uses a combination of an EM38 survey and physical soil samples that are sent to an accredited laboratory for analysis. The system measures 60 soil parameters and creates a 3D soil map.

The location of the physical samples is guided by the EM survey and samples are taken at two depths (0-60cm and 60-120cm) which are analysed separately. Surface compaction is also measured. All the data is processed by Trimble US and located on the user’s Connected Farm account.

The soil map can be used to support irrigation scheduling and variable rate inputs such as gypsum.

While Bryan’s focus was the soil, Terry Granshaw of Burdekin Productivity Services presented on precision herbicide management.

Two of his key messages were to make sure rate controllers were set up correctly and to check the plumbing of their sprayer was appropriate to achieve consistent and correct droplet size.

Investing in new systems such as three-tier, three-step dual boomspray systems or Vari-jet nozzles can overcome the issue of droplet size changing with ground speed.

However, Terry explained how rate controller set-up will help ensure droplet size is maintained even when ground speed and pressure are altered. This is achieved by entering suitable minimum and maximum ground speeds for nozzle and droplet size into the rate controller.

Appropriate minimum and maximum speeds can be found on tables sourced from the nozzle manufacturer.

Bryan also talked about the value of technologies such as autoboom shut-off to minimise overlap and bypass plumbing systems which has been found to increase application accuracy.

Technologies to improve weed control in cane were also the focus of the presentation by Steven Rees, National Centre for Engineering in Agriculture (NCEA, based at the University of Southern Queensland). Steve is pictured on the right with Peter Samson, SRA (centre) and David Brown, DAF (left).

The NCEA is developing precision spraying systems using machine vision and image analysis to discriminate weeds from crops. Such systems enable spot spraying of target weeds.

In trials using glyphosate to control Guinea Grass in cane, 85 percent of the weeds were controlled and very low rates of miss spraying of sugarcane occured. Herbicide use significantly reduced. Research is continuing using 3D rather than 2D algorithms which increase accuracy where there is leaf shadow and to make the system more reliable in varying light conditions.

Other presenters included Troy Jensen, USQ (pictured) on cane yield mapping, farmer and experienced PA and CTF grain grower St John Kent and Steve Attard, Agritech Solutions. Steve illustrated how automation of irrigation could reduce water usage, energy usage, reduce losses, improve production and all importantly save labour and travel time.

For more details you can access their slides on the SPAA Past Events page of the website.
SPAA was an event supporter of the International Irrigation Conference. If you follow SPAA on twitter (@SPAA_EO) you may have spotted that I attended this event as editor of Precision Ag News. Here are a few points of interest from the conference and more reports and interviews will be published in future issues of Precision Ag News.

‘Smarter Irrigation’
This is a multidisciplinary research, development and extension focus that is looking at technologies and techniques to help ensure more irrigators are using best management practice.

The use of sensors and switching gear to improve ‘precision adaptive irrigation management’ in drip, spray and flood irrigation systems is a key component of the research that was presented at the conference.

While we heard from several progressive farmers, changing farmers’ attitudes about how they manage water seems to be a sticking point that the industry has been grappling with for many years.

Perhaps the irrigation scheduling app presented by Michael Scobie, National Centre for Engineering in Agriculture, University of Southern Queensland, might help.

Check out www.kmsi.usq.edu.au or for more output from less manual inputs, download the Scheduling Irrigation Diary app. This app is using augmented reality and is available for Android and iOS platforms.

**Aussie irrigation innovation**
There was plenty of Aussie irrigation innovation on the conference program and displayed in the trade show.

Developed in partnership with the CRC for Irrigation Futures, IrriSAT uses satellite imagery to estimate crop coefficients at a 30m resolution. A delivery platform is being developed using the Google App Engine. The app will provide easy access to the IrriSAT crop water use data, which coupled with weather data will enable irrigators to track their soil moisture deficit and better manage irrigation schedules.

A spray on biodegradable polymer membrane offers flexibility and significant improvements in water productivity. The polymer devised by CSIRO has potential applications in all bare soil production systems. It also reduces the requirement for the millions of tonnes of surface plastic mulch currently used across the globe to conserve soil moisture, control weeds and modify soil temperature. Think about the potential for spatial application of this polymer only where required.

Australian designed and built irrigation sensor systems by MEA and Sentek were also on show and offer innovative, robust and simple to use design features demanded by Australian irrigators.

**BOM**
If you have not looked at the Bureau of Meteorology (www.bom.gov.au) website recently I encourage you to do so. There are some great new features and not all of them are found in the Agriculture section.

In Water Information, the Landscape Water Balance maps show soil moisture percentage on a 5m by 5m grid. Pick your location and look at change over the year and compare years.

I want to learn more about how this is generated as I feel it could be useful for fertiliser planning in broadacre cropping.

MetEye is a good starting point to take a look at some of the new features - http://www.bom.gov.au/australia/meteye/
As a self-confessed ‘Techno Addict’, Ashley Wakefield has been an early adopter of many precision agriculture (PA) technologies. He has also spent considerable time helping developers make their technology suitably robust, accurate and ‘friendly’ for Australian farmers.

Ashley has generously shared his PA story many times, including being featured in the SPAA publications PA in Practice I and II. In PA in Practice I, produced in 2008, Ashley estimated that his investment in PA was providing a benefit of $19/ha, basically due to reduced overlap.

In 2008, Ashley was already testing the third prototype on-harvester protein meter but it was not until 2013 that this equipment started to pay its way offering substantial increases to the dollar per hectare value of PA to his farming business (Figure 1 and Table 1).

“In-paddock blending helped ensure 17 out of 18 trucks of wheat were delivered as Australian Premium White (APW protein>10.5%); at $30 a tonne price benefit that represented an increased income of $37.29/ha across this 185ha paddock,” said Ashley.

“If we had not blended, about half of this paddock would have been sold at a lower grade and price.” Ashley started PA 20 years ago with a Microtrak yield monitor, a Farmscan guidance system and Omnistar GPS correction giving +/-10-30cm accuracy.

He now uses a John Deere yield monitor and has his own base station to provide the correction system for his RTK guidance. All tractor units are fitted with Topcon autosteer and rate controllers, which are used for fertiliser/bait spreading, seeding with a Bourgault disc and on the Miller Nitro self-propelled boomspray which is fitted with Arag Seletron individual nozzle control.

Ashley has worked closely with Topcon on the development of its PA software and hardware including the CropSpec™ sensors which are central to his variable rate program.

Data layers
As an early adopter of PA, Ashley now has multiple data layers for his paddocks and in many cases, multiple yield maps for the same crop in the same paddock.

“In the past, we have grown canola but currently we are running a three year rotation of wheat, barley and a legume so we are collecting wheat and barley data from a paddock every three years.

“Combining multiple years of yield, protein, soil and biomass data, as well as our paddock knowledge, is helping to produce more reliable and useful maps.”

For example, overlaying protein and yield maps can help determine where additional nitrogen (N) probably will and will not result in a significant yield or protein increase.
The remaining areas are probably limited by a soil constraint other than moisture, so the map helps indicate areas for further analysis.

All of the farm has been soil surveyed with EM38 and gamma-radiometrics. The electromagnetic (EM38) soil maps, together with yield maps, have been used to generate replacement fertiliser maps for seeding.

**Variable rate**

Ashley works on a rule of thumb that four units of phosphorus (P) are removed for one tonne of grain. This means rates of diammonium phosphate at seeding range from 80kg/ha to 120kg/ha. Previously a flat rate of 100kg/ha was applied.

“Following a year with a dry spring, we can produce a disproportionate amount of straw to grain so we add soil data to the rate decision. Any paddocks with a Colwell-P of less than 25ppm will receive an additional base rate of P.”

Ashley contracts local PA consultant Peter Treloar and Michael Wells of PCT to produce the maps and to carry out most of the soil surveys and on-farm trial analysis.

Biomass and crop greenness data is recorded during every pass of the boomspray in a cereal crop using the CropSpec™ sensors mounted on the cab roof. This data is used to produce normalised difference vegetation index (NDVI) maps and together with data from the moisture probes and protein meter, is used to establish rates of in-crop nitrogen (N). These NDVI maps have also been used to target weed patches.

“The NDVI maps for N are correlated against N rich strips, which provide a non N limited area of crop, and are now used with the protein maps to help determine N rates.”

**Protein mapping**

Ashley’s interest in protein mapping started when he was still running a piggery and wanted to know the spatial variation in the protein of his feed barley. Moving to continuous cropping in 2003, his interest in protein mapping remained but the objective became focused on the consistent delivery of grain that met higher value protein specifications.

Over the years, Ashley has worked closely with Next Instruments, the Australian company that has developed and now markets the CropScan 3000H.

“There were many times when I nearly threw in the project as it was causing us more problems than benefits, but I love trying to make the technology work and to see a project to its completion.”

Ashley’s commitment and patience have paid off. Over the past four seasons, he has produced meaningful grain protein maps that have supported in-paddock blending (Figure 1) and nitrogen fertiliser decisions (Table 1).

The CropScan is mounted on the clean grain elevator and takes readings approximately every 17m, producing about 15 measurements per hectare.

Real-time data for samples is displayed in the cab. For this, Ashley is using an industrialised computer. The individual samples are displayed as a map but for immediate use, the protein is presented as the bin average. This figure can be reset automatically every time the harvester grain box is emptied.

**Table 1. N removal maps were generated for 185ha paddock, using the formula 1kg protein removes 0.175kg N. When the rate based on N removal was compared to five blanket rates based on yield, substantial savings in urea were made for all except the lowest yield, where a cost would have been incurred.**

<table>
<thead>
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<th>$ urea based on N removal</th>
<th>$ urea based on 2t/ha yield</th>
<th>$ urea based on 2.8t/ha yield</th>
<th>$ urea based on 3t/ha yield</th>
<th>$ urea based on 3.5t/ha yield</th>
<th>$ urea based on 4t/ha yield</th>
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<td>variable</td>
<td>40kg/ha</td>
<td>56kg/ha</td>
<td>60kg/ha</td>
<td>70kg/ha</td>
<td>80kg/ha</td>
</tr>
<tr>
<td>Cost</td>
<td>$10,632</td>
<td>$8,710</td>
<td>$12,194</td>
<td>$13,065</td>
<td>$15,243</td>
</tr>
<tr>
<td>Saving</td>
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<td>-$1,922</td>
<td>$1,562</td>
<td>$2,433</td>
<td>$4,611</td>
</tr>
<tr>
<td>Saving/ha</td>
<td>$0/ha</td>
<td>-$10.4</td>
<td>$8.40</td>
<td>$13.20</td>
<td>$24.90</td>
</tr>
<tr>
<td>%saving</td>
<td>0%</td>
<td>-22%</td>
<td>13%</td>
<td>19%</td>
<td>30%</td>
</tr>
</tbody>
</table>
We use a two bin system with the aim of creating low and high protein silos which are blended as we load the truck.”

Ashley calls this system of blending ‘active paddock management’. He can log on the screen which harvester bin has gone to each silo to produce a running weight and average protein for each silo.

When on-the-go data was tested against Viterra’s system at delivery, readings for protein and moisture in wheat and barley were within 0.2%. Ashley encourages users to carefully calibrate the monitor at the start of harvest for each grain type and then stick with that calibration for the season.

By doing this, Ashley can compare protein production and variation within and between paddocks. “By combining protein, moisture and yield maps, I can look at my gross margin spatially and locate the under-performing or unprofitable parts of the paddock. For example, we found that if we had not cropped the areas producing a gross margin of zero or less in a 185ha paddock, we could have increased the paddock gross margin by $3,835.”

The CropScan 3000H can also be mounted on an auger to measure protein in grain coming out of a bin to manage the loading of trucks.

“The protein monitor is probably still creating more questions than it answers. For example, it is still early days for us to understand the relationship between soil and protein, but at least we are now able to collect reliable data.”

**Details:**
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**PA applications**

Blending resulted in 17 out of 18 trucks going APW rather than ASW, a total increase of $6,900 off the 185 hectares.

**Figure 1.** The upper portion of the two paddocks (yellow and red) had protein below 10.5 per cent, while the lower portion (green to black) had protein over 10.5 per cent. Blending resulted in 17 out of 18 trucks going APW rather than ASW, a total increase of $6,900 off the 185 hectares.

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**Ashley's top PA tips**

1. Back-up your data regularly, file carefully and store in two separate locations.
2. Test equipment about a month before you want to use it. On the first day of seeding/harvest, etc, you are still likely to have small ‘teething problems’ but you will be much more prepared.
3. Work with experts. Use a specialist to process your data as it is very time and cost effective.
4. If you have a yield monitor fitted, start gathering data - it might be several years before you use the data but the sooner you start collecting, the sooner it can be put to use.
5. Collect and use multiple data layers - they help quantify and qualify your paddock knowledge and in combination help you make better management decisions.

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Producing 142t/ha of cane in the 2015 season, and that excludes about 23t/ha of dry matter of leaf material, requires considerable inputs of nutrients and water. Yet Burdekin sugar producer Denis Pozzebon has seen a gradual increase in cane and sugar production from the same or even less inputs. This change has occurred since the use of RTK GPS guidance which allowed improvements to his pre-planting program.

“Before changing to zonal tillage and bed formation, a legume in the fallow period and variable rate gypsum, we were producing about 117t/ha. But even better than increasing yield is that guidance means less time spent on the tractor and the whole system is more profitable,” said Denis.

It takes cane over a year to go from planting (March to May) to harvest, which can run for 22 weeks from June to November, the following year. Once planted, the billets of sugarcane will be managed to return a crop for five harvests. So any mistakes in the pre-planting preparation can have long lasting ramifications.

For Denis Pozzebon, pre-planting preparation starts after harvest when the cane stool and trash are incorporated into the soil, in readiness for levelling of that paddock.

“Each year between 10 to 20 per cent of the farm is fallowed and sown to a legume during the summer. But the legume is really the last step in the paddock preparation for the next sugarcane crop.”

**Steps to planting**

Step one is for a contractor to level the paddock. Traditionally this has been done using laser levelling, but for the past three years, the contractor has been able to supply GPS land forming. This system results in about 30 per cent less topsoil being moved depending on the paddock.

The application of gypsum to help improve soil structure, water movement and reduce sodicity is the next part of the fallow management. Working with researchers at CSIRO, Denis saw the benefits of variable rate gypsum. A combination of EM38 soil surveys and elevation was used to identify sodic areas and produce two or three gypsum rate zones.

Instead of applying a blanket rate of 3.5t/ha across the whole fallow paddock, gypsum is generally now spread at 6.0t/ha in the sodic areas and at 1t/ha as a maintenance application across the remaining area. This has resulted in a considerable saving in inputs and a yield benefit was recorded on the sodic areas (Table 1).

Zonal ripping is the next paddock preparation and accurate GPS has allowed Denis to implement this practice. Denis works on planting rows spaced at 1.55m. He rips each planting row to a depth of 500 to 550mm. With RTK GPS, he has the confidence that he will be able to come back and plant directly above the rip line.

“The accuracy of this zonal tillage ensures I maximise the number of planting rows in the paddock, that I can place the cane billets exactly above the rip line and I can irrigate directly into the rip line.
“This level of precision allows me to improve the soil environment and apply inputs exactly where they are required by the cane.”

After ripping, the cane bed is formed so that the rip line sits in the centre of the bed and into this the cowpeas or soybeans are sown to provide a nitrogen fixing fallow. In late February, the legume is sprayed out. The bed is then prepared with a pass with a wavy coulter and the 20 to 25cm billets of cane planted over the rip line.

Zonal ripping and bed formation mean that Denis is now only working 60 to 70 per cent of the soil in the paddock. Less soil disturbance means soils are ‘healthier’ and less prone to loss by erosion.

“From my perspective, healthy soils start with my management in the fallow period.”

In-crop precision

While Denis is confident that he could apply varying rates of fertiliser by in-crop zone, he lacks confidence in what the correct range of fertiliser rates are for his situation. So, fertiliser rates are calculated using the industry ‘6 easy steps’. This program provides guidelines on how to implement balanced nutrition on-farm with the ultimate aim of optimising productivity and profitability, without adversely influencing soil fertility or causing off-farm effects. These steps are applied in relation to yield on a paddock by paddock basis.

In-crop fertiliser is applied as a blanket rate across the paddock as a liquid or a granule. Well, not quite across the paddock, as Denis uses a stool splitter to shoot the fertiliser into the centre of the crop row, confining fertiliser to strips at 1.5m across the paddock.

“Targeting fertiliser this way means that it is right where the crop can use it and so the potential for leaching or runoff is greatly reduced, a big plus especially when you farm in the vicinity of the Great Barrier Reef.”

Irrigation is furrow flood irrigation so water is targeted to the crop row and retained in the bed which is helping to improve water use. Denis is currently working with researchers at the Central Queensland University to automate irrigation. His moisture probes help schedule when to water, but a new system adds end of row sensors to shut off the water once it has reached the row end. This system will then initiate the next set of valves to be opened and a new section to be watered.

“Until now, we have used a set-time period for irrigation – generally 6am-6pm. The new system may identify that water has filled the furrow in only 10 hours, so it would cut off two hours early, generating a 20 per cent saving in water and power. A win-win situation, we hope.”

By accurately setting up the planting rows, Denis has been able to use a combination of a shielded sprayer and unshielded sprayer for herbicide applications. The shields run between the rows where glyphosate is applied as a knockdown. Over the crop row, a selective herbicide is applied.

“In combination with the use of boom section control with the Trimble Field IQ system, I have reduced my use of selective herbicides by 80 per cent which represents a substantial cost saving and is better for the environment.”

Harvesting

Despite considerable research investment, the sugar industry has yet to source a reliable yield monitor or surrogate yield monitoring system. While sugarcane

<table>
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<tr>
<th>Gypsum cost $150/tonne spread</th>
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<tr>
<td>Paddock size 26.7ha</td>
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<tr>
<td>Area</td>
<td>Rate</td>
<td>Total cost</td>
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<tr>
<td>Uniform application</td>
<td>26.7ha</td>
<td>3.5t/ha</td>
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<tr>
<td>Variable application</td>
<td>6.4ha</td>
<td>6t/ha</td>
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<td></td>
<td>20.3ha</td>
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<td>Total Cost VR</td>
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<td>Saving</td>
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The value of the yield benefit from gypsum was estimated to be $113/ha/year
is delivered by weight, growers are paid for sugar. On average, 7t of sugarcane produces 1t of sugar. Cane is harvested into bins that hold about 5t of cane and each bin is individually numbered. At the mill, sugar content is averaged over every four bins, 20 tonnes, excluding the first and last four bins. By linking the GPS location with the bin number, there is potential to roughly map cane and sugar yield but such a process still needs to be refined.

**Flying high**
Denis has recently purchased a remotely piloted aircraft and is hoping to use this to produce biomass and crop stress maps based on normalised difference vegetation index (NDVI). It is early days with this technology, but he sees real value in being able to visualise and locate in-crop variation.

“I have to find the problems or potential before I can manage them. An aerial view could really help in sugarcane which is such a tall crop.”

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**Denis’s keys to soil health with sugarcane**
- GPS land forming
- targeted/zonal tillage
- variable rate gypsum
- legume brown manure fallow.

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**Details:**
Denis Pozzebon,
pozzo07@bigpond.com

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**“From my perspective, healthy soils start with my management in the fallow period”**

The shielded sprayer and stool splitter for applying fertiliser are set up to target products precisely in the crop row or in the interrow.

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A new twist for ‘terroirists’

According to my French dictionary, ‘terroir’ translates as ‘soil’. However, in the context of wine, it has a more mystical connotation relating to the combined impacts of soil, geology, climate, landscape and social factors on wine.

The social factors, which are considered very important in ‘Old World’ countries such as France, include tradition and long-standing practice in terms of the grape varieties being grown, their management and intended wine style. Overall, terroir is a term that is closely associated with the provenance of the wine and so ‘sense of place’ is an approximate English translation that captures most of what is involved. It is a term that has become intertwined with regional labelling and with history in the ‘Old World’ production regions.

Yet, we know from research and the hard reality of digging post holes and laying irrigation pipe that soils and the other biophysical factors vary across regions, vineyards and along and across vine rows. So how much are we missing by considering the influences on terroir only on a regional basis?

In our previous research, much of which has been reported in Precision Ag News, we used high resolution soil mapping (EM38 electromagnetic surveys) to show strong relationships between soil properties and elements of grape production. I have also reported relationships between soil properties, yield and vine vigour as measured by remote and proximal sensing of ‘plant cell density’ (PCD).

In research in New Zealand, we identified that the PCD image could be used to show how a juice score, composed of juice quality attributes, varied both across vineyards (spatially) and in the period between veraison and harvest (temporally).

With all the evidence suggesting that there is much more to ‘terroir’ than a regional soil type, geology or climate, we established a small study in a 6.1ha vineyard block in the Grampians region, Victoria. Our aim was to investigate the within-vineyard spatial variation in the ‘pepper’ compound rotundone. This compound contributes to the distinctive peppery flavour of ‘cool climate’ shiraz.

Our collaborating wine company, ‘Mt Langi Ghiran’, knew that being in the Grampians meant that its wines were potentially more peppery than other regions, but wanted to know whether and how rotundone concentrations varied within one of its key vineyard blocks.

Considering terroir at a sub paddock level could be more relevant for optimising grape and wine characteristics.

A new twist for ‘terroirists’

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Figure 1 showing the stability of rotundone zones across (a) seasons or (b) when combined with specific attributes of the 6.1ha block - soil (ECa), slope (SI) and aspect, expressed as degrees from north (fN).
The block was planted in 1968 on 3m row spacing with 1.8m between vines. Vines are trained using a single wire arched cane system. The block is managed uniformly. An EM38 survey provided information on soil variation as well as providing the data for producing a 3D elevation model from which we obtained slope and aspect. Remotely sensed PCD imagery was also available.

What we did
In the season that culminated with the 2012 vintage, 177 target vines were identified within the block for subsequent sampling. Each vine was georeferenced and grapes were collected immediately prior to harvest in 2012 and 2013. Vintage 2012 proved to have a high berry rotundone concentration, while in 2013 the concentration was low, as was the case in 2014. Sampling of the 177 vines was repeated in 2015 after analysis of nine sub-samples from different areas across the vineyard indicated that 2015 was a ‘medium’ rotundone year.

The data were then mapped for each year and compared and overlain with soil, elevation and aspect data to look at the potential for creation of zones for selective harvesting.
What we found

Irrespective of whether we used a unique (season specific) or common variogram in the map production process, we found that the spatial patterns of rotundone showed strong similarity across the years. This stability across the years was rather surprising considering that there was a 40-fold difference in mean rotundone concentration between 2012 and 2013, a 13-fold difference between 2012 and 2015 and a 3-fold difference between 2013 and 2015.

This temporal stability in the spatial pattern of berry rotundone concentration suggests that variation in the underlying land supporting the vineyard is driving the pattern of rotundone variation.

When clustered to produce zones based purely on berry rotundone concentration or with the inclusion of soil properties, slope and aspect, these zones can be seen to remain similar (Figure 1).

These patterns of rotundone variation are very similar to the pattern identified by the vineyard manager based on his experience of the block.

How each of these elements influences the zones is more clearly seen in Figure 2 and emphasises the importance of bringing multiple data layers together to produce more robust zone maps. In this situation, topography was seen as a strong influence on the spatial pattern of berry rotundone concentration.

Of interest in this work was the fact that vine vigour variation, as measured using PCD imagery, had no relation to the rotundone variation. This is in contrast to many other studies in which more generalised descriptors of fruit quality have been seen to relate to PCD.

“Terroir has narrower influences than that of a region”

In this situation, using information on underlying vineyard properties including soil, slope and aspect would provide better guides for decisions about selective harvesting.

However, the decision to selectively harvest in order to assist the management of wine pepperiness needs to be supported by chemical analysis pre-harvest. In years of low rotundone concentrations, as recorded in 2013, the level of rotundone production would offer little opportunity in optimising wine pepperiness. Instead it would be more sensible to harvest as a single parcel.

We also have to remember that pepperiness is only one aspect of importance when a winemaker is determining when and how to harvest. Indeed, this vineyard still produces very fine wines in low pepper years.

However, these results again suggest that we need to think about ‘terroir’ at a vineyard or block level rather than thinking of it at a regional scale. Such a focus on terroir is greatly assisted by the use of spatial tools to help assess and manage vine vigour, grape yield and fruit composition, and therefore produce the wines that we want to produce.

Blog. Dr Rob Bramley has been a long time supporter of SPAA and Precision Ag News. He is Senior Principal Research Scientist - Precision Agriculture at CSIRO based at Waite Campus in South Australia. In this article he could be called a terroir terrorist!

Details:
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Rob Bramley’s research indicates that spatial tools can help assess and manage vine vigour, grape yield and fruit composition to produce the wines that we want.
In what types of tree crops have you used robots to gather data?

Our work was initially in almond and apple crops where we used the robots to gather information on changes in the canopy over time. We have also looked at some tropical tree crops including mangos, avocados and bananas.

What sort of robot are you using?

Much of our work has been done using a ground-based robot that is able to move between the tree rows gathering data from the ground, truck and canopy. We have also used remotely piloted aircraft to fly over the orchards. Our robots are all fully electric and powered by batteries. Our newest generation of robots also use solar power.

What data have you been gathering with the robot?

The ground-based robot, nicknamed the Shrimp after the Mantis Shrimp which has super multispectral sensing capabilities, moves up and down the rows. It is fitted with a GPS for positioning and measuring elevation and changes in terrain. A vertical sweeping laser (LiDAR) gathers data on the structure of the tree canopy, which is converted to 3D models (georeferenced). Colour cameras and hyperspectral sensors gather data on differences in colour which might relate to bud burst, blossom, fruit-set or nutrient deficiency and disease or pest damage.

How does the robot know what it is observing?

We hand-label sample buds, leaves, flowers and fruit at different sizes. We could also do this for weeds, disease and pest damage. We teach the robot what these look like by distinguishing differences in the algorithms for colour, shape, texture, size, etc. As you can imagine, this is a laborious task as it is required for each growth stage and tree crop. We are working on ways to streamline this task in order to make it as efficient as possible for the operator.

The algorithms developed for each crop are able to be used across different orchards. However, we have to refine them for different varieties and canopy management systems.

Does the system work the same for all the tree crops you have studied?

No. It works similarly in the crops that fruit seasonally such as almonds, apples, mangos and avocados. Bananas are quite different as individual trees in a plantation fruit and flower at different times (asynchronous growth cycles). In these crops we looked at measuring the height of suckers as a prediction of bunching date and harvest.

How might this spatial information be converted into improved management decisions?

This will depend on what data is collected and when. But this type of intensive, geolocated sampling can help farmers see how individual trees change through the season and year on year.

In an almond orchard, we scanned at flowering, fruit set and just before harvest. This data enabled us to count individual flowers and fruits on a tree and to map the strength of the blossom and potential yield across the orchard.

An apple grower involved in the trials weighed his harvest at the end of each row – which is incredibly
labour intensive. With this data we could ground truth our systems.

We found a strong relationship between the robotically and manually collected data and this revealed a trend for a decrease in yield from east to west. This may have never been quantified without the robot. The farmer suspects it might relate to the placement of pollinator trees so he has planted additional pollinators in this area.

**What are the biggest challenges in using robots in orchards?**

Reliably acquiring the GPS signal in the canopy can be challenging as many orchardists will report.

One way we have addressed the problem is to use a tall GPS mast. This worked well in tall crops like avocados and macadamias where there is still an open canopy at the top. However, it is unlikely to solve the problem for banana plantations which have fully-closed canopies. The use of more and newer satellites might help, but reliability for banana localisation may only be possible with ‘GPS free’ approaches. One method, for example, is to use the onboard sensors including cameras and lasers to simultaneously localise the platform while mapping the environment. This is called simultaneous localisation and mapping (SLAM). This would be very effective in banana plantations because the taller suckers would make excellent features for this purpose. They are like natural localisation beacons.

Converting from a research robot to a fully autonomous commercial machine will take further development.

**Biog. Dr. James Patrick Underwood** is a senior research fellow at the Australian Centre for Field Robotics (ACFR) at The University of Sydney. He is an expert in the area of perception systems for field robotics.

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http://sydney.edu.au/acfr/agriculture
Managing your ag data

Who controls the access to the agricultural data (ag data) that is being collected from your farming operations? In Australia and around the globe, this issue is attracting more and more attention.

While the potential for increases in productivity from the use of digital farming technologies are undeniable, the issue of who controls access to and use of the data that has been collected, aggregated and stored is one that is often overlooked and ignored.

One notable exception is the Australian Farm Institute (AFI) that has recently released a research report “The Implications of Digital Agriculture and Big Data for Australian Agriculture” (discussed in this article).

Those farmers aware of the lack of clarity around data ownership and control are concerned about the security and privacy of their farm data, as well as the terms that regulate the collection storage and use of their farm data by third parties.

Leanne Wiseman

Farmers need to read and understand the small print associated with the data contracts before signing.

Software versus hardware

Twenty years ago, when a farmer purchased farming equipment, it was a straightforward transaction of purchasing the physical machine. Today farmers who buy digital farming machinery may own the machine and associated controllers, sensors and monitors, but they do not own the technology that operates the machine.

Basically, when purchasing digital equipment, be it a machine, computer or phone, farmers enter into an agreement with the technology owner that grants them permission to use the sophisticated software that operates the digital machinery. This permission is in the form of a software licence or a data contract.

It is these licences and contracts that regulate the ownership of the input data and the resultant aggregated data, the storage and management of that data, the security and privacy provisions of the data,
and the restrictions on the use or modification of the data.

Typically, the entry into the software licences or data contracts occurs at the point of sale of the physical equipment. It is at this time, that a farmer agrees to terms that regulate ownership and use of their farm data. The software licence terms need be fully transparent to all parties.

If you are concerned about who controls and can access your farm data, now and into the future, it is worth doing some homework. Prior to, or at the time of purchase of the digital machinery, examine the terms of the data contracts thoroughly, and discuss the terms with your digital technology suppliers. It is important that farmers read the agreements before accepting the terms offered. This is important whether the technology is in the form of an app and/or a cloud-based recording system.

While this issue is often put into the too hard basket, the US has taken an interesting approach to ensure their farmers are more aware of, and confident about the terms of the software agreements they are entering into when adopting new digital technologies. It is useful to here examine what they have done.

**Approaches to data contracts in the US**

Raising awareness of the contractual terms in data contracts with farmers has gained momentum in the United States. In 2014, the American Farm Bureau Federation (AFBF) responded to concerns raised by American farmers about the ownership and use of their farm data. After much lobbying and negotiations, the AFBF reached agreement with a number of significant technology providers on some Principles of Data Management.

These data principles, which address data transparency, were agreed to by the AFBF and 37 agricultural technology companies including Monsanto, John Deere and DuPont Pioneer. The aim of the data principles is that they encourage technology providers to contract with farmers on a basis that is consistent with the data principles.

The data principles highlight the importance of a range of factors including:

- farmers’ education;
- simple, plainly drafted contracts that are easy to understand;
- principles around ownership of data and the use and sharing of data;
- the idea that access and control of data only be with the explicit consent of the farmers who must be notified that their data is being collected; and
- how the farm data will be disclosed to others and used.

More details about these principles can be found at http://www.fb.org/tmp/uploads/PrivacyAndSecurityPrinciplesForFarm-Data.pdf

While many of the technology providers’ contracts addressed these matters, it was still not necessarily easy for farmers to identify those companies whose contracts...
complied with the data principles and those that did not. To address this, the AFBF also created a “Read before you sign” guide to inform farmers/farmers about what questions they should raise with their technology providers. Examples of the questions include: what information was being collected; what controls farmers had over the data collected and if a company will advise them of any policy changes.

The “Read before you sign” guide can be downloaded from [http://www.fb.org/issues/bigdata/questionagtechprovider/](http://www.fb.org/issues/bigdata/questionagtechprovider/)

More recently, an Ag Data Transparency Evaluator ([http://www.fb.org/agdatatransparent/](http://www.fb.org/agdatatransparent/)) has been developed. US farmers can use this to assess agricultural technology providers’ contracts and policies about ownership and sharing of data. This is a process by which US ag technology providers voluntarily submit their ag data contracts to a simple, 10 question evaluation. Answers are reviewed by an independent third party administrator, and the results are posted on [http://www.aglaw.us/](http://www.aglaw.us/) for farmers and other ag professionals to consult and review. Only companies receiving approval are allowed to use the ‘Ag Data Transparent’ seal. The seal appears to be similar to certification Trade Marks that can be registered in Australia by organisations who strictly control the use of their trade mark.

One word of caution when looking at the US approach, contracts from the US can differ to those offered to farmers outside the US due to differences in legislation that operate in each legal jurisdiction.

Another approach to ag data control and management can be seen in New Zealand. Here, the Farm Data Code of Practice is an example of an alternative approach. For further details see - [http://www.farmdatastandards.org.nz/about-2/](http://www.farmdatastandards.org.nz/about-2/)

“many farmers do not know where and how their data is used”

**Conclusion**

I am not suggesting that the approach taken by the AFBF in the US is necessarily the right approach for Australian farmers.

What I am suggesting is that a greater awareness and understanding of the terms of the data contracts and licences associated with current agricultural machinery would certainly empower farmers to have a more meaningful dialogue with their equipment suppliers. This would assist in encouraging transparency around the terms of the data licences which in turn would develop more trust in the parties’ contractual relationships.

This suggestion is consistent with the recent recommendations made by the AFI in their ‘Digital Agriculture and Big Data’ report.

In relation to the management and access to farm data, the AFI have recommended that Australian agricultural industries and agricultural technology providers ‘should commit to open access data protocols, modelled on the standards adopted by the Open Agriculture Data Alliance established in the US’ (Recommendation 3) and that there should also be ‘the appointment of a Farm Data Ombudsman to oversee data privacy standards, to establish data use categories, and to audit compliance by providers with industry standards for data privacy’ (Recommendation 4).

Securing farmer confidence in the use and control of their data is important. Opening meaningful debate and dialogue about the control of and access to and use of farm data in Australia is an important step toward building this trust and confidence.

**Editor’s note:** Dr Wiseman is currently conducting research into legal implications of agricultural data and the types of licences that are governing digital agricultural machinery in Australia. She would be interested to hear from farmers who are also interested in the control and management of their farm data.

**Biog.** Dr Leanne Wiseman is an Associate Professor of Law and Associate Director of the Australian Centre for Intellectual Property in Agriculture (ACIPA), based at the Griffith Law School at Griffith University, Nathan, Queensland.

**Details:**
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After more than 30 years of research and from my perspective too many years of anticipation, virtual fencing looks like it will become a reality.

At SELM 16 Ian Reilly, CEO, of Agersens explained how they were in the process of commercialising virtual fencing based on a system of solar powered GPS collars.

The virtual fence concept works on the animal’s flight and fight response in a similar way to an electric fence. However, rather than having a physical barrier the fence is literally ‘wireless’.

The fence line of the virtual paddock perimeter is marked on the GIS, just like adding a polygon in Google Earth™. The software relays the geographic references to the neck mounted GPS tracker via the wireless sensor network.

If the reference received and the location of the tracker are within a predetermined distance of the virtual fence, the animal will receive an audio stimulus that triggers it to move away from the virtual fence. If this is ignored a second audio stimulus followed by an electric stimulus, far less than a conventional electric fence, are received.

Agersens plan to make their system more than just a fence but a complete system of virtual shepherding, although the current system is only suited to cattle.

Animals have been shown to learn quickly and not to breach the virtual fence unless forced. They also rapidly return to normal grazing behaviour having received the stimulus.

Check out their video – on the SPAA YouTube site

Accelerometers

Many of the projects reported at SELM were exploring applications for accelerometers. The technology in your phone that stimulates the screen to rotate is an accelerometer.

Tri-axial accelerometers measure three different movements—up/down – tilt; backwards/forwards; left/right (Figure 1). These three movements are plotted separately and the graphs compared to visual observations or to synchronised video footage of the animal’s actual movement.

Using mathematics, the researchers are working to relate the readings from the accelerometer to locomotive movement, grazing, ruminating, standing, lying and other activities.

Ultimately they hope to produce algorithms that can automatically interpret these motions to provide remote management solutions. Such solutions could relate to:

- automated oestrus detection,
- early identification of lameness,
- reducing the stress response to castration or dehorning; and
- early identification of changes in grazing behaviour.

Automated oestrus detection in sows

University of Sydney PhD student Dannielle Glencorse reported on her work that is using tri-axial accelerometers to predict the timing of oestrus in group housed sows.

Sows are only sexually receptive for 2-3 days and ovulation occurs 70 per cent of the way through oestrus. Consequently, the correct timing of insemination is highly reliant on accurate oestrus detection.

Currently, a range of oestrus detection techniques are used including a back pressure test and behavioural observations such as boar contact, mounting other sows, snout contact, depressed appetite and increased activity.
Accelerometers have been used successfully to detect oestrus in individually housed sows. However, as the industry moves to group housing of sows this adds a new challenge.

Dannielle found the ear-tag mounted accelerometers attracted too much attention from other sows, but a collar mounted system was robust enough to withstand biting and damage and less disruptive to normal sow behaviour.

Video and visual observations of behavioural state, e.g. standing, drinking, etc were made as were details of any behavioural events e.g. interaction with male or other sows, ear flicking, fighting, etc. The duration and time of occurrence were also logged. Results of the back pressure test were recorded and faecal hormone concentrations measured to determine the time of oestrus onset.

With the industry moving to group housing, the outcome of Dannielle’s research could make a huge contribution to maintaining and improving sow reproductive performance. Indeed, an accurate, automated method of heat detection could also increase the use of frozen semen in the pig industry. A move from fresh to frozen semen offers improved potential for advances in genetic gain.

**Individual tracking free-range laying hens**

Several of the presentations related to the use of spatial livestock monitoring tools to quantify animal welfare issues.

Hannah Larsen’s research at The University of Melbourne used radio frequency identification (RFID) in free-range laying hens. Results from this work have been referenced in the new national code for free-range for laying hens in Australia. Individual tracking rather than flock monitoring helped to illustrate how hens use the range space provided.

Working with an 18,000 hen commercial flock, Hannah subdivided an area of shed and paddock large enough for 2,000 hens. The hens had ad libitum feed, nest boxes were inside the shed and access to the range was between 10am and 6pm. To 440 birds she attached a silicon leg band containing and radio frequency identification chip.

Antennas were located either side of the pop holes between the shed and a covered yard, and at two distances from the shed in a large rotational paddock. When a chicken walked across the antenna, it was logged. The 13 day study found 85.6 per cent of birds accessed the outdoor area at least once a day and 68.8 per cent of the flock accessed the paddock every day. But not every chicken went out every day and while the majority went to all parts of the range, most of their time was spent in the covered yard close to the shed.

Further analysis will look at movement patterns for individual hens to see if some are more reluctant to leave the shed or access parts of the outside areas.

Hannah acknowledged that this system of individual chicken monitoring is only suited to research and is not a commercially viable system. However, the only other recorded work of this nature on a commercial farm was carried out in Switzerland, so it is early days in individual chicken monitoring.

Next year SELM is to be incorporated with the 7th Asian-Australasian Conference on Precision Agriculture (ACPA) in New Zealand www.selmsymposium.wix.com/selm
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* Conditions apply. Finance available through John Deere Financial Limited to approved commercial applicants only. Offer is based on 30% deposit, GST back and 4 year term with 4 annual repayments. Fees and charges apply. If not amended or withdrawn earlier, the promotion expires on 31 July 2016. Other terms and rates are available.