

# VARIABLE RATE TECHNOLOGY: MAXIMISING RETURNS FOR WESTERN AUSTRALIAN GRAIN PRODUCERS



**GRDC**<sup>™</sup>

REGIONAL CROPPING  
SOLUTIONS NETWORK

WESTERN REGION



**A SERIES OF CASE STUDIES INITIATED BY THE ESPERANCE AND  
GERALDTON REGIONAL CROPPING SOLUTIONS NETWORK**

# Acknowledgements

Grateful acknowledgement is made of the ideas and time committed to this initiative by the growers and consultants who are featured in this case study publication.

This book showcases some of the Variable Rate Technology (VRT) tactics used by WA grain growers mostly in the Esperance and Geraldton Port Zones to increase productivity and profitability in their farming systems. This was highlighted as being a research and development priority by the Grains Research and Development Corporation's (GRDC) Western Region in 2016.

The GRDC Regional Cropping Solutions Networks in Geraldton and Esperance saw VRT as being a useful tool worth extending further. GRDC enlisted the South East Premium Wheat Growers' Association (SEPWA) to oversee the project.

Case studies in the more northern grain growing regions of Western Australia were undertaken by Erin Green of Yuna.

In the southern regions, case studies were compiled by Michelle Handley, Alice Butler, and Niki Curtis.

Comments from four experienced consultants working in the field have also been included.

Two YouTube videos are being released as part of the project.

GRDC's Regional Cropping Solutions Network would like to congratulate SEPWA on producing an excellent quality resource for growers in the Western Region.

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# Introduction

## Variable Rate Technology – is it for me?

This book serves as an overview of how some progressive farmers in Western Australia are working with rapidly changing technology in their farming systems.

Precision Agriculture (PA), using Variable Rate Technology (VRT) is seen by some as an obvious and on-going gradual progression in refining their farm management program. But others are either daunted by the new technology, or can't see the benefits outweighing the cost of purchasing new machinery.

VRT involves developing a management strategy to target inputs rather than applying them as a blanket rate at paddock scale. It can be used throughout the year from pre-sowing; sowing and in-crop application to maximise profit and efficiency by varying inputs as required.

The required technology and machinery is easier to use and more affordable than ever before, but many growers are still sitting on the fence when it comes to adopting PA. Their usual causes for reticence include: the expense in getting new machinery, paying for expertise support, difficulty in understanding the technology, access to technical support, and the amount of time needed to learn and implement the technology.

## The technology

There are many ways to utilise VRT, but all methods require spatial information and software to apply the input in variable rates at the desired location. And so, the Global Navigation Satellite System (GNSS) that encompasses the global network of satellites such as GPS (United States), GLONASS (Russia), Galileo (EU) and Compass (China) as well as other regional systems, are key to generating the location data.

Geographical Information Systems (GIS) is the software that stores, manages and allows you to manipulate spatial data. These are the two key technologies that underpin VRT.

While GNSS allows producers to identify field locations so that inputs can be applied at the correct rate on a specific area, GIS technology allows users to store field input and output data as separate layers in a digital map and to retrieve and utilize the data for future input allocation decisions.

PA technology allows producers to:

- capture detailed field spatial data
- interpret and analyse that data
- then implement an appropriate management response based on the information.

PA is not simply a single technology, but rather a suite of technologies that allows producers to monitor and control farm management factors. Various components of PA may be adopted as a package. However, some components may require adoption of other components.

For instance, to allow variable application of fertiliser inputs, data is needed on which to base fertiliser recommendations. This fertility data could be developed from grid soil sampling, soil surveys or estimated from yield monitoring data and/or aerial or satellite imagery.

## Western Australian growers

Two main paths are chosen by WA farmers to VRT adoption: some undertake simple tasks such as using ameliorants; and others rely on consultants to oversee their systems which manage multiple inputs using a raft of technologies.

Some growers have found that yield data is unreliable and this has led to surveying their farms

with EM and gamma radiometric equipment. These surveys provide information that does not change seasonally and generally correlates to soil type variation within a paddock.

Lack of support has been a major issue preventing WA growers from utilising VRT. Local agronomists are an obvious fit for this service as they understand the agronomic issues and how the farm performs. However, to date most have not found the time to provide this service or develop their expertise.

Mobile devices (primarily the iPad) and existing apps do offer opportunities to simplify the VRT process that has worked well for the patch out (removing areas) method. YouTube tutorials can provide step-by-step guides for growers wanting to implement VRT themselves and cloud services can retire the requirement of software knowledge for downloading data cards. However, with current data accessibility issues in regional areas these options can be clunky and frustrating to implement, resulting in slow adoption rates.

## Where do I start?

VRT can be expensive to set up, however a major expense which is not generally budgeted for is the time required for implementation. Time is required to learn the software, analyse data to underpin decision-making and to make sure the equipment is working. The amount of time will change from farmer to farmer, depending on computer literacy, software choice and machinery.

Because every paddock has multiple inputs, analysing data to make decisions on rates and zoning can become very complex. Having a goal in mind when you go into VRT helps to simplify the process. Time can be saved by outsourcing the work to a consultant; however there is still a level of understanding needed by the person operating the machinery and hardware to implement VRT.

To reduce the investment cost during implementation, it is important to make the most of low cost data sources such as yield data and satellite and biomass imagery before investing in a farm survey.

Issues at time critical points in the season can be frustrating and costly. Therefore, it is recommended to begin implementation when time isn't critical to the operation, such as spreading ameliorants over summer. This way a manager will build confidence with the hardware and be much more prepared for what can go wrong come seeding.



Location of case study farms featured in this publication.

### How do I know I am making the right decision?

Evaluation is key to making sure that VRT is worth employing in a paddock. Ground-truthing via soil testing provides confirmation of soil type. Embedding strip trials, such as high rates and zero strips within zones will offer visual verification throughout the year, as well as the ability to collect yield data on the go at harvest time. Analysing yield data of strip trials across zones will enable economic evaluation of the VRT program.

## Terminology

When you get into the world of precision agriculture or PA, you will find that everyone talks in acronyms. Below is a list of the most commonly used ones used in this book.

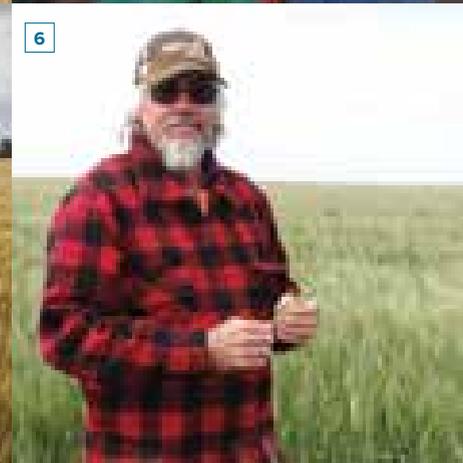
Abbreviation	What it means
CEC	Cation Exchange Capacity
CTF	Controlled Traffic Farming
EM	Electromagnetic
GIS	Global Information System
GPS	Global Positioning System
GRM	Gamma Radiometric
NDVI	Normalised Difference Vegetative Index
PA	Precision Agriculture
PAWC	Plant Available Water Content
PBI	Phosphorus Buffering Index
RAM	Random Access Memory
RTK	Real Time Kinematic
SMS	Spatial Management System
VRA	Variable Rate Application
VRT	Variable Rate Technology
WUE	Water Use Efficiency

Nutrients	
C	Carbon
K	Potassium
N	Nitrogen
P	Phosphorus

# Northern Farmers – case studies

This publication would not have been possible without the generous input from the growers and consultants using VRT technology. We gratefully thank:

- 1 Jason & Nicole Batten, Kim & Jasmine Batten, Batten Farms, East Yuna
- 2 Murray, Jeremy & Bridgitte Brooks, Brookdale Farms, North East Yuna
- 3 Erin & Natalie Cahill, Walebing and Dandaragan
- 4 Ben Cripps, Wepowie Farming Co, Ogilvie
- 5 Mark & John Flannagan, Mullewa
- 6 Rohan & Carol Ford, Nookanderra Farm, East Binnu
- 7 Daniel & Corrina Michael, Clancy & Jan Michael, Geraldine Farms, West Mingenew
- 8 Scott & Belinda Morgan, Gerard & Carlie Rowe, Adrian & DI Morgan, Uvee Four Farms, West Arrino and Woongoondy



# Jason & Nicole Batten, Kim & Jasmine Batten

## Batten Farms, East Yuna

### OPERATION AT A GLANCE

<b>Annual rainfall</b>	280mm	<b>Average wheat yield</b>	1.5t/ha
<b>Soil types</b>	Sandy loam, loam, gravel	<b>Enterprises</b>	Wheat, lupins, barley, canola, Dorper stud for wool & prime lambs
<b>Farm area</b>	9000ha	<b>PA consultant</b>	Julien Coles (Precision Technology Solutions)
<b>Topography</b>	Flat and open	<b>Agronomy consultant</b>	Landmark representative



Jason and Kim Batten share the VRT responsibilities and use their combined farm management skills to work around technical difficulties.

### KEY MESSAGES

- Adopting VRT in a low rainfall area has to be cost effective to ensure the rewards are greater than the investment.
- Jason and Kim Batten share most machinery operations during peak times so that with the complexities and challenges of VRT they don't have to rely on casual staff.
- A grower's local knowledge of their farm is crucial to setting up zones.
- Investment in VRT has proved worthwhile for the business.

**For the Batten family of Yuna, the journey of adopting VRT into their low rainfall cropping system has met plenty of hurdles, hiccups and learnings along the way.**

Jason and Kim Batten share the bulk of the machinery operations during peak times which allow them to overcome many of the challenges and system complexities that come with VRT, which would have perhaps been too difficult if relying on casual staff.

### Machinery matters

The Battens have run Case machinery for many years and Case seemed to be quite proactive in the area of PA and VRT technologies, so when they bought a new seeder bar in 2000 they chose a 48-foot Case Concorde seeder bar and

box. At the time this was one of the few limited options that were considered precision seeders. The Battens were looking to vary fertiliser and seeding rates, but although their seeder could vary rates there was limited compatible software available that had the functionality to read maps and enable VRT to be implemented easily.

They used their advantage of being owner operators and went ahead; manually varying rates. Using yield maps produced through a Rinex system and Case software for the air seeder box, they began varying rates manually by dropping seed and fertiliser rates on the corners (at that time they were still working paddocks round and round) and other obvious poor performing areas. These small changes alone gave enough of a reduction in input costs to show that varying rates was worthwhile for their business.

Adopting VRT in a low rainfall area has to be done cost effectively to ensure the rewards are greater than the investment. Although the Battens would have liked to have upgraded their software to have the capacity to use prescription maps, financially the figures didn't stack up for them at the time.

### **Creation of zones**

Based on yield maps; biomass imagery; Jason and Kim's knowledge of their farm; and observations of the soil types within the paddock; two yield potential zones were established – low and higher.

Conscious of the array of seasonal factors that can affect yield, the brothers were careful to select only relevant years of yield maps to analyse and overlay them with biomass imagery to strengthen the identification of zones. They

also worked on the basis of ensuring the zones were larger manageable areas rather than needing to be precise lines of variation.

A grower's knowledge of their farm is also quite crucial to setting up zones.

"It would be ideal if zones could be easily mapped just based on yield and biomass but local knowledge plays a big part. Our farm knowledge plays as much a role in setting up zones as what the maps do," Jason said.

As it worked out, the zones were generally set with shallow soil types having less yield potential, and better loams having higher yield potential. At seeding time, seed and fertiliser rates would be adjusted between the differing areas according to summer rainfall and soil moisture profiles at the start of the season.

### **A case of learn as you go**

In the lower production zones, input rates were dropped back for seed and compound fertiliser to 40kg/ha. In the higher production zones, the input rates were seed at 50–70kg/ha and compound fertiliser at 60–80kg/ha. Additionally, nitrogen was added at 20–30kg/ha, whereas the lower production zone did not have any nitrogen-based fertiliser applied. Average soil types (sands) received a blanket application.

Being one of the first in their area with a VRT seeding box, the journey into variable rates has been a true process of 'learn as you go' for the Battens. Without having other growers in a similar situation to learn from, or readily available local technical expertise, the only real way to get answers to their many questions, or solutions to their problems, was up to them.

Increasing seeding inputs on some of the yellow sandplain areas seemed to be the logical choice to increase ground cover and plants per square metre but as the biomass in these areas was boosted so too was the susceptibility to frost. It took five years of increasing inputs in these areas to decide it wasn't working. In comparison, increasing inputs on the loams has been beneficial, perhaps because they don't have the same undulating hollows.

### **One leap forward, one step back**

In 2014, the Battens upgraded their seeder bar and box to an ex-demo 80-foot Morris Contour 2, complete with software. Although the options for an 80-foot bar were limited, the Battens' choice was based on the ability to do VRT with prescription maps (automated zone changes), improved seed placement, strong dealer support and a reasonable price.

In their first season with the new seeding bar the Pro600 guidance system in their Case tractor was unable to send the VR prescription maps to the seeding box software. It was an early start to seeding and neither the Battens nor the dealer had the expertise to identify and resolve the compatibility issues quickly. Rather than having costly downtime during seeding, the decision was made to drop the hope of using seeding prescription maps, and seeding continued with the rates being varied manually as had been done in previous years.

Half way through the season the transmission failed on the tractor and an older tractor and seeding bar were used to finish the program with only blanket rate capabilities.

Although that seeding was far from smooth running it did produce one clear observation: the areas that ended up with blanket applications of seed and fertiliser suffered a yield penalty compared to when the rates had been varied in similar seasons, hence their investment in VRT was worthwhile for the business.

### **Another season, another curve ball**

In 2015, the Battens replaced their tractor with a Quadtrac 535 with a Pro700 guidance system. The seeding prescription maps were created, the dealer's technician set up the software in the tractor to enable it to read the maps, all the systems were compatible and everything was ready as seeding time approached.

Unfortunately, the monitor for the seeding box (Morris X20) failed at the start of seeding and had to be swapped for a replacement screen while the original was sent away for repairs. Jason spent a night installing the replacement screen himself but a technician was still required to adjust the screen's technical settings so that it could read the prescription maps. Given the monitor was only on loan for the short term and that seeding time was critical, the decision was made yet again to go ahead with varying rates manually.

As with the rest of their journey into VRT, Jason has also had issues at the office and computer level. The Battens originally began yield mapping in 2004, however after a full computer meltdown they now only have records from 2011 onwards.

"I've had computers and laptops fail and Windows Vista compatibility issues. We've also had issues with old data needing to be updated before it can be loaded into SMS."

As Jason nonchalantly says: "No wonder no-one does VRT. Hopefully next year everything will work."

### **Post-seeding nitrogen applications**

Situated on the north-east corner of WA's wheatbelt the growing season usually has a quick cut-off so the Battens are conscious of not over-supplying crops with nitrogen. If the season is looking positive, UAN is applied in late June or early July at a blanket rate with a tow behind Auspray Boomspray with Farmscan monitor. This is generally a blanket application if the need for additional nitrogen has come about because of a favourable season.

### **Software and hardware issues**

While some of the hurdles the Battens have faced have been completely random, they have also been learning the compromise between balancing the budget and the key software and hardware factors that (in hindsight) would have made implementation much easier.

Jason reiterates that setting zones and application rates is not simple with many factors to consider.

"Our low production zones are generally our shallow soils but they are also higher in nutrition. It's not possible to have a rule of thumb for VRT. Every farm is different and you have to do what suits your soil type and where you are farming," he explained.

Although it seemed like a good deal and a practical decision at the time, buying an ex-demonstration seeding box, with Raven software already installed, was possibly not the best

option for the Battens. In hindsight they would have bought ISO-reader software which is more compatible with all systems and would cut the need for an additional screen in the tractor.

The Battens still have the option of changing their systems over but it's another cost that has to be covered.

"Having software and hardware that is fully compatible, with no extra tweaking required is the ultimate and would make implementing VRT much simpler," Jason said.

"But it comes down to what you are willing to invest in time and money and what you are willing to compromise versus the benefits generated."

Jason advises speaking to a PA consultant about your needs prior to purchasing machinery and software, and being realistic in what you are going to try and achieve.

"There are so many options available for guidance systems, software within tractors, boxes and bars and it can be time consuming and confusing working through the options to see what's right for you."

The Battens' approach to VRT is that it's more about input savings than boosting yield because there are so many other variables that factor into a growing season.

### **Technical expertise versus self-learning**

Jason suggests that no matter what systems you use, the grower still needs to be technically capable, have a reasonable amount of computer literacy, and an interest in learning.

“No one will be able to do everything for you. You can choose to invest into expertise or consultants but you’ll still need to do some of the leg work and have a handle on the technology for when things go wrong. As we’ve learnt, it always happens at peak times.”

Jason believes there will always be a need for growers to upskill in new technologies but he’s hopeful that as the technologies become more readily adopted there will also be more technical support available to growers.

“The dealers are offering as much support as they can, but no one can expect them to be completely up to speed with how fast the technology changes. There are private precision agriculture consultants but they are not always readily available especially at peak times.”

Although based in Esperance, Jason calls on Julien Coles of Precision Technology Solutions (PTS) for any technical questions. Having been introduced to Julien through the GRDC-funded and SEPWA-run DIY PA workshops, Jason is happy to pay for Julien’s expertise.

“The DIY PA workshops helped me get a lot more organised with sorting yield map files, creating prescription maps, and understanding how the actual software works. To be able to use your yield maps you need to understand SMS, or the software you use.”

Spending time in the office preparing prescription maps is something Jason would prefer to offload and may look to pay for expertise in this area. He would like to have a simpler way of getting the zones mapped and prescriptions loaded such as using a map on an iPad where he can outline the zones and then send it to someone else to make the prescriptions.

“I’d prefer to pay for expertise in creating maps and then be comfortable knowing they’re right and they’ll work rather than doing it for weeks myself and not being sure it’s right.”

### Going forward

All things going to plan, the Battens will be using prescription maps to vary rates next seeding. At this stage they don’t think VRT will be needed across their whole farm and it will be applied only in the paddocks that have obvious variability in soil types and production potential.

In future seasons they will look to change over their seeding box to allow them to vary potassium at seeding, with the aim of increasing yields in the higher production zones. Although they don’t have a huge lime program they may consider applying lime relative to pH levels rather than the current blanket paddock applications.

### Positive results

VRT has given the Battens a better understanding of what the different production zones on their farm are really capable of and they are now more aware of not over-supplying inputs in some areas. For them, the performance of the higher production zones were comparable to how they were pre-VRT but the lower production zones have improved since implementing varying rates, particularly in the last six to eight years.

“For us, VRT is more about dropping the input costs in the lower production zones where we used to end up with high biomass but low yield. It’s evolving our cropping system with climate change.”

## LESSONS LEARNT

- No matter what systems are used, the grower still needs to be technically capable, have reasonable computer literacy, and interest in learning.
- You can choose to invest in consultants but still need to do some leg-work and understand the technology when things go wrong.
- The Battens prefer to pay for expertise in creating maps and know they are right, rather than doing it for weeks themselves and not being sure.
- VRT has given a better understanding of the capability of different production zones on their farm. They are now more aware of not over-supplying inputs in some areas.
- Higher production zones are performing similarly to pre-VRT but lower production zones have improved since varying rates, particularly in the last six to eight years.
- VRT is more about dropping input costs in the lower production zones that used to result in high biomass but low grain yield. It’s evolving the cropping system with climate change.

# Murray, Jeremy & Bridgitte Brooks

## Brookdale Farms, North East Yuna

### OPERATION AT A GLANCE

<b>Farm location</b>	North East Yuna	<b>Topography</b>	Slightly undulating
<b>Annual rainfall</b>	280mm	<b>Enterprises</b>	Wheat, lupins, canola
<b>Soil types</b>	Red loam, mallee sandplain	<b>Average wheat yield</b>	1.6t/ha
<b>Farm area</b>	6300ha	<b>Agronomy consultant</b>	Belinda Eastough, Elders



Jeremy Brooks installed a John Deere rate controller on his multi-stream DBS air cart to manage seeding inputs.

### KEY MESSAGES

- The Brooks family had been yield mapping for 10 years before deciding to vary inputs for wheat and canola. It was a clear financial decision in a lean cash flow year.
- It meant the poorer paddocks still had the potential to generate income while not requiring much upfront cost.
- It's all about the gross margins – giving the better areas their greatest potential.
- At first it took “a good week” in the office getting everything set up for VRT. Now it takes about a day to prepare the maps for the season – one for each paddock.

**When a lean budget year was forecast for Murray and Jeremy Brooks in 2014, they drew on the efficiencies of VRT to give them their best return on inputs and put them back on track.**

The Brooks had been yield mapping for 10 years before they decided to vary inputs for their wheat and canola program. It was a clear financial decision in what was a lean cash flow year for the farm business.

Rather than taking the advice of their farm consultant who suggested leaving poorer paddocks out of the program, Jeremy and his father Murray decided the logistics of that wasn't the best option and chose to cut inputs in areas instead. It also meant the poorer paddocks still had the potential of generating income whilst not requiring much in terms of upfront costs.

## Setting up the system

The paddocks were zoned, based on past performance measured through the yield maps and also biomass maps. The zones generally correlated with changes in soil types and resulted in most paddocks being mapped into three zones – some with four. The potential of the poorer zones was based on the accumulation of yield map data.

As well as starting VRT in 2014 the Brooks decided to use the time spent mapping paddocks to set up their farm with tram lines and boundaries for CTF.

It took Jeremy a couple of days to mark out the paddock boundaries in his ute (with a borrowed GPS receiver and harness). The AFGRI Equipment dealership in Geraldton assisted with the initial set up of the paddock zones and boundaries into Apex software and supported Jeremy as he learnt the program.

The Brooks predominantly run John Deere tractors and software so for increased simplicity they swapped the Topcon rate controller on their multi-stream DBS air cart for a John Deere rate controller. By integrating a GPS into a rate controller, it enabled them to use data they were creating with other machines and convert it into prescription maps.

“We’re happy with the gear we have, but to lessen the risk of any compatibility issues we wanted to be working with one software system and so swapping the rate controllers was a good low cost decision,” Jeremy explained.

Everything now runs off an RTK tower located on the farm. Yield maps are synced wirelessly through My John Deere software, but are also backed up on USB.

## The first year

Jeremy worked with their agronomist and local CSBP area manager to decide on nutrient recommendations and input rates across the various crops and zones according to yield potential. He then created the paddock prescription maps using the Apex software.

The DBS air cart has four bins, one for seed, one for liquid nitrogen, one for a compound fertiliser and the fourth for potash. In the first year, the nitrogen was varied across the three zones with the poorer zone having zero liquid nitrogen at seeding and the high zone getting about 25 units of liquid nitrogen. After seeding, liquid nitrogen was applied at a blanket rate of 20 units across all zones.

The compound fertiliser was varied across the same zones as nitrogen, using the same shape file for the prescription maps. A variable rate of potash was also applied; however these maps were drawn manually. The potash zones were based on soil type and created using their own knowledge and Google Earth.

As a comparison, in the first season about 600ha and various test strips were cropped with the usual blanket applications. Jeremy said the results showed varying rates was a good economic decision for their business.

“Some of the results were a bit hard to measure but it’s all about the gross margins. For us it’s about giving the better areas their greatest potential. And by dropping inputs in the poorer zones, we could afford to increase them in the better areas.”

The Brooks were fortunate to have a relatively smooth transition into VRT, with very limited downtime, but Jeremy is an advocate for understanding the system so that you can troubleshoot when needed.

“If you’re going to do VRT, you need to be prepared to learn the software and be able to use and understand it yourself. The data’s all there but it’s about reading and manipulating it for what you need.”

## Working within your potential – seasons and soil

In their second year of VRT Jeremy and Murray altered their zones slightly to increase the size of their medium zone and decrease the area of lower potential areas.

Across all zones fertiliser rates are tweaked each year based on the size of the previous crop and the outlook for the coming season. Soil test results are also taken into account. Historically, each paddock is soil tested every three years, however the Brooks are planning on testing every paddock before next seeding as a gauge to where things are at and what inputs are needed (such as lime) in the long-term plan.

“With VRT we are managing our inputs while also trying to boost our poorer soils over the longer term. It allows us to keep poorer paddocks in and apply inputs to their potential at the time,” Jeremy said.

In the 2015 seeding program, the Brooks applied nitrogen on the poorer zone (15 units) and trialled varying the wheat seed rate across a 500ha paddock using the same shape file as the compound fertiliser. As the paddock runs from heavier red country to deep sands, they applied seed at rates of 50, 65 and 75kg/ha compared with the rest of the farm that was sown at 60kg/ha. A control strip was also left in the variable rated paddock.

Finding the happy medium of how to treat the zones in each different season, and knowing there are so many other variables to consider is one of the challenges going forward. Jeremy tries to manage this by not overcomplicating things.



Jeremy Brooks uses My John Deere software to manage his VRT system.



Jeremy finds younger staff such as his cousin Mitchell Rowe handle the VRT in-crop technology well.

“You can make VRT as simple or as complicated as you like. It’s not a silver bullet but for us it’s a low cost way to manage risk and even out the good and bad years.

“Not fertilising the poorer soils more may be a bit of a yield limitation but it’s about risk and gross margins by not having losses in drier years but having the yield exposure in good years.

“You need to feel comfortable that areas are not underdone, but you can also take advantage of better areas and better years. Comparing results of similar past seasons is a good benchmark,” he said.

### Behind the scenes

Having the prescription maps ready, having to be on hand, and being on top of everything has slightly increased Jeremy’s responsibilities at seeding, however having the one software system has been an advantage.

“One software system makes life a lot easier. I highly recommend making it simple and using the one system if you can. It also has a massive influence in the machinery you buy.”

In each tractor Jeremy has a laminated ‘start-up checklist’ to help drivers and lessen the need for him to be called on. To check the machinery and maps are working properly, the drivers also

check the rates and zones visually as they go. With the increased use of technology, Jeremy is finding that casual seasonal employees need to have some familiarity with computers and a willingness to learn new systems.

He estimates it took him “a good week” in the office getting everything initially set up for VRT. Now it takes about a day to prepare the whole farm’s maps for the season – one map for each paddock.

“It hasn’t been that hard and now I can get a map done, or make last minute changes, in 10 to 15 minutes if needed,” he said.

### Next steps

VRT is set to become more and more a part of the Brooks’ business. Next season Jeremy will vary wheat seed rates across a larger area with one of the aims being to get higher plant numbers on the poorer soils. He is considering varying canola seeding rates and may look to vary Flexi-N applications in future years.

Jeremy will continue transitioning from Apex to My John Deere software where enhanced capabilities include more wireless syncing, monitoring service requirements and tracking machinery movements.

In terms of controlled traffic, the Brooks now have their header, tractors, boomspray and chaser bins all running on 12 metres width while their DBS air seeder is 18m. To complete the system they may look to change to a 24m bar in the future.

### LESSONS LEARNT

- If you’re going to do VRT, you need to be prepared to learn the software and understand it. The data’s all there but it’s about manipulating it for what you need.
- VRT allows them to manage inputs while trying to boost poorer soils over the longer term. It allows them to keep poorer paddocks in and apply inputs to their potential.
- Finding the happy medium of how to treat the zones in each different season, and knowing there are many other variables to consider is one challenge going forward. Jeremy tries to manage this by not overcomplicating things.
- You can make VRT as simple or as complicated as you like. It’s not a silver bullet but a low cost way to manage risk and even out the good and bad years.
- Less fertiliser on poorer soils may limit yield but it’s about risk and gross margins, avoiding losses in drier years while having yield exposure in good years.
- One software system makes life a lot easier. It also makes a massive influence in the machinery you buy.
- Casual seasonal employees need to have some familiarity with computers and a willingness to learn new systems.

# Erin & Natalie Cahill

## Walebing and Dandaragan

### OPERATION AT A GLANCE

<b>Farm location</b>	Walebing and Dandaragan	<b>Topography</b>	Variable
<b>Annual rainfall</b>	480mm long-term average, 378mm (last 5 years); growing season rainfall 285mm (average last 5 years)		
<b>Soil types</b>	White gum and York gum loams, mallee gravels, blackbutt and pear tree sandplain, poor white sand		
<b>Farm area</b>	1470ha (share-farmed, owned and leased)	<b>Enterprises</b>	Wheat, lupins, barley, canola
<b>Average yields</b>	Last 5 years: wheat (3.51t/ha), barley (4.64t/ha), canola (1.84t/ha)		



Grower and private agronomist Erin Cahill farms at Walebing and Dandaragan.

#### KEY MESSAGES

- VRT prevents wasting money on poorer soils, resulting in better gross margins.
- Before you begin, use good soil tests and data to know why you are varying rates, rather than doing it just because others are, or the machine has the capability.
- The results of VRT can be analysed easily with yield maps, soil and plant tests, and comparing test strips across the zones.
- Rather than persisting with overcoming compatibility issues, Erin should have changed to one software system earlier.
- With the machinery, software and hardware systems in place and financial implications of the system better understood, VRT is now a key part of each season's cropping program.

**As a private agronomist to 30 clients, a former nutrition consultant, farmer, and share-farmer it's fair to say that knowing the numbers and their impact on the bottom line are business fundamentals for Erin Cahill.**

In 2007 Erin bought his first GPS (SF1) and started varying fertiliser rates on the outside runs of his paddocks for a more efficient spend on the nutrition budget. His Morris air seeder had VR capability but wasn't map-based. Because he was the air seeder driver, Erin varied the rates manually for the first few seasons.

"When you're share farming, every dollar that's wasted comes directly off your bottom line. The outside runs of our paddocks equate to about 10–15% of our cropped area and are predominantly shallower cap rock or have significant tree effects. You could see where these runs were burning



EM38 maps are also useful for identifying shallow areas when deep-ripping with the Western Ripper.

off from over-fertilising throughout the years so we reduced the nitrogen rate by 25% on these laps and shifted that nitrogen saving to the better soils," Erin said.

Reducing nitrogen on the outside lap resulted in a better quality grain sample with fewer screenings.

In both the 2008 and 2009 seasons the whole farm had high resolution biomass imagery (1m x 1m pixels) collected on it from an aircraft. This highlighted evidence of very uneven nitrogen application from post-emergent urea spread on 24m swaths, most of which was invisible from the ground.

By 2009, Erin was trialling varied fertiliser rates across a number of paddocks, gaining a better understanding of the implications and gradually making changes to improve the system.

He switched from using a mix of granular and liquid nitrogen to completely liquid nitrogen and upgraded the air seeder to a newer Morris with a Topcon software system. Although the ability to use prescription maps was a benefit, getting

the air seeder software and the tractor's John Deere software working together was more time consuming and not as straight forward as Erin initially thought it would be.

Confident with the effect that varying rates was having on gross margins, nitrogen rates were varied across the whole farm in 2010.

### Investing in the system

The 2013 year was pivotal for Erin's transition into VRT. Having persisted with the complications of running two software systems for a number of years, the decision was made to run everything with John Deere software. That year, 500ha was EM38 surveyed and Erin began varying compound fertiliser rates at seeding.

"Swapping everything over to one software system was a business decision. We think John Deere is the best guidance software, it standardises things, and having one system to learn makes it easier for staff to operate," he said.

EM38 surveying was carried out to see if it would support Erin's knowledge of the soil's variability and if it was of value to the business.

"The EM38 confirmed why some areas, particularly the sands, perform the way they do. In some higher performing paddocks it all looked the same on the surface but then the yield monitor showed variations. The EM38 showed areas of differing clay content, gravel content, shallower soils and areas lower in potassium. This helped to further fine-tune and tighten our variable rate zones."

The remaining area was EM38-surveyed in 2013 and 2014. The maps produced have also been helpful for deep-ripping – outlining the shallow gravel areas where the ripper needed to be lifted.

As technology has improved over the years, Erin's GPS software has changed from SF1 to SF2 and now everything is running on Real Time Kinematics.

### Targeting VRT to your needs

With the machinery, software and hardware systems in place and the financial implications of the system better understood, VRT is now a key part of each season's cropping program.

Each paddock has been mapped into two or three zones according to data from yield maps, biomass maps, the EM38 surveying and soil test results. High resolution aerial maps were also consulted initially.

"You've got to be practical about the whole system. We keep it simple by limiting it to two or three production zones per paddock," Erin said.

The EM38 data was originally manipulated using

the Gateway software and the yield maps were exported from SMS. All data is now managed in John Deere's Apex software and each year Erin analyses the results of the various layers to set the coming season's program.

Although running with one software system has simplified things greatly; learning how to use Apex was a continual case of trial and error for Erin, particularly in terms of importing data from the different brands of machinery. One of the local John Deere support staff was exceptionally helpful in setting up the software to be "plug and play" with the air seeder.

Before seeding, Erin prepares the season's maps based on the expectations of an average season. If the season's potential changes he can alter input rates on the John Deere software screens rather than needing to redo prescription maps.

"VRT allows us to work different areas to a season's potential. In 2016 it was a wetter year with more potential, so for the six-leaf application we increased our liquid nitrogen rates across the zones."

Until 2016 the farm's liming program was a blanket application. Now that pH levels have improved, lime is spread to either two or three zones, with the higher pH areas receiving a maintenance application of 1.25t/ha and more acidic areas treated with 2.5 to 3t/ha. Potash spreading is also targeted with one zone receiving potash while the other doesn't.

Seed is sown at a flat rate at seeding time. Flexi-N is banded at a flat rate and for wheat, barley and canola crops, the compound fertiliser is varied across two or three zones depending on the paddock's needs. Nitrogen is applied variably at the six-leaf stage, and blanketed (with any fungicides needed) at flag leaf.

Until now, Erin has opted not to vary seed rates as he's been utilising the higher crop competition for weed control. However, as weeds and lime have both been managed and improved over time, there is potential to vary seed application rates in coming years.

#### LESSONS LEARNT

- Swapping everything to one software system standardises things, and makes it easier for staff.
- EM38 survey confirmed why some areas performed as they did. It showed areas of differing clay, gravel and potassium content, and soil depth. This helped fine-tune variable rate zones.
- EM38 maps have also been helpful for deep-ripping – outlining the shallow gravel areas where the ripper needed to be lifted.

# Ben Cripps

## Wepowie Farming Co, Ogilvie

### OPERATION AT A GLANCE

<b>Farm location</b>	Ogilvie	<b>Topography</b>	Slightly undulating
<b>Annual rainfall</b>	300mm	<b>Enterprises</b>	Wheat, lupins, canola, barley
<b>Soil types</b>	Sand, loam, gravel	<b>Average wheat yield</b>	2t/ha
<b>Farm area</b>	4300ha	<b>Agronomy consultant</b>	Chris Pinkney (Agrarian Management)



Ben Cripps says his motorbike is an essential tool for VRT ground-truthing.

#### KEY MESSAGES

- Buy the best computer available with as much RAM and hard drive as you can.
- Learn your management software. You'll be able to adjust during seeding and be able to manage if your consultant moves on or is not available when needed.
- Back-up your data.
- File well and be structured.
- Take it one step at a time starting with what will give you the biggest bang for your buck.

**A systematic approach to managing data and self-determination to learn a new software program have been two of the key elements of Ben Cripps's adoption of VRT into his farming business situated 40 kilometres north-east of Northampton.**

#### Creating and managing zones

Ben Cripps's first step into VRT was having his farm EM38 and radiometric surveyed in 2011 and yield mapped in 2012. He used the EM38 results (basically the water-holding capacity of the soil) to create production zones with Gateway software, and followed that up with a week of ground-truthing. Soil testing was done on 72 sites across the farm and he compared the drafted zone maps with his knowledge of paddock variability and potential.

In 2012 Ben applied potash at variable rates at seeding. Progressively he has implemented variable rates into most of his input applications including lime, compound fertilisers, Flexi-N, and pre- and post-herbicides.

At times Ben also uses VRT to save on herbicide costs. “For one paddock in particular which was 300ha, I rode around and dropped pins on GIS areas with differing weed burdens, and then I made a prescription map using those areas. Instead of spraying Sakura across the whole paddock I only sprayed about 130ha and the rest with Treflan. Post-emergent I might use a blanket application of Ester but vary the velocity as required.”

Ben said his approach to VRT had been different to how some other growers operate.

“I started VRT saying that I would use the zones to fix the better areas of my farm and manage the poorer soils as they need it, whereas some other guys prefer to apply blanket rates to improve all soils, then move to variable rate to manage different areas. We are all trying to improve and better manage what we have, it’s just which step you want to put first.”

In the years that Ben’s been using VRT, he’s noticed that the zones haven’t really changed but their properties have.

“The management of the zones is continually evolving as you fix problems over time and I use my motorbike a lot to ground-truth and assess where we are at. My bike is probably one of my main VRT tools,” he said.

Each paddock is soil tested every three to four years to a minimum of 30cm, some to 50cm. These results are becoming more and more crucial to planning how zones and paddocks are managed, particularly prior to deep-ripping so that



Ben Cripps runs Case machinery with the VRT managed through SMS software.

constraints can be addressed if needed during this operation.

The deep-ripping program and operating as a CTF system have now mostly fixed soil compaction which was one of the farm’s main constraints.

### Software plays a vital role

Ben currently operates with red machinery (Case tractors and header, and a Patriot boomspray) running on Spatial Management Systems (SMS) software, however when he started out the Advanced Farming Systems (AFS) technology was what came with the header he owned.

SMS is Ben’s software of choice as it reads “every colour of machine” and allows him to use one system for everything, which when the pressure of seeding is on, can make a big difference.

Learning SMS has been the most frustrating but also one of the most integral parts of adopting VRT at Wepowie.

“Whichever way you look at it, you’ve got to learn. It’s an absolute pain learning a program but

now I find it so easy. The benefits are paying off for me and I’m glad I’ve done it the way I have, by spending the time to teach myself.”

At the start of each season Ben spends approximately three hours to produce three prescription maps (seed rate, compound fertiliser and potash) for each paddock. Each bin on the air seeder cart has its own map and even if a paddock is receiving a blanket application of inputs, a map will still be produced to make it easier for the driver.

For the first couple of years, Ben printed off a PDF of each prescription map. The print-offs were left in the tractor to be used as a backup so that rates could be varied manually in case any technical faults occurred. Today, this is not needed.

### Recording, evaluating and data management

Zone areas are precisely mapped to ensure that yield and grain quality are not compromised from a misallocation of inputs. The recording and filing of each paddock’s operations and data are also accurately managed with detail.

Ben estimates he spends about a day a week in the office, perhaps more, in the lead up to the growing season.

Now that Ben has realised the potential of the SMS software, he uses it to record all operations and cost of operations such as deep-ripping, weed-it applications and the like. This in turn simplifies his ability to analyse financial results by negating the need for a second paddock management program. He does however develop a paddock plan annually with his agronomist, which he refers to as a static guide (PDF format only) and records all actuals in SMS.

“We always record what we’re doing and what we see in paddocks. Collating all the information into one system simply means I can remember where it is and where to find it.

“I can pretty easily produce a financial statement or return on investment for each paddock. I also have a spreadsheet that I work through with my agronomist to evaluate the zones, input rates applied and individual nutrients received compared to what the soil tests said they needed.”

Since 2012 the Cripps family has found that overall the purpose and impact of varying rates is hugely dependent on the season.

“One year, VRT saves you money, the next it makes you money. My prescription maps are made with the same consideration; if the season outlook isn’t great I have a more defensive or cost saving approach, but if the seasonal outlook is good I’ll go more aggressively with the aim of making money from varying rates.”

### LESSONS LEARNT

- Since using VRT, the zones haven’t really changed but their properties have.
- Soil testing results are becoming more crucial to planning how zones and paddocks are managed, particularly prior to deep-ripping.
- SMS is the software of choice as it reads “every colour of machine” and allows one system for everything, which can make a big difference at seeding.
- Learning SMS has been the most frustrating but also an integral part of adopting VRT. The benefits are now paying off.
- SMS software records and costs operations such as deep-ripping, weed-it applications and the like. This in turn simplifies ability to analyse financial results.
- One year, VRT saves money, the next it makes money.

# Mark & John Flannagan

## Mullewa

### OPERATION AT A GLANCE

<b>Farm location</b>	Mullewa	<b>Topography</b>	Slightly undulating
<b>Annual rainfall</b>	300mm	<b>Enterprises</b>	Wheat, lupins
<b>Soil types</b>	Red loam, sandy loam, gravel, sandplain, shallow rock	<b>Average wheat yield</b>	1.35t/ha
<b>Farm area</b>	24,000ha arable	<b>Agronomy consultant</b>	Peter Norris (Synergy Consulting)
<b>PA consultants</b>	Craig Topham (Agrarian Management) and Nick Ross (Precision Agronomics)		



Brothers Mark and John Flannagan work their VRT system within large blocks for ease of management and time efficiencies.

#### KEY MESSAGES

- The Flannagans are well aware that the more they know about their farm, its soil constraints and characteristics, the more efficiently they can manage it.
- Ease of management is a priority.
- Before settling on three zones, they first mapped some areas into five zones but this was too complicated.
- Characterising the soil and working with a consultant has made VRT more manageable.

**For Mark and John Flannagan, farming 24,000ha across four blocks that are spread about 50km to the south, west and north of the home farm ensures that ease of management is a priority.**

The brothers have been yield mapping since John Deere first brought the technology to their clients in WA about 18 years ago. At that stage it was a case of collecting the data without knowing how they would use it. Today, the Flannagans are well aware that the more they know about their farm, its soil constraints and characteristics, the more efficiently they can manage it.

#### **Starting with the obvious – what the eye can see**

In the early 2000s, the Flannagans began adopting VRT practices by varying rates of their post-seeding nitrogen based on the lie of the



The Flannagans farm 24,000 hectares spread about 50km to the south, west and north of the main block, Windsong, east of Mullewa.

land. In dips and hollows where the deeper soils stored moisture and the crop stayed greener for longer, nitrogen was doubled. These areas were also visible on the yield maps.

The higher potential areas were where lupins had been grown in the season prior. As the variations were done by what they could see in the paddock, Mark and John found it easier to drive the spreader themselves rather than expecting staff to do it correctly.

The extra nitrogen application resulted in the crop looking visibly thicker and the yield and protein being lifted.

### Varying seeding rates

In 2008 the Flannagans purchased two second-hand John Deere 1910 Air Carts, enabling them to vary rates at seeding. They had the ability to produce prescription maps with their Apex software, but found it too complex and time consuming. Alternatively, they opted to vary rates manually based on the maps loaded onto the screens in the tractor cab.

Beginning with a few paddocks, the Flannagans altered seed and fertiliser rates across three zones identified from the yield maps. The

medium zone received average input rates; the low zone about 40kg/ha; and the high zone 60kg/ha each of seed and fertiliser.

Before settling on the three zones; the Flannagans had mapped some areas into five zones but realised this made things too complicated.

They have found using yield maps to determine zones has some limitations and complexities.

“The problem with all of this is that it needs to be done on a median season before the season really starts,” Mark said.

“There are huge variations between seasons and our sandier light soils yield more in the tighter seasons, whereas in the wetter years it’s the heavier clay soils that perform better. Hence, if zones are based on yield potential it’s extremely difficult to determine before seeding.”

### Understanding potential through soil characterisation

In 2010, the Flannagans took part in a GRDC-funded project that analysed the potential for EM38. Managed by local consultant Craig Topham, 500ha was surveyed and characterised within the project. Additionally, they paid to have 2000ha of their better producing or regularly cropped paddocks surveyed in 2011.

Measuring the water-holding capacity and clay content of their soils was key to further understanding the potential of the farm’s differing soil types.

“The variability across our soil types is huge. We have sands and gravels that are generally acid at depth, red loams, shallow soils, rock and granite. The EM38 showed areas that we thought were rocky and shallow were actually deeper and had a

fair bit of potential,” Mark said.

The zones identified through EM38 weren’t significantly different to what they had previously, but it enabled the Flannagans to combine the soil characterisation with soil test results and then use the data for three *Yield Prophet* sites spread across the farm. *Yield Prophet* is then used as a guide for post-seeding nitrogen applications that range from 30 to 70kg/ha.

Since the EM38 work, the Flannagans have used Craig Topham to annually review their zones, recommend input rates, and produce the required prescription maps. A day is spent in the office with Craig working through the whole farm, overlaying the zones, yield maps and soil test results, to determine their VRT plan for the coming season.

Characterising the soil and working with a consultant has made VRT a less complicated and more manageable system. The results of the GRDC project also confirmed what they could see on the headers’ yield maps that the economics of VRT worked for their farm.

The Flannagans regularly assess the effects of applying variable rates by running control or ‘out of spec’ test strips for comparison, particularly with nitrogen applications.

### Bigger works better

The Flannagans don’t write prescription maps for each paddock. Instead, they work on large blocks for ease of management and time efficiencies.

“We set our zones based on the soil types and potential, then we produce the prescription maps and manage the areas in approximately 500ha blocks,” John said.

“Working in larger blocks saves a lot of time.

There are fewer maps to be written, less computer time, less changing of paddocks and reloading of data. It's the loading of maps and set up at the start of individual paddocks that can be time consuming and generally when things go wrong.

"If we head into a new block at the end of the day, we know that the tractors should be right to run through the night without needing to change files. If they do have a bit of a problem, they go back to the default rates of 50:50 until it's fixed. Either way, the tractor doesn't stop."

There's time required in setting paddocks up into larger blocks, particularly in ensuring the run lines are correct. For simplicity, all of the Flannagans' runs either go directly north-south or east-west. Consideration also needs to be given to the amount of data that can be stored on a single file, particularly at harvest time.

The Flannagans don't have the luxury of mobile service on most of their farm so all files are loaded and unloaded onto USBs. A laptop is always in a vehicle nearby in case any adjustments are needed.

## Managing the system

The Flannagans have three full-time employees and casual staff when required. Having had two of the full-timers for a number of years has allowed tasks such as loading maps; checking machines are working correctly; and creating extra prescription maps for urea applications to be delegated when needed.

Working with the one software system (John Deere) makes training new staff and moving staff between machines relatively simple.

Mark advises: "Compatibility is everything. Start with a system that you want to work with. Most

of our machines are John Deere and once staff get used to the system they're okay. If a system works, don't bother messing with it."

Having one system also allows screens to be shifted between machines when required. The Flannagans set a screen up in their boomspray so they can see the zones while spraying and check everything is looking as it should. At harvest, background maps on the yield monitor can be viewed while driving across different zones.

## Advice for other growers starting VRT

Compared to some farm business and system costs, the cost of implementing variable rate technology is minimal. The Flannagans' advice is to start simply by choosing a block or paddock with slightly varying soil types and employ a consultant to help get started.

"Set up zones and maps based on the potential of average or median years. Biomass is okay to work with, yield maps are twice as good as biomass; and then EM38 is better again. To keep things easier to manage, only use as many zones as you really need and work with larger blocks not individual paddocks," said Mark.

The Flannagans' investment into VRT began with a \$3500 Hydramotor being fitted to a Marshall multi-spreader with a John Deere rate controller. They contracted Nick Ross of Precision Agronomics in Esperance to set up the system and still pay an annual subscription to have access to Nick's expertise when required.

"We are probably quite average at technology. We've had to get better at it but we also have no problem paying a consultant to help as we learn. You evaluate the consultant's fee back to dollars per hectare and it's reasonable in the scheme of things," Mark said.

## The next step

New seeding boxes with three bins have been purchased for the 2017 season. The brothers are considering varying potash rates but also want to ensure that adding another variant won't make the logistics of seeding too complicated. Varying potash would require some more thought into the compound fertilisers used and how to manage the changeover of fertilisers between blocks and zones.

Subsoil acidity is the Flannagans' biggest yield constraint which they have been addressing with a significant liming program since the mid-1990s. With most areas now having improved pH the next step may be to use the savings they gained from variable rate application of fertiliser to be allocated to variable rate lime applications with higher rates in the more acidic areas.

## LESSONS LEARNT

- Compared to some farm business and system costs, variable rate technology costs are minimal. The Flannagans advise new growers to start simply by choosing a block or paddock with slightly varying soil types and employ a consultant to help get started.
- Set up zones and maps based on the potential of average years. Biomass is okay to work with; yield maps are twice as good as biomass; and EM38 is better again.
- Only use as many zones as you really need and work with larger blocks not individual paddocks.
- The Flannagans feel they are probably average at technology but have had to get better. They have no problem paying a consultant to help as they learn.

# Rohan & Carol Ford

## Nookanderri Farm, East Binnu

### OPERATION AT A GLANCE

<b>Farm location</b>	East Binnu	<b>Topography</b>	Undulating
<b>Annual rainfall</b>	275mm	<b>Enterprises</b>	50% wheat, 25%c canola and 25% lupins
<b>Farm area</b>	4400ha	<b>Average wheat yield</b>	1.6t/ha
<b>Soil types</b>	Yellow sand over gravel, red loam		
<b>PA consultants</b>	Nick Ross (Precision Agronomics Australia), Craig Topham (Agrarian Management), Michael Ford (son)		
<b>Agronomy consultants</b>	Chris Pinkney (Agrarian Management), Wayne Pluske (Equii)		



Rohan Ford has found the more he learns about soils the more questions it seems to raise.

### KEY MESSAGES

- Rohan Ford sees VRT as a tool to fine-tune what you are already doing. He advises planning ahead, being sure of what you are trying to achieve, being confident in your background research, and confident that VRT will return what is being spent.
- Before investing time and money in VRT, all of the basics including varieties, nutrition and good agronomy need to be right. VRT should be the last step.
- Work with your agronomist, farm consultant and bank manager and communicate plans to ensure you are all working together.
- Be prepared to pay for the skills you don't have. Running with the one system is ideal.
- All of the home farm is now managed with variable rates, while the more northerly lower rainfall block receives blanket, lower inputs.

**For Rohan and Carol Ford of East Binnum variable rate technology is a tool they use to farm better and is the last step in fine-tuning a system once the other foundations of good agronomy are in place.**

The Fords' progression into varying input rates came about in 2008, about 10 years after they began collecting yield data and implementing controlled traffic farming.

### Understanding what you have

In 2008 the Fords invested in EM38 and radiometrics, surveying Nookanderry, 60% of their total area farmed. They did not do the remaining area as they wanted to see the results first. They were not using VRT at this stage. As Rohan explained, the surveying was used to measure the depth of soils.

"I believe that most of our yield comes from being able to get crop roots to the bottom of the bucket so it's important to know how deep the bucket is," said Rohan.

The surveying enabled the Fords to ground-truth the results of their existing knowledge of the farm and soil test results. The farm was characterised into four main soil types: yellow sand over gravel, deep yellow sands, sand over clay and red loam. The soil characterisation was used to map the farm into three basic production zones (low, medium and high) based on soil type and yield potential.

Rohan has found the more he learns about soils the more questions it seems to raise. "The more you work out, the more you realise you don't know, particularly regarding variability in yields at

harvest. You then question whether VRT is about better sharing the nutrition budget or boosting some areas?

"I believe it is important to know the rooting depth because some crops have more or less ability to seek moisture and nutrition.

"Wheat roots go down 2 metres plus, but canola and lupins are more like 3 to 4 metres plus. That's why our yields can vary so much and why it's important for us not to steal nutrition from our deeper soil types because in drier seasons they are the highest yielding areas for lupins."

To assist with understanding the soil's potential in differing seasons a *Yield Prophet* site was established in 2011 with the help of Craig Topham of Agrarian Management. *Yield Prophet* is combined with pre-seeding nitrate testing to give a guide for the season's nitrogen applications.

### Implementing varied rates

Over a number of years the Fords have adapted and traded existing machinery to help in adopting and simplifying their VRT system.

Granular nitrogen was the first input the Fords applied at variable rates. To allow the post-seeding nitrogen application to be targeted across their three zones, in 2008 Nick Ross of Precision Agronomics Australia set up an electric controller to run the VRT using the remotes on the John Deere 8100 with the Marshall multi-spreader.

Rohan did the hydraulics. The multi-spreader was originally truck-mounted but was frame-mounted when the controlled traffic farming system was adopted in 2002.

"This was a starting point to learn all the stuff-ups cheaply," Rohan said.

The next step was setting up the Hardi boomspray with a liquid rate controller so that later applications of Flexi-N could be varied. In 2015 the Hardi was traded for a John Deere 4930 self-propelled boomspray. Liquid nitrogen rates are varied as needed, with the seasonal outlook determining whether nitrogen is applied sparingly or boosted to increase yield and protein potential in better years. Rohan opts to apply nitrogen for yield potential rather than trying to hit a protein window, which he has found can be quite tricky.

When their Morris air cart was changed to a John Deere 1910 bin, the Fords began varying potash and compound rates for wheat and canola. Prior to varying potash rates, it was applied either post-seeding as a blanket application, or with nitrogen.

With the ability to vary top-up rates, nitrogen is often applied at lower rates at seeding. The Fords are careful not to cut back on phosphorus or any other nutrients that can't be applied post-seeding as the season progresses.

All of the Fords' home farm is now managed with variable rates, while their more northern, lower rainfall block receives blanket, lower inputs.

### Drawing on expertise

Chris Pinkney of Agrarian Management in Geraldton has been the Fords' agronomist and farm consultant for 12 years and has been integral in their ability to adopt VRT.



Rohan and Carol's son Michael's interest and expertise in technology is becoming increasingly beneficial to the farm business.

Rohan explains his experience: "You've got to have a good agronomist who understands the farm over the long term, including the past years and how they affect what you're trying to achieve in future years. Knowing that everything you change will cause a reaction on something else means you need to have a detailed database and history of the farm.

"Being our agronomist and our farm consultant, Chris knows the bigger picture of this business and understands what each paddock can produce, but also what we can afford to be spend on it."

Chris Pinkney's role includes analysing historical data including yield maps, soil tests, tissue tests and soil water-holding capacity to set recommendations, paddock plans and prescription maps. Prescription maps are emailed to Rohan as an RX file, saved on a USB stick and then loaded into the machinery bypassing Apex.



Original multi-spreader set up.

Every paddock operation and any changes to recommendations are recorded. Seeding and harvest data from the John Deere 8370 tractor and John Deere header is automatically uploaded to an iCloud account.

In addition to Chris, the Fords also use Wayne Pluske of soil consultancy Equii. They have an annual subscription to Precision Agronomics Australia and draw on their son Michael's technical expertise. Michael has a keen interest in the farm but is also developing his own technology and an app that aims to simplify the storage and interpretation of data for the industry. Chris, Wayne and Michael all have access to the raw data in the iCloud account.

Good data storage is important but as Rohan explains so too is understanding the data, and knowing how to use it.

"The more marginal a season is, the more you need to change and adapt. Changing a small percentage of costs can stop a bad year becoming really bad. All the little bits of data can help make those efficiencies. You need to make sense of the data and understand why you're using it."

Rohan's passion for learning and adopting new technologies has meant his computer skills and understanding of technology have improved in recent years. But to be implementing VRT he feels you either need to be very computer savvy yourself or be prepared to pay someone who is.

## Software and hardware

The Fords operate with John Deere machinery, software and hardware. This was the preferred system for them due to John Deere's longevity in the industry, the relatively lower cost of the software and the availability of local service and support.

The ability to 'plug and play' between machines but also to swap hardware between machines are valued benefits. Having the one system makes troubleshooting and seeking technical support easier as you know which company to call. When it comes to training seasonal staff they only need to learn the one machine and one set of software to be able to operate any machine.

"Make sure all of your equipment will talk to each other. Understand the difference between hardware and software and how they need to communicate. Having all of the same equipment is a blessing," Rohan commented.

Rohan relies heavily on Chris Pinkney's expertise to manipulate the raw data and prepare the prescription maps before sending them through to Rohan to load into the My John Deere system. This is something Michael will do in the future.

## Confirming the benefits

Throughout the farm test strips are applied each year with differing nutrient applications. Every paddock is yield mapped and tissue tests are used to measure the impact of the different applications. Head and tiller counts are taken during the season. Rohan and Chris sit down annually to analyse the results of the nutrition rates applied, versus the yield and tissue test results.

For the Fords the bottom line is improving. In addition to analysing their business they can also draw on Chris's insight as he sees how other farms are operating and performing.

The next step for the Fords is to continue refining their system and learning what is happening in their soils at depth. They will also try to use the knowledge and data they have of their farm to strengthen a neighbouring block they have recently acquired that has no recorded paddock history.

Rohan anticipates that the adoption of VRT will be similar to that of minimum tillage and liming, a slow uptake at first and then it will take off rapidly as newer technologies and the next generation of farmers come through.

### LESSONS LEARNT

- You've got to have a good agronomist who understands the farm over the long term, and how the past affects future years. Knowing that every change will react on something else means you need a detailed database and history of the farm.
- The seasonal outlook determines whether nitrogen is applied sparingly or boosted to increase yield and protein potential in better years. Rohan Ford opts to apply nitrogen for yield potential rather than trying to hit a protein window.
- With the ability to vary top-up rates, lower nitrogen is often applied at seeding. The Fords are careful not to cut back on phosphorus or other nutrients that can't be applied as the season progresses.
- Good data storage is important, but so too is understanding the data, and knowing how to use it.

# Daniel & Corrina Michael, Clancy & Jan Michael Geraldine Farms, West Mingenew

## OPERATION AT A GLANCE

<b>Farm location</b>	West Mingenew/Strawberry	<b>Topography</b>	Loam river flats to open undulating sandplains
<b>Annual rainfall</b>	400mm	<b>Enterprises</b>	Wheat, lupins, canola, cattle
<b>Soil types</b>	Yellow sandplain, sand over gravel, deep white sand, red loam		
<b>Farm area</b>	5500ha	<b>Average wheat yield</b>	2.8t/ha
<b>Agromony consultant</b>	Luigi Moreschi (CSBP Area Manager)		



Farmhand Richie Marsland and Daniel Michael.

### KEY MESSAGES

- Huge variation in soil types and production capabilities were the driving factors in the Mich decision to venture into VRT in 2011.
- Since they began their VRT journey there is a lot more information, expertise and research readily available to help get started.
- As adoption of VRT increases, it should only get easier.

### A huge variation in soil types and subsequent production capabilities were driving factors in the Michael family's decision to venture into VRT in 2011.

Ten years of yield maps produced with their headers' John Deere software was the basis of data initially used to create three production zones across the Michaels' farm.

With the selection of key years and crops to analyse, and technical expertise from precision agriculture expert Roger Mandell (formerly of Curtin University) helping to interpret the data, Daniel found it relatively straight forward to map their farm into low, medium and high production areas.

Biomass imagery provided through CSBP further reinforced the alignment of the zones.

With the zones set, soil samples were taken and fertiliser recommendations were made for the first year of applying variable rate technology.

## Small steps to start

With an emphasis on keeping things simple and taking one step at a time, the Michaels set up their 20-year-old Marshall multi-spreader with a hydra motor allowing them to vary their nitrogen input in two paddocks via the first post-seeding urea application.

Grain protein was tested during the first harvest with pleasing results. With the ability to vary nitrogen simply and still remain in the protein window, Daniel had the confidence to continue with the VRT in the second year.

Typically, their crops receive two shots of nitrogen post-seeding. This allows for nitrogen to be increased or decreased according to yield potential as the season progresses. Usually, the first application is urea applied variably; the second is a uniform application of Flexi-N.

## Broadening the VRT potential

Keeping things simple is critical to the ongoing success of VRT for the Michaels. Happy with the results of varying nitrogen, varying phosphorus at seeding was next on the list of things to try.

“We varied phosphorus at seeding for one year, but it just made things too complicated. The stronger soils will always perform, and the poorer soils will always underperform but we didn’t want to run the risk of varying P, resulting in the poorer areas dropping more yield,” Daniel said.

Instead they looked at their potassium levels and began varying applications at seeding. They are now in the third year of varying potassium through their John Deere air seeder with a few learnings noted along the way.



The Michaels are not set on a brand of machinery but running the same machinery throughout has its advantages.

“We’ve been banding potassium down the tube on the light to medium soils and next year we’ll continue to do it with the wheat and canola but not with the lupins, because of the potential for fertiliser toxicity which we experienced this year.”

The 2016 season was the first wet seeding since they’ve been applying K this way and there were some difficulties with getting it down the tube. Putting a radiator on the air seeder fan to keep the tubes dry is a consideration for future wet years.

## Continual process of analysing and adjusting

As every season is different, the variable rate needs of each crop changes year to year.

Ultimately the Michaels are applying variable rate technology to spend their fertiliser budget more wisely. “It’s not about cutting input costs, it’s about spending in the areas that give returns,” Daniel said.

Soil sampling has been key to setting the VRT application rates in the last six years. Within the mapped low, medium and high production zones, there are a minimum of two soil sampling sites

per zone with sites sampled at the top, medium and sub level over a four-year period.

The soil test results are cross-referenced with yield maps. Then, in consultation with their CSBP Area Manager, the combined data is used to set the varying fertiliser applications according to nutrient requirements and zone production capabilities.

In the cereal and canola rotations there’s always a base rate of nitrogen applied with rates varying between 50 and 110 units. Potassium is only applied to the lighter soils and varies from a low base rate up to 40 units of K-Till depending on the soil data in each zone. K-Till is a range of granulated fertilisers from CSBP, based on muriate of potash and also containing nitrogen, phosphorus and sulphur. Phosphorus is applied at a blanket rate which also allows for Flutriafol (intake-in-furrow) to be applied with it. The air seeder is only required to be filled once a day.

Going forward, the Michaels are pleased with the outcomes of their VRT applications. Within the next few years they will look at varying lime but they don’t see the need to take on many more variations apart from possibly varying seeding rates at some point.

## LESSONS LEARNT

- Daniel Michael has found that once production zones are set it doesn't take much time annually to set up the VRT applications. He wonders if many growers think VRT is more complicated or harder than it actually is.
- Setting up the compatibility between different software can be time-consuming, particularly when bringing in new machinery.
- VRT is at a stage where everyone (farmers, machinery dealers and industry consultants) is learning at the same time so it's expected that there will be a few hurdles.
- Anyone considering VRT should first work out why they want to do it and then use available expertise to help with the initial set-up.



Daniel Michael operating his header.



A large portion of the Michaels' farm at Strawberry, west of Mingenew is sandplain.

# Scott & Belinda Morgan, Gerard & Carlie Rowe, Adrian & Di Morgan

## Uvee Four Farms, West Arrino and Woongoondy

### OPERATION AT A GLANCE

<b>Farm location</b>	West Arrino & Wongoondy	<b>Soil types</b>	Sands, gravel, red loam
<b>Annual rainfall</b>	300 and 400mm	<b>Farm area</b>	7800ha
<b>Topography</b>	Gently undulating & sandplain breakaways at West Arrino; relatively flat at Wongoondy		
<b>Enterprises</b>	Wheat, lupins, canola; 600 traded Merino x Poll Dorsets		
<b>Average wheat yield</b>	2.3t/ha at West Arrino	<b>PA and agronomy consultant</b>	Craig Topham (Agrarian Management)



Scott Morgan farms with his wife Belinda, sister Carlie and her husband Gerard, and his parents Adrian and Di.

### KEY MESSAGES

- One of the biggest steps was finding an agronomist who was interested in, and had a passion for VRT.
- Starting simply and finding the right advice is an important step and money well spent.
- To help things run smoothly prior to the start of season, Scott Morgan ensures that everything is pre-loaded, paddock names are correct, and everything is working.
- One of the hardest parts has been having staff understand the system. As the grower, you have to have an interest in VRT because there's a lot to learn and to manage.

**In recent years the Morgan family of Mingenew has undertaken some big changes to their farm business, expanding the farming operation and making significant steps towards succession from one generation to the next.**

Parents Adrian and Di moved off the farm to nearby Dongara enabling their son Scott and his family to move into the 2950ha home block west of Arrino. Their daughter Carlie and her husband Gerard are based 100km away on the 3500ha northern block of heavier country at Wongoondy. An additional block of 1350ha was purchased closer to Arrino a couple of seasons ago. The farm is managed and operated as one, with seeding and harvest carried out from one block to the next.



As well as using VRT Scott is trying to improve the performance of his soils with a Bednar Terraland ripper.

## A steady approach to VRT

In 2012, Scott decided to trial variable nitrogen rates as a way of managing the extreme soil variability on the home block.

To get his machinery ready, Scott called on Nick Ross of Precision Agronomics Australia in Esperance to set up a Topcon X20 rate controller on his Marshall multi-spreader.

“We chose to go with Topcon because it’s pretty commonly used for VRT and I’d just set up the tractor’s auto steer with it,” said Scott.

Andrew Whitlock and Tim Neale of Precision Agriculture in Queensland were contracted to set up the production zones. Referencing 10 years of stacked biomass imagery they divided a 360ha pocket of the farm (which was going into wheat that season) into two zones and using SMS software, they developed prescription maps for the nitrogen application.

Nitrogen was applied at the three to four leaf stage with a lower rate of 30 units on the pale white sands and 45 units on the higher zone, predominantly comprising sand over clay. After harvest the results from the two zones were analysed and showed that cutting the nitrogen rate on the weaker sands was a good economical decision.

In 2013 and 2014 Scott increased the area receiving variable rates of nitrogen to about 600ha using Farmworks software to manage the zones. Varying results between the seasons possibly posed more questions than answers, and although Scott was interested in gaining a better understanding of the impacts of VRT, his agronomist at the time wasn’t as enthusiastic.

## Finding the right expertise

Scott says changing their agronomist in 2015 was an integral part in the Morgan family’s ability to effectively adopt VRT.

“One of the biggest stepping stones for us was finding an agronomist who was interested and had a passion for VRT,” he said.

“I think most growers are capable of doing VRT but we don’t really have the time to spend on it. Starting simply and finding the right advice from someone who’s passionate about it is a pretty important step – it’s money well spent.”

## Analysing data to vary rates where it’s needed

The Wongoondy farm is a considerable distance from a lime sand pit and has predominantly higher pH loams and acidic red gravels. So in

2015 VRT was used to reduce the costs of the liming program.

Soil test results, six years of yield data and Google Earth maps were used to define three zones across 500ha. Prescription maps were created in SMS with application rates set at 1, 2 and 3 tonnes per hectare. Targeting the application rate to the soil type resulted in using 300 tonnes less lime sand than would have been used if it had been applied at a blanket rate.

Each year the Morgans soil sample 25 sites across their farm for a full analysis to 30cm. The aim is that every paddock will have the same sites tested every three to four years. An annual subscription is paid to Equii to have the results of each site mapped on Google Earth and the data collated.

Utilising the Equii results, yield data maps and agronomist Craig Topham’s knowledge of the soil types, the Morgans now vary the rate of both nitrogen and potassium applications on the home farm. Across 2400ha, most paddocks are split into two or three zones.

In summer, potassium is top-dressed at rates of approximately 12, 32 and 27 units per hectare. Interestingly, the high production zone does not receive the highest application rate. The medium zone has a higher potassium rate to try and boost its production to be closer to that of the higher potential zone, which are generally the gravel areas. Potassium is also applied at seeding, as a blanket application of muriate of potash.

The rates for topdressing nitrogen at the three to four leaf stage are generally 35, 50 and 84 units per hectare.

Overall, Scott expects these application rates to result in increased production and a saving in the cost of potassium. “The big picture is about increasing production and the savings made should also pay for the consultancy costs.”

### Managing the data

All yield data is collected using John Deere software. Scott imports it into the Farmworks program, an external back-up is made, and it's saved in Dropbox. The agronomist accesses the raw data via Dropbox, analyses and manipulates it before putting it back into Dropbox for Scott to save onto a USB stick and load onto the tractor or header.

To help ensure things run smoothly prior to the start of a season, Scott ensures that everything is pre-loaded, paddock names are correct, and everything is working.

“One of the hardest parts of this whole thing has been having staff get their heads around the system and understanding the controls. As the grower, you have to have an interest in VRT because there's a lot to learn and to manage,” he said.

### Going forward

The next big step is to upgrade the air seeder cart to a three-bin capable of VRT. The first objective for this will be varying the potassium rate at seeding which will save the cost of a separate top-dressed application. At this point, Scott may consider using all John Deere software as this is what the tractors and headers already use.

To improve the potential of their soils particularly the poorer areas, the Morgans purchased a Bednar Terraland deep-ripper for the 2016 season. The machine has a delving tyne and early results from test strips left within paddocks indicate that ripping to a depth of 550–600mm has improved yields. Scott plans to rip whole paddocks but will use the paddock yield maps to assess the benefit across different production zones.

As they evolve over time, Scott will continue to refine the management of the different zones. At the moment he's focused on managing the variability of the home block but is open to using VRT across the other blocks if there's a need.

“There's still no guarantee we're doing the right thing but as the cost of inputs is so high these days I think you've got to try and be more efficient where you can,” he added.

#### LESSONS LEARNT

- The next big step is to upgrade the air seeder cart to a three-bin unit capable of VRT. The first objective will be varying potassium applications at seeding which will save the cost of a separate topdressing.
- Scott will continue to refine the management of the different zones. He's focused on the home block but is open to using VRT across the other blocks if there's a need.
- There's still no guarantee they are doing the right thing but as the cost of inputs is so they high feel they have to try and be more efficient.



# Southern Farmers – case studies

**This publication would not have been possible without the generous input from the growers and consultants using VRT technology. We gratefully thank:**

- 1 Andy, Jenny, Kye, Portia, Mitchell, Sophie & Tracie Chambers, Moolyall Farms, Ravensthorpe
- 2 Ken & Karen Drummond, Woolark Pastoral Company, Woogenellup
- 3 Mic & Marnie Fels, Halycon Downs, Wittenoom Hills and Three Springs
- 4 Rodd & Christine King, River Plains, Cascade
- 5 Peter & Tamara Kuiper, Kuibrook Farms, West River
- 6 Phil and Bindy Longmire, Coorong Pastoral Co, Beaumont
- 7 Con Murphy, Warakirri Cropping, Condingup
- 8 Scott & Jane Wandel, Ridley Plains, Mount Ridley
- 9 Kentyn & Jill Wehr, and Tyson Redding, Speddingup East
- 10 Ted & Rachel Young, Mick & Jodi Young, Matt & Ange Hill, Young Hill Farms, Beaumont

# Andy, Jenny, Kye, Portia, Mitchell, Sophie & Tracie Chambers

## Moolyall Farms, Ravensthorpe

### OPERATION AT A GLANCE

<b>Farm location</b>	20km north-east of Ravensthorpe	<b>Farm area</b>	10,500ha
<b>Annual rainfall</b>	390mm	<b>Average wheat yield</b>	2.2t/ha
<b>Soil types</b>	Duplex shallow sand over clay, gravel over clay		
<b>Enterprises</b>	Barley, wheat, canola with oats, peas, lupins; some cross-bred lambs and wethers		
<b>Agronomy consultant</b>	Luke Marquis (South East Agronomy Services)		



The Chambers Family.

#### KEY MESSAGES

- Variable rate technology was first implemented in 2007 for lime and gypsum application to ameliorate acidic subsoils.
- Working with a combination of soil and yield data plus EM38 mapping and trials has allowed for paddock zoning and setting rates for each zone.
- Lack of field data is one of the biggest issues in the Esperance Port Zone, as many farmers are sceptical of the results specific to the region.

**Variable rate technology was first implemented at Moolyall Farms in 2007 for lime and gypsum application to ameliorate acidic subsoils. Working with a combination of soil and yield data as well as EM38 mapping and trials has allowed for paddock zoning and rate prescriptions for each zone.**

Lime and gypsum are spread using a John Deere tractor pulling a Spread Mor fertiliser spreader with a hydraulic drive hooked up to a John Deere rate controller. Apex farm management software is used to monitor the data.

Andy sources gypsum from nearby Lake King at \$22/t and he or his sons cart it back to the farm at a freight cost of about \$10/t.

Their lime is from Lancelin (130km north of Perth) at \$10/t which is picked up as a backload from carting peas to Perth. They also use Dalyup lime at \$12/t with a \$16/t freight cost. The price of lime



Stingray canola next to Bonito.



Seeder is set up with double chute and liquid.



Wheat head.

is one of the main drivers behind the Chambers adopting VRT, allowing money to be spent where it's needed.

Lack of field data is one of the biggest issues surrounding VRT for lime and gypsum in the Esperance Port Zone as many farmers are sceptical of the results specific to the region.

Andy is taking part in a South East Premium Wheat Growers' Association (SEPWA) lime trial as part of the Council of Grain Grower Organisation's (COGGO) Esperance Port Zone project *Laying Lime Trials for Future Research*. The project aims to determine the economic and pH increasing effects of lime application in the region past the traditional time of a one or two-year project.

Andy has found that both crop yield and ease of establishment have improved with lime applications, and VRT provides a cost saving method of application. He is working with his agronomist to develop VRT prescriptions for the application of nitrogen, phosphorus and potassium with further field trials.

### LESSONS LEARNT

- Lime and gypsum are easy to vary. Decisions are cut and dried using available maps and recommended rates.
- Trying to vary fertiliser rates is frustrating. Each season is different and varying soil types react differently depending on the type of rainfall year.
- Anyone thinking about VRT should plan for this when buying machinery, as it's expensive to modify machines.
- Both crop yield and ease of establishment have improved with lime, and VRT provides a cost saving method of application.



Agronomist visit looking at trials.

# Ken & Karen Drummond

## Woolark Pastoral Company, Woogenellup

### OPERATION AT A GLANCE

<b>Farm location</b>	Woogenellup	<b>Topography</b>	Undulating
<b>Annual rainfall</b>	450mm	<b>Enterprises</b>	90% cropping, 10% fat lambs and wool
<b>Farm area</b>	4800ha	<b>Average yield</b>	Barley 3.5t/ha, canola 1.6t/ha
<b>Soil types</b>	Sand over gravel, sand over clay duplex, forest gravels		
<b>PA consultant</b>	Precision Agronomics Australia (PAA)	<b>Agronomy consultant</b>	James Bee, Elders
<b>Varieties grown</b>	Barley (Flinders, La Trobe, Granger), canola (Stingray, Bonito, GM and hybrids)		



Karen and Ken Drummond at their home in Woogenellup.

### KEY MESSAGES

- The Drummonds see their biggest gain from VRT as lowering fertiliser use (particularly phosphorus) on poorer soils.
- Hostile acid subsoils (pH 4.3), compaction and non-wetting sands are some of their biggest constraints. Using VRT they can isolate problem areas and treat them differently.
- Precision agriculture has simplified trial work, as they can change input rates easily or incorporate strip trials on the go, and analyse them using yield data after harvest.
- Ken Drummond highlights software compatibility as one of the major problems in using VRT.

**Karen and Ken Drummond farm just south of the Stirling Ranges in Woogenellup, growing predominately barley and canola. Their farm has an undulating landscape and a range of soil types including sand over gravel, sand over clay duplex, and some forest gravels. The variation in soil type drove them into variable rate as a blanket application on their soils didn't seem appropriate.**

They began considering VRT in the 1990s, initially using biomass imagery. Through the Department of Land and Administration (DOLA) they could purchase a composite biomass map looking at the previous 10 years of biomass history. Ken would use this composite map as a reference layer to draw polygons around the different production areas to create his prescription maps for seeding.



The Bredal spreader is used to apply inputs at VR.

Prescription maps were generated in Farmscan's Data Manager, which could be read by the Farmscan monitors on his seeding tractors. This method of creating prescription maps was very time-intensive, Ken said. It took 10-fold of the time it takes today.

Ken and Karen went on to get their farm EM38 surveyed by Precision Agronomics Australia (PAA). Quenten Knight and Frank D'Emden from PAA who provided them with a lot of support through this process, creating soil maps which Ken could read into Data Manager and assign rates and then put onto his seeding machinery. An update in harvest machinery allowed yield mapping capabilities, which also provided another layer of information to help Ken make his maps and are critical to his phosphorus replacement strategy today.

Ken has always used various types of machinery, hardware and software, and one of his biggest issues is getting those instruments to talk to each other. He still uses his Farmscan monitors on his seeding tractor with an Ausplow multi-stream box, as well as GreenStar 2 monitors on his John Deere tractors.



Soil tests are used to correct application rates in the varying zones.

He runs Bredal spreaders and CLAAS headers. The John Deere and Bredal machinery can use Apex to generate maps; however for all the rest of the machinery and record keeping the Drummonds use PAM software. With their previous software, Data Manager, Ken had to get the software writers to create conversion formulas so it could handle data from all their various machinery. Ken highlights compatibility issues as one of the major problems he faces in using VRT.

Today, Ken varies the rates of urea, lime and potash using a combination of yield maps and the original EM38 soil type maps to create phosphorus replacement maps from the previous year's yield map. Soil tests are also used to direct application rates. Ken has found through soil testing that some of their farm has a low phosphorus buffering index (PBI) and he has adjusted phosphorus rates accordingly.

The Drummonds see their biggest gain from VRT is lowering their fertiliser use (particularly phosphorus) on the poor producing soils.

"We work out the fertiliser requirements for the highest yielding soils and then work back from there, so on the lower yielding soils we don't over-fertilise," Ken said.

On some of the lower PBI soils, applications are down by around 9–10 units of phosphorus, as it doesn't get tied up.

Karen and Ken agree that as the technology changes and expertise increases, their system will continue to develop and become easier.

## LESSONS LEARNT

- Hostile acid subsoils (pH 4.3), compaction and non-wetting sands are some of the Drummonds' biggest soil constraints. Being in the high rainfall zone, waterlogging also plays an issue seasonally. By using VRT they can isolate these problem areas and treat them differently.
- PA has simplified trial work, as they can easily change input rates or incorporate strip trials on the go and then come back and analyse the trials using yield data after harvest.
- Educating the drivers is important as they have had a couple of issues with fertiliser shutting off in areas for no apparent reason, and if they weren't on to it they wouldn't have noticed.
- Gathering data can also be a challenge. In 2016 their header had issues which resulted in unusable yield maps.

# Mic & Marnie Fels

## Halycon Downs, Wittenoom Hills and Three Springs

### OPERATION AT A GLANCE

<b>Farm location</b>	6500ha at Wittenoom Hills, 50km NE of Esperance; 4400ha, 30km west of Three Springs		
<b>Annual rainfall</b>	450mm on both farms	<b>Enterprises</b>	Wheat, canola, barley, lupins
<b>Varieties grown</b>	Mace, Hindmarsh, Bonito, GT50, Gunyidi	<b>Agronomy consultants</b>	Richard Quinlan, Luke Marquis
<b>Soil types</b>	Esperance: mallee clay loams, shallow duplex, sandplain gravel duplex and deep sands Three Springs: heavy gravel loams, sand over gravel and some deeper sands		
<b>Topography</b>	Esperance: mallee well drained, sandplain low undulation, internally drained Three Springs: undulating, well drained		
<b>Average yield</b>	Esperance: 3t/ha Three Springs: Still early days but expect to average around 2.2–2.5t/ha		



Mic and Marnie Fels.

#### KEY MESSAGES

- Mic Fels has two properties, near Esperance and at Three Springs, and finds applying VRT is much easier at Three Springs.
- Variation is clearly defined at Three Springs and easy to zone, with multiple mapping layers (biomass, gamma and Google Earth imagery) correlating directly to yield.
- Major challenges include getting systems to talk to each other; having to use different software for different machinery; and then getting the VRT hardware to actually work.

**Mic and Marnie Fels have farmed 50km north-east of Esperance in Wittenoom Hills for more than two decades. In 2013, they expanded their operation north, purchasing 4400 hectares 30km west of Three Springs. This was driven by the lack of available competitively priced land in the Esperance region.**

For the past 10 years Mic has been trying to use VRT on his Esperance farm, however to date he still mostly applies blanket rate inputs. Productivity at Esperance is affected by a wide range of factors including cation exchange capacity (CEC), sodicity, salinity, non-wetting soils and waterlogging, which makes creating a reliable zoned map difficult. Layers can flip-flop against yield depending on the season.



Three Springs manager Anthon Viljoen and spray driver Rees Boddiner.



One pass mouldboard plough and seeding operation at Three Springs.



Disc seeder on 7.5 inch spacings.

“I have not yet found a layer or combination of layers that reliably mark out production zones,” Mic said.

Conversely, on his Three Springs property he finds the variation is clearly defined and easy to zone, with multiple layers (biomass, gamma and Google Earth imagery) correlating directly to yield.

Mic has found that the biggest limiting factors in Three Springs are soil water-holding capacity (WHC) and cation exchange capacity (CEC) that are directly linked to soil type. These factors have allowed Three Springs to be divided into four main production zones using a combination of yield, biomass and gamma.

Zone 1 comprises the weaker pale sands with low organic carbon and low buffering, meaning that only low rates of phosphorus are required to reach potential yield as phosphorus is not tied up in the soil.

Zone 2 contains the better sands which respond to medium rates, but lack the WHC for very high yields in normal years.

Zone 3 is made up of the sandy gravels which have good WHC and respond well to all nutrients. This zone generally receives the ‘average’ rate that would be applied in a blanket application.

And zone 4 is the heavy gravels and conglomerate rises which are extremely productive, with high CEC and WHC. These areas produce high responses to very high rates of nitrogen, phosphorus and potassium, creating a much higher yield potential.

Once zoned, Mic compares zones to the soil test results for CEC and has found a strong correlation, confirming CEC as the core driver to productivity on their farms.

He now varies rates of all fertiliser applications, pre-emergent herbicides and some post-emergent herbicides at Three Springs. He creates the maps himself in Apex and Spatial

Management Software (SMS) and uses a mix of John Deere and Trimble monitors for his and his contractor’s green and red machinery.

Mic estimates he spends at least five days creating the maps, which includes analysing trials and drawing up zones.

“The good thing is that in this environment I don’t expect the zones to change as they are driven by fixed soil conditions,” he said. “However, as we ameliorate the soils with mouldboarding and deep-ripping we may need to alter the treatments applied to each zone to suit the increased potential yield, particularly on the sandy soils (zones 1 and 2).”

Mic and Marnie have seen multiple benefits to using a VRT system at Three Springs. On soil zones 1 and 2 they have slightly increased the yields as well as reducing costs by lowering fertiliser and chemical rates. On zone 4 (the high production zone) the yields have increased by 0.5t/ha through applying very high rates of fertiliser (N, P and K).



Contract spreader.



Protein monitor.

Ryegrass and radish selectively prefer the best gravels, so through using VRT for pre-emergent and broadleaf herbicides they are getting better weed kill on those soils without affecting seedling establishment on the lower organic carbon soils which have less buffering capacity. Yet, these benefits have come with challenges.

Major challenges include getting systems to talk to each other; having to use different software for different machinery; and then getting the VRT hardware to actually work. And generally when things go wrong they are at critical times within the season, such as seeding. Mic says a lot of this is because not many people are actually using these systems so the level of knowledge and experience in the service sector is still quite low.

### Where to next?

For the Three Springs operation, Mic aims to improve WHC and CEC by increasing the amount

of organic material through full stubble retention and higher biomass production by using narrow row spacing. Deep inversion (mouldboarding and deep-ripping with inclusion plates) will also help to increase total organic matter in the profile at depth which improves WHC and CEC.

Mic and Marnie's profit model is to spend no more than required to reach potential yield from the poorer soil types, while using a high input model on the very productive soils which produce the lion's share of the total grain output from the farm.

At Esperance Mic has just fitted a protein monitor to one header to help with VRT nitrogen, which is their biggest single input. Rather than zoning paddocks and then allocating rates, he will measure yield and protein and adjust nitrogen rates the following year based on the amount that would have been required to achieve 10.5% protein.

### LESSONS LEARNT

- At Esperance Mic fitted a protein monitor to one header to help with VRT nitrogen, their biggest single input. Rather than zoning paddocks and then allocating rates, he will measure yield and protein, then adjust nitrogen the following year based on the amount required to achieve 10.5% protein.
- Cation exchange capacity has been confirmed as the core driver to greater productivity on their farms.
- Mic estimates he spends at least five days creating maps each season, which includes analysing trials and drawing up zones.

# Rodd & Christine King

## River Plains, Cascade

### OPERATION AT A GLANCE

<b>Farm location</b>	Cascade (120km north-west of Esperance)	<b>Farm area</b>	5800ha
<b>Annual rainfall</b>	400mm	<b>Soil types</b>	Gravel sands to heavy grey clay
<b>Enterprises</b>	Three year continuous cropping rotation: canola, wheat, barley		
<b>PA consultants</b>	Julien Coles (Precision Technology Solutions); Nigel Metz (SEPWA) provided considerable support in the beginning		
<b>Agronomy consultant</b>	Luke Marquis (South East Agronomy Services)		



Rodd King in crop.

#### KEY MESSAGES

- Gains can be had from VRT but the priorities depend on soil types.
- The Kings' business has profited as much, if not more, from VR gypsum and lime spreading as from seeding technology.
- VR technology is available in most machinery and it is common to use auto steering options. But other uses are worth looking at to ensure you're using your machinery to its full capacity.
- The Kings save about \$30,000 on seeding fertiliser costs, and invest this back into their business by spending it on a gypsum program across the farm.

**Cascade farmers Rodd and Christine King took over the reins of River Plains from Rodd's parents in 2006. The property had been cleared by Rodd's father in the late 1970s and early 1980s and Rodd started working on the farm in 1985. Variable rate technology (VRT) was first introduced to the farm's operations in 2008.**

To kick things off in 2008 an EM38 survey was conducted by Precision Agronomics Australia on the first of River Plains' five locations that accurately identified varying soil types from heavy grey clay to small areas of gravel sands.

Rodd's agronomist, Luke Marquis, then used the survey results to undertake a more detailed soil testing program from which he was able to prepare a map of the area, divided into three different soil type zones.



Rod with his seeding box for variable rate fertiliser.

Rodd and Luke's thinking was that each of these zones required different rates of fertiliser at seeding time. They had noticed that the heavy grey clay areas in particular didn't germinate crops as well as the farm's other soil types, hence crop plant density was lower in these areas.

For Rodd and Christine this presented an opportunity, not so much to save money but to reduce costs in less productive areas and maximise the costs invested in other areas where soil types were likely to deliver better yields.

To test their thinking on applying different fertiliser rates to different soil types, Rodd and Luke did some trials which clearly indicated that River Plains' grey clays did not need fertiliser at the same rate as other soil types because they just didn't produce any more crop when more fertiliser was applied. And so began variable rate application of mono-ammonium phosphate (MAP) and urea at seeding time.



Rod King with his variable rate spreader for gypsum and lime application.

### Variable rate fertiliser, gypsum and lime applied

As you might expect, initial use of VRT was not trouble-free. When the first gear with VR capacity arrived Rodd felt a bit like a guinea pig in terms of getting it to work. The software had glitches that needed ironing out and producing variable rate maps for paddocks was difficult to do. It seemed that from the time an advertisement appeared in the paper showcasing the latest machinery with "new beaut" technology on board it took another three years for the software problems and its use to be sorted out and for it to be fully functional. Also, every time there was a new software upgrade it caused issues with getting the desktop to talk to the tractor or vice versa. But with the help of local technical support, especially from Darryl Wright from Farmers Centre and Nigel Metz from SEPWA, these issues were able to be sorted out.

Since using VRT on the first block, the rest of the farm has been EM38 surveyed by Julien Coles from

Precision Technology Solutions and all MAP and urea are now applied at varying rates at seeding time. What Rodd and Christine save on seeding fertiliser input costs, which is on average around \$30,000, they invest back into their business by spending it on a gypsum program across the farm.

Like fertiliser, they target their heavier soil types, applying gypsum at one of three rates varying from 2.5 to 3.5t/ha. Since kicking off the gypsum program in 2009 Rodd has seen a huge improvement in production from his poorer soils. All of his priority areas across the whole farm have been treated twice with gypsum and some areas have now received three applications.

This ameliorant application program has been enhanced by the decision in 2013 to invest in a Bredal spreader to keep the program moving. Undoubtedly the ability to spread gypsum and lime where it is most needed, at the best rate, has reduced the amount of product required and maximised the production gains achieved by their application.

Rodd finds that they can now go two or three times as far with the same amount of gypsum as what they used to. He simply drives through zones that don't need it and the spreader turns off and then turns on again when needed. Variable rate lime is also applied, targeted to the farm's lighter, sandier country.

### Small cost savings yield improved returns

The annual input savings that Rodd and Christine have seen by varying MAP and urea application rates at seeding may seem relatively small when compared to the total annual fertiliser bill for their business, but when you consider this over a 10-year timeframe this small amount becomes large.



Rodd King with header in crop.

The significance of these small savings has been expanded further by their decision to reinvest these savings back into the business by paying for soil type surveying and mapping, and the purchase and application of soil ameliorants to under-performing soils types. These actions have resulted in improvements in crop yield in what were poor performing areas.

### Recommended steps

- Rodd and Christine have found their experience with variable rate technology requires the following sequential steps:
  1. Find a place to start. At River Plains it was a soil survey so they could understand their soil types and what limitations they may have been having on crop production. You could also use harvest yield maps to establish production zones within paddocks.
  2. Decide on the priorities to deal with these production issues.
  3. Ensure you have the machinery, with the right technology on board, to deliver variable rate inputs.
  4. Get a map created with input application zones identified.
  5. Get the zone map onto desktop software.
  6. Get the desktop software to talk to the monitor software and you're away.
- Access to software and hardware support has been very important in both getting started in using VRT and use of the new technology that has arrived with each new machinery purchase. Without this it would have been hopeless, Rodd just wouldn't have gotten things started. It has been much more cost effective to pay for technical expertise rather than chew up his time trying to nut it out.
- Deciding on a labelling system for all paddocks is important from the outset to ensure all files are labelled systematically – this can avoid a lot of confusion.
- Once the technology has been set up, with the input of technical support, Rodd and Christine found that their employees have found it easy to work with. Their team includes one permanent and one semi-permanent employee as well as casual employees for seeding and harvest.
- Keep the number of soil type zones used as simple as possible otherwise the machines are turning on and off quite a lot. They have found three soil zones effective for River Plains.
- Be prepared to revisit the variable rate input zones you're using over time. Rodd has found that as his VR gypsum program has

progressed, grain production has become more even across the farm. Soil nutrition testing may be required in the future to establish new zones to address different production issues, like lime application to sandier soils, with the goal of increasing production further. He is also interested to see if it may now be worth increasing seeding fertiliser rates on the treated grey clay areas, given that germination has improved in response to the gypsum.

### LESSONS LEARNT

- You need to work out current limitations on production through surveys or mapping.
- Decide priorities to deal with these production issues.
- Ensure you have the right machinery with the right software to deliver variable rate inputs.
- Get a map created for production zones and the right desktop software.

# Peter & Tamara Kuiper

## Kuibrook Farms, West River

### OPERATION AT A GLANCE

<b>Farm area</b>	4300ha	<b>Annual rainfall</b>	420mm
<b>Soil types</b>	Undulating duplex sand/gravel/clay		
<b>Enterprises</b>	Canola/wheat/barley/pasture; 150 breeding cattle, 1500 Dohne ewes		
<b>History</b>	Parents cleared farm in the 1960s; Peter has been working on it since 1997		



Peter Kuiper.

#### KEY MESSAGES

- Peter Kuiper spent considerable sums on EM38 mapping more than a decade ago, but failed to use the information in a run of lean seasons.
- Their greatest problem is distance to service centres, 250km from Esperance and 330km from Albany, so getting technical support is often not cost effective.
- They bought a drone in 2016 and believe this technology could have huge impacts on production for varying applications such as herbicides, through access to photo imagery.
- Google Earth maps proved very useful in identifying clay soils on a new farm.

**Like many farmers around him, Peter Kuiper mapped a section of his family's West River farm using the EM38 over a decade ago, but then wasn't quite sure what to do next with his new-found data. They didn't have machinery that could work with VRT and even when they did later, there wasn't a local contractor that could spread gypsum using the technology.**

Around 1000ha of the farm was mapped and deep core soil tested, costing the business a large amount of money back then. "We just didn't do anything with the information after that, probably also mostly due to financial constraints following some lean years," he said.

Due to the Kuipers' proximity to the coast, yield maps often didn't truly reflect the potential of their soils because they usually had highly variable seasonal conditions impacting on yields. Peter said getting machinery to correspond with

the program was also expensive and uploading software always takes longer than anticipated.

But the hardest drawback for the Kuipers is their distance to service centres. They are 250km from Esperance and Albany, so getting technical support on the farm is often not cost effective (travel would usually add at least \$500 onto a bill).

However, in recent years, with a run of good seasons and the purchase of another farm, the Kuipers have revisited variable rate practices. At this stage it is just for varying gypsum applications which had until recently been applied at blanket rates.

The EM38 maps have helped with choosing zones for gypsum rates on the original property, but Peter didn't want to EM38 the entire farm due to the cost, since he only needed to work out the best areas (clays) to apply gypsum.

"We just needed to know where clays and the sandy gravelly soils were so we could adjust our gypsum rates accordingly," Peter said. "Really the maps are useless unless you have invested in the machinery to do the work, although the maps were interesting to compare for the heavier soils."

The Kuipers found that the biomass maps often don't correlate since the season has such a big impact on yield. Gypsum was just basic to work with. "If you have clay and it's gypsum responsive, then it's a simple to know where to put it."

Peter just worked out rates of gypsum into 4, 2 and 0.5t/ha zones – correlating to the three different soil types.

## Looking to the future

In 2016 the Kuipers purchased a drone and Peter said this kind of technology could have huge impacts on crop production in the future for varying applications such as herbicides, through the access of photo imagery.

Satellite imagery was also proving useful and provided cheap and effective means of getting a better perspective of the farm.

When the Kuipers purchased their new property they looked at Google Earth maps and one of the images showed the new property in subterranean clover and it was very easy to see the clay areas on the farm.

"We just drew circles around the clay areas on the satellite photo. We then jumped in the ute and spent around half a day driving around the property to check we got the areas right," Peter said.

Their rough map was then emailed to PTS's Julien Coles and he turned it into a digitised map. This map worked really well and cost the Kuipers less than \$1000 to have made.

"I don't have time to do this kind of stuff myself, it's much easier to outsource, especially with the better costings these days," Peter said.

"Getting a VRT map sorted can take me a whole day, but Julien can do it in a couple of hours. The software is getting more user-friendly and eventually there will be an easy app to use too, I hope. I think most farmers just want simple-to-use stuff because we have so many other things going on and we just forget how it all works one year to the next with everything else we do now."

## LESSONS LEARNT

- Just drawing a rough map of soil zones from the Google Earth photo was better than doing a blanket application rate for gypsum.
- Getting a file off a desktop that syncs with machinery can sometimes be enough of a challenge; so outsourcing technicians for this kind of work is still the best option when as a farmer you are time-poor already.
- When purchasing machinery and being so far from a service centre, you have to make sure you have good back-up service to get more PA-focused, which is tricky.

# Phil and Bindy Longmire

## Coorong Pastoral Co, Beaumont

### OPERATION AT A GLANCE

<b>Farm location</b>	Beaumont (90km north-east of Esperance)	<b>Annual rainfall</b>	425–460mm
<b>Soil types</b>	Circle Valley loam, red-grey loam	<b>Farm area</b>	5700ha
<b>Enterprises</b>	Continuous cropping in 5-year rotation: peas, wheat, canola, wheat, barley		
<b>PA consultant</b>	Julien Coles (Precision Technology Solutions)	<b>Agronomy consultant</b>	Dan Bell (Landmark)



Phil Longmire.

#### KEY MESSAGES

- Unless investing in the technology on offer, in up-front purchase costs, realistic payback period and the time to master its use, is a priority it's worth considering if your money is better spent elsewhere.
- You have to be patient and want to persevere to really maximise the benefits possible.
- There's no use in having all of the latest technology and then being a week late for seeding.
- A lot of good farmers are out there with good ideas that may be able to be adapted to your farming business.

**In 2004 Beaumont farmer Phil Longmire travelled to the US, Canada, Europe and South Africa on a GRDC-supported Nuffield Scholarship to investigate whether producers in these countries were getting a financial response from their use of variable rate technology, and if so could what they were doing on their properties be adapted to Esperance's soil types and climate.**

He was especially keen to learn from the experience of other producers about the path he and his wife Bindy should take in buying equipment that would keep all technology options open to their business.

While the enterprises Phil visited were not exactly the same as his, he could see that some of the approaches being used could be transferred. One thing that became clear to him was that if he was to introduce VRT he needed a point to start from if their business was to benefit.

## Variable rate input application begins

Phil's starting point was to analyse harvest yield data maps that had been collected over a few years and the results of an EM38 survey undertaken in 2005/06 by Precision Agronomics Australia (PAA). From this analysis it was evident that the sodic clays that occurred on parts of their property were underperforming.

In response, he embarked on a three-pronged management approach using VRT as the delivery tool to try and increase production from these soils. First, Phil had variable rate gypsum spread on these sodic clay areas and then at seeding time he increased seeding rates by 17% and reduced the rate of deep-banded fertiliser by 20%. His thinking behind changing crop seeding rates and fertiliser inputs was based on what he had seen in Canada where one producer had taken this approach on soil profiles with higher salinity. These poorly performing areas had been identified by analysing yield data and soil testing.

## Headland seeding system designed for lakes

Once Phil had sorted this approach to identifying and improving the performance of priority soil types across the farm he started thinking about whether there were other ways his business could benefit from VRT. As he looked closely at crop growth across his paddocks he saw clear visual evidence of another efficiency issue, this time related to the lakes that occurred on his farm. He could see that as his machinery had widened, significant seeding overlaps were occurring as the machinery was manoeuvred around each lake.

Phil used the data collection capacity of his technology to analyse the extent of the problem. He compared the numbers recorded for paddock hectares versus sown hectares versus sprayed hectares to see how these figures compared to the farm's true hectares. Then came the question of what to do about it?

First, Phil and Bindy turned to their overall farm budget to make sure overlaps were factored in. To do this they worked out the total overlap for the whole farm and then deducted this from their total fertiliser budget for the season.

Because they did not have the capacity to deliver liquid fertiliser at varying rates, an extra 26,100 litres of liquid nitrogen was applied through overlap. With a goal of achieving a P budget through solid fertiliser rates of 5% gain on a five-year average, they deducted the percentage overlap and then worked it from there. This done, they then turned their attention to how they could make this better, which led to the design of a variable rate headland seeding program around their lakes and boundaries.

To start the process, all lakes and boundaries were mapped and the area adjacent to the lakes was divided into two zones corresponding to one lap closest to the lake and a second lap adjacent to the first.

Seed and solid fertiliser application was reduced by 15% in the lap closest to the lake and then reduced further by 25% in the second lap. A third rate reduction zone in which seed and fertiliser rates were reduced by 35% was introduced around some lakes depending on the angle of approach to the lake resulting from the direction the machinery was travelling relative to the shape of the lake.

Following design and implementation of this seeding system overlap inefficiency now ranges from 4 to 35% overlap across the farm's paddocks. The drive for input efficiency has also led to alteration of the farm's physical infrastructure including removal of certain fences and realignment of bush lines to reduce the number of turns required by machinery.

Each year the internal map is analysed for yield, EM data and other relevant information, and rates are appropriated accordingly.

Successful implementation of this VR headland seeding system has relied on precise auto steering accuracy and equipment modifications have been required. Initially there was only one receiver mounted on the tractor which meant that the controller was unable to track when the seeder bar was turning, undermining the accuracy of the system. To solve this problem, in 2010 a second receiver was introduced, mounted on the seeder bar, to control the variable rate seed and fertiliser delivery while the receiver on the tractor controlled the auto steering.

## VRT business benefits revealed

Adoption of VR technology and the modification of farm infrastructure and seeding and harvest management practices that have come with its use, have become standard practice for Phil and Bindy's farming operation and they are getting long-term gains from their initial investment.

Just by providing the opportunity to collect, map and analyse production data, VRT has provided peripheral gains to their business, be they in relation to agronomics or operational efficiency. VRT has enabled better physical analysis of their

farming practices and their crop averages have improved while their costs in relative terms have not increased.

It's worth noting, that while Phil can see VRT has provided opportunities for their business he doesn't believe it will change the world. Alone, it will not transform the profitability of a farming business.

VRT has also provided a less expected benefit to the business. Rather than the technology providing a management barrier or problem when it comes to getting the seasonal workforce up to speed for seeding and harvest, they have found it has provided a tool to engage and interest employees and help break the boredom of tractor driving.

Individual employees appear to enjoy tracking their performance from season to season in terms of driving efficiency and comparing their results to those of others. It has also provided a great basis for discussion about ideas on how they can improve their business operations.

### **Section control may offer the next input efficiency gain**

Phil believes that it's important to keep looking for the next piece of technology as things are changing and emerging all the time. While the technology he has used to deliver his headland seeding system has produced good results, Phil can see that it will become less important as section control technology improves. What served a purpose will eventually become obsolete as technology develops and improves.

### **Recommended steps**

Ask yourself: "Do I really need this?" Unless investing in the technology on offer (in terms of up-front purchase costs, realistic payback period and the time required to master its use) is a priority for your business it's worth considering if your money is better spent elsewhere. If it's number 5 on your priority list don't do it until it's number 1.

Consider if you are suited to the use of VRT. You have to be patient and you have to want to persevere to really maximise the business benefits that are possible. It has at times been a frustrating area of Phil's business, especially when first trying to use the technology. It was very easy to just turn it off and walk away. That said, this sector is a lot better resourced locally now than it was 10 years ago and the technology itself is more user friendly so adoption of the technology is easier. Phil draws on the expertise of local PA technology specialist Julien Coles from Precision Technology Solutions to help maximise use of the options available and to deal with processing of data collected.

There's no use in having all of the latest technology and then being a week late for seeding. Phil was given this important piece of advice while talking with a producer in Scotland who reminded him that every gain that technology can offer your business is lost before you've begun if you don't seed or harvest at the optimum time.

There are a lot of good farmers out there with a lot of good ideas that may be able to be adapted to your farming business.

### **LESSONS LEARNT**

- If you're going to invest in an EM38 soil survey do it with a benefit in mind for the same year, be it to inform gypsum or liming plans, variable seeding or fertiliser rates, or other management action.
- Reliance on seasonal labour during seeding and harvest means the technology interface has to be user-friendly.
- Time has to be put in to preparing guidance or 'cheat sheets' for machinery operators. Training time also needs to be invested at the beginning of the season to make sure employees understand what they're doing. Young people have great capacity to pick up technology and if he has explained things well and has cheat sheets to support them generally after a day or two of using the technology they're pretty capable.
- VRT can add variety and interest to your business. To stay motivated day-to-day Phil finds farming must be interesting, and precision agriculture has provided a great platform for him and younger people involved in the business.
- Not everything you try will work. Biomass mapping was an example of this.

# Con Murphy

## Warakirri Cropping, Condingup

### OPERATION AT A GLANCE

<b>Farm location</b>	Condingup (100km east of Esperance)	<b>Annual rainfall</b>	550–600mm
<b>Farm area</b>	13,600ha; 12,750ha cropped		
<b>Soil types</b>	Deep sand, gravel sands over clay and loamy clay		
<b>Enterprises</b>	3-year continuous cropping rotation: canola, wheat, barley		
<b>Agronomy and PA consultant</b>	Quenten Knight (Precision Agronomics Australia)		



Con Murphy who manages Warakirri's Lobethal property west of Condingup.

### KEY MESSAGES

- The first step towards using VRT was an EM38 and gamma-radiometric survey on one block.
- Potash application was reduced on this block from a blanket 30kg/ha to an average 17kg/ha, with rates from zero to 30kg/ha. These cost savings paid for most of the soil survey costs for this block in the same year.
- The whole property has since had an EM38 survey with 230 soil tests to ground-truth the results.
- Data was then used to determine variable application zones across the different soil types for potash, lime and urea.

**Since its establishment by Warakirri Asset Management on behalf of Australian superannuation funds REST Industry Super and Australian Retirement Fund in 1996, Warakirri Cropping has developed a diverse farming portfolio.**

The company currently owns and operates 10 farming properties across six production regions throughout Victoria, northern and southern NSW, southern Queensland and Western Australia. The land area covered by the company's holdings totals approximately 78,000 hectares and their annual grain production is around 180,000 tonnes.

Warakirri Cropping aims to meet and exceed their investors' expectations, while developing and supporting their employees to ensure a sustainable future. In doing so they seek to operate efficient farms, utilising industry best practice, conservation and sustainable farming

techniques. With this policy in mind Warakirri Cropping has sought to achieve cost savings through the use of variable rate technology.

VRT was first introduced to operations at the largest of Warakirri's properties, Lobethal, in 2015. Lobethal is on the South Coast of Western Australia, about 100km east of the Esperance townsite. It was formerly a sheep station but 2016 marked its seventh season as a continuous cropping property.

Lobethal is managed by Con Murphy who joined Warakirri Cropping in 2014 after seven years at Mount Madden. Management and administrative support is provided by a team in Melbourne and contract service providers perform a number of key farming operations throughout the year.

### **Soil surveys provide place to start**

In order to begin using variable rate technology at Lobethal, Con felt he needed to understand the soil types that occurred across the property to provide a starting point. In March 2015 Precision Agronomics Australia (PAA) undertook an EM38 and gamma-radiometric survey on one block, just over 3000ha in size.

The results of these surveys were then used to prepare a variable rate potash prescription map which was applied using a Bredal Spreader in April 2015.

By taking this approach, potash application was reduced on this block from the budgeted average for blanket spreading of 30kg/ha to an average of 17kg/ha, with rates ranging from zero to 30kg/ha. The input cost savings achieved paid for most of the soil survey costs for this block in the same year.

This outcome provided the impetus for the decision to EM38 survey the rest of the property in December 2015 and January 2016 with the view of then applying variable rate potash across the whole farm in 2016.

Two-hundred-and-thirty soil tests were undertaken following the EM38 surveys to ground-truth the survey results. All data was then used to determine variable rate application zones across the property's different soil types for potash, lime and urea.

### **Input costs reduced in first year**

Lime and urea were applied at varying rates in 2016 by a contractor using Bredal Spreaders controlled by John Deere rate controllers, and potash was applied using a Morris Seed Cart at seeding time to meter out variable rates. This approach resulted in cost savings for each input.

Potash application was reduced from an average of 30kg/ha blanket spread to an average of 17kg/ha. Similarly, average lime application was reduced from 2t/ha blanket spread down to an average of 1.5t/ha, with rates ranging from 1.0 to 3.0t/ha.

In terms of urea, Lobethal's planned blanket average of 80kg/ha applied to cereals was reduced to 68kg/ha in 2016, with rates ranging from 40 to 140 kg/ha.

Importantly, areas that did not need lime or potash did not receive it and areas that required higher rates received it.

Not only were Lobethal's total lime and potash costs reduced in 2016 but these inputs were targeted to soil types that were most likely to respond to their application. While the cost

savings for the enterprise's total nitrogen budget were not large Con is expecting these savings to be coupled with improved crop yields from his better soils given they received higher rates of urea while his poorer yielding soils received less.

Growing season decisions on nitrogen application are also enhanced at Lobethal by use of the yield prediction tool Yield Prophet.

To test the effectiveness of the variable rate zones designated across Lobethal's paddocks, Con and his agronomist Quenten Knight established nitrogen and potash-rich strips across different soil types which they will take a close look at after harvest when analysing grain harvest yield maps.

### **Technical support enables smooth introduction of technology**

In order to ensure the introduction of variable rate technology to Lobethal's operations was as smooth as possible, Con drew on the technical expertise provided by PAA to undertake soil surveys and establish variable rate prescription maps.

PAA also helped resolve software compatibility issues that arose while trying to download prescription maps to their contractor's seeder controller and getting different GPS equipment to accept prescription maps.

### **What's next for VRT at Lobethal?**

Con believes that there are potentially many ways technology can be used to enhance the profitability of Lobethal's operations and he continues to seek new opportunities to maximise use of the technology he has access to both now and in the future.

Current ideas under consideration for 2017 include varying seeding rates at seeding time on sandy soil types to try and increase crop density in these areas. Con is also intending to apply gypsum at variable rates to Lobethal's clay soils to improve crop yield potential rather than blanket spreading, and to use EM38 survey maps to create prescription maps to enhance an extensive deep-ripping program he intends to undertake.

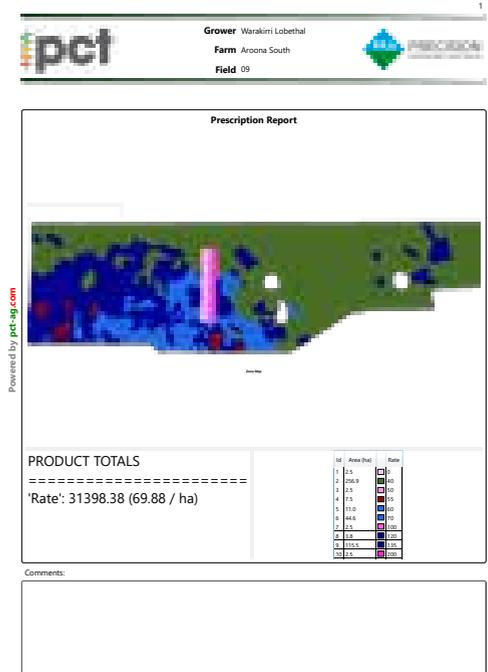
Con has first-hand experience of the importance of deep-ripping to crop performance in waterlogging-prone areas across the property and so is keen to pursue a prioritised deep-ripping program.

In 2015, 2500 hectares were deep-ripped and crop loss due to waterlogging in the 2016 growing season was around 2%, while in some of the neighbouring paddocks that had not been deep-ripped crop loss or damage due to waterlogging was around 60%.

In order to maximise efficiency of the planned program Con is looking to use EM38 survey maps to identify both soil types that can be deep-ripped to the full 600mm depth shown to be most beneficial to crop yield and those where the ripper will need to be lifted to a shallower depth.



Prescription map for urea application in Lobethal's Paddock #9 in 2016. Urea was applied at four rates ranging from 40 to 135kg/ha. The average rate across the paddock was 69.88kg/ha, down from 80kg/ha at a blanket rate in 2015. The linear pink strips are urea rate test strips.



## LESSONS LEARNT

- Trust what you're doing.
- Don't be afraid to embrace the technology.
- Keep looking for ways to ensure you're using the technology you already have to full capacity.
- Factor in variable rate capacity when making machinery purchase decisions.
- A lot of time and frustration is avoided by drawing on people with expertise. Con has found the technical support provided by PAA very important to the introduction of variable rate technology to Lobethal and to the resolution of "in season" operational issues along the way.
- When deciding on variable rate zones, keep it simple. Three or four rates per paddock are ideal. More than this makes it too complex and is difficult to deliver on-ground.
- Once prescription maps have been created most variable rate technology use is automated so it does not present too many hurdles for machinery operators, unless something doesn't work properly.
- Establish input test strips over different soil types and analyse harvest yields from them to ensure the variable rate zones employed during the season resulted in maximum returns. Keep testing the technology in the paddock.

# Scott & Jane Wandel

## Ridley Plains, Mount Ridley

### OPERATION AT A GLANCE

<b>Farm location</b>	Mount Ridley (75km north of Esperance)	<b>Farm area</b>	10,000ha
<b>Soil types</b>	Sandy loam to clay loams	<b>Annual rainfall</b>	370mm during growing season – around 400mm annual
<b>Enterprises</b>	100% crop in rotation of legumes, wheat and barley, oaten and vetch hay		
<b>Average wheat yield</b>	2.5–3t/ha	<b>Agronomist</b>	Quenten Knight (Precision Agronomics Australia)
<b>Varieties</b>	Wheat (Mace, Trojan, Sceptre); barley (Bass, La Trobe); canola (Bonito); pulses: vetch, field peas, lentils; tried chickpeas (and a bit of quinoa) in 2016		



Scott Wandel.

#### KEY MESSAGES

- Scott Wandel has built up a substantial database of information over seven years that now gives him confidence to make decisions.
- Soil moisture probes on the farm help make pre- and post-seeding decisions on a variety of inputs.
- Section control on the boomspray has enabled more savings than anything else, up to 20% in some paddock zones.
- Yield maps are not reliable on which to base prescription maps as they are affected by too many factors.

**Neil and Mary Wandel (Scott's parents) purchased the block in 1992 and he took over in 2002. Sheep were on the farm until 1996. They have been tramlining since 2002. Variable rate technology has been in operation since 2009.**

Working with Esperance agronomist, Quenten Knight, Scott has managed to build up a substantial database of information over seven years that now gives him the confidence to make decisions based on this reliable data bank.

Due to sometimes challenging harvest conditions on the South Coast, he doesn't rely on yield data, but has instead EM mapped and comprehensively soil tested his 10,000ha farm into three major zones.

Six soil moisture probes placed around Scott's farm support decisions before and during the growing season. Although they took a few years to give him accurate data, he now uses these probes to make pre- and post-seeding decisions on such things as what varieties to sow, chemical and fertiliser inputs, seeding rates and gypsum.

"The probes can show me exactly how much moisture we have in the profile at seeding and (fertiliser) top-up," Scott said.

Section control on his boom spray has enabled more cost savings than anything else, and at times this can be 20% in some paddock zones.

The three zones that he now focuses on comprise 'gutless' sands, sandy loams and heavier clays. Since 2009 the lighter country has been ripped and spaded and the heavier clays have had regular gypsum applications.

### Using the data

It took Scott six years to get to where he wanted to be with his PA system and he now has so much yield data stored on his Apex software, he wonders how much of it he will use in coming years.

"I actually have too much information on file now which I don't ever look at. I could spend all day in the office if I wanted, just calculating all the data now stored," he said.

"But it's still more important to be out in the paddock getting a good sense of what is going on. I'm a farmer – not a data analyst – but I'm sure there are going to be more jobs for people looking at this information in time."

### Making the change to VRT

EM and the VRT zone maps were done of the entire farm in 2002 and each year in February Scott makes up prescription maps based on his chosen seeding program. During seeding, the maps are uploaded each morning into tractors for his staff.

He said one of the limiting factors in the VRT system is that many decisions have to be made quickly due to seasonal factors. This can increase stress levels when having to upload data onto machinery at the last minute.

There is no point in using yield maps to make prescription maps since they provide unreliable data.

"It may have rained or frosted, or something else half-way through harvest and that will have an impact on the yield, so we find there is too much noise behind yield maps and they are unreliable," he said.

Initially, Scott purchased a new air seeder with VRT capabilities. He then converted the old flexi coil, etc to fit the system. John Deere machinery dealers, Ratten and Slater, helped him to find a fit between the actual computer and machinery. Things have changed a lot since then and he said it was much easier now to change to a PA system. In the earlier days it was much harder to calibrate everything but machinery has become much easier to work with.

There was no doubt that VRT worked better in a bigger operation. Scott said one of the problems with having more staff now was that he probably didn't spend enough time in the tractor anymore and his long-term workers "probably know more about some of my paddocks than I do!"

During seeding he employs between 12 and 14 people and it is important to be able to load information quickly and easily into the tractors each morning.

Scott applies gypsum and compound fertilisers at varying rates. Ripping and spading have helped improve pH and no liming program is required on the farm at this stage.

He increases seeding rates on the lower yielding areas ('gutless' sands) to get cover and then decreases inputs during the growing season. He has around 200ha of this zoned 'gutless' sand country from which he would be lucky to get 1 tonne of wheat. The rest of the zones have a yield potential of around 3 tonnes so he feeds them more.

"We rob Paul to pay Peter," Scott said.

But water was still the biggest limiting factor on his property.

He used Gateway software to convert the EM maps to make the initial shape files and then Apex (John Deere) software to store all the data.

Three long-term fertiliser trials in the program help him look at in-season rate adjustments. These trials over the three different soil zones have variable rates applied which then provide visual information and GreenSeeker readings to make in-season decisions.

His four headers are linked at harvest through John Deere.

Annually, he soil tests for phosphorus replacement. A legume rotation helps with nitrogen replacement also.

Scott said he had enjoyed two record crops in 2013 and 2015 which indicated to him he was doing something right.

### Recommendations for new players

- The issue with VRT is the struggle with decisions that have to be made at the last minute based on the season (break and rainfall).
- With the John Deere rate controllers he can only adjust by percentage – can't change individual amounts.
- When dry seeding you are always going to pull back on the inputs. So you can't make the decision until just before, which adds pressure at that time of year.
- Mobile coverage on the farm isn't too bad. The tractor will pick up the signal at some point when moving around but this can be an issue for others. The idea of having an office in the ute is useless though.
- Automatically, the file update goes into the clouds once the paddock is done.
- There is around a 15% saving by using VRT only on the fertile sands each year – and for four years he didn't put any on the low yielding areas (low rainfall years).
- Over the entire farm there is conservatively a 4% saving (soil types are consistent so less saving probably than other farms with more variability such as Scaddan which is more transitional country).
- The set control on his air seeder is saving the most money (around 8–9%) due to less overlap. This comes straight off the fertiliser bill.

- Scott works to his yield potential of 2.5t/ha and doesn't look for the 2-in-10 year crop events.
- He turns off the outside section of the paddock with Flexi-N application since this is always the lowest yielding part anyway.

### LESSONS LEARNT

- The main issue with VRT is the struggle with last minute decisions based on the season.
- Mobile coverage on the farm isn't too bad, but the idea of having an office in the ute is useless.
- There is around a 15% saving by using VRT only on the fertile sands each year. Over the entire farm there is a conservative 4% saving.
- The set control on his air seeder is saving the most money (around 8–9%) due to less overlap. This comes straight off the fertiliser bill.

# Kentyn & Jill Wehr, and Tyson Redding Speddingup East

## OPERATION AT A GLANCE

<b>Farm location</b>	Speddingup East (50km north-east of Esperance)	<b>Annual rainfall</b>	400–450mm
<b>Soil types</b>	Sand over clay, shallow sand, duplex	<b>Area cropped</b>	2956ha
<b>Enterprises</b>	Continuous cropping of canola, cereals & occasional legumes	<b>Average wheat yield</b>	4t/ha
<b>PA and agronomy consultant</b>	Greg Warren (Farm & General)		



Kentyn exiting the variable rate 'control room' at seeding time.

### KEY MESSAGES

- An EM38 survey in 2005 provided a breakthrough when combined with soil and yield data collected earlier.
- This gave a clear picture of which areas were underperforming in varying weather conditions and different crops. This led to finding yield constraints and options to address them.
- Yields have increased by 0.5 to 1 tonne per hectare over the last five years as a result of improvements including VRT.

**Like producers the world over, each year Speddingup East grain growers Kentyn and Jill Wehr and their nephew Tyson Redding, review the success of their farming enterprise. In doing so, they consider how their crops yielded, how much profit was made, and where they think they can achieve improvements.**

Over the years, they have sought gains through improved financial management, changes to their machinery and farming practices, and improvements in agronomic management. One key component they have been keen to address is mitigation of as many physical and chemical soil constraints on yield as they can, and variable rate technology (VRT) has been one tool they've used to help them in this endeavour.



Tyson Redding using a penetrometer to establish soil compaction priorities as part of their plan to address limitations to crop rooting depth.

## We have VRT capacity – now what?

Kentyn's introduction to VRT came in 2000 when he took ownership of a John Deere air seeder with the ability to change rates on the go, but he found it an unimpressive beginning. He had no crop biomass, yield or soil data to draw on as he made decisions on varying the rate of inputs, so he felt he was going in blind. Technical training and support to use the technology was limited, and the computing capacity of the monitor was poor.

Screen freezes were common and frustration came hand in hand with its use. As a result, Kentyn put the technology to one side confident that improvements would be on the way in the not too distant future as the technology became more common.

Also in 2000, Kentyn took ownership of a John Deere header with yield mapping capability. For the next five years he collected harvest yield

data and built up a picture of how his farms yielded and regularly asked the question: "What am I going to do with all this yield data?"

In 2003 he used his yield maps to help decide priorities for clay application on his most underperforming sandy soils. Then in 2005, Kentyn made the decision to have one of his farms EM38 surveyed. With this decision came the opportunity to combine soil data and the harvest yield data he had been collecting.

He overlaid his EM38 survey map with his annual yield maps from the same farm and saw a clear picture of which areas were underperforming each year under the varying weather conditions that had prevailed and the different crops he had grown. He used this picture to then go looking for the yield constraints he faced in these areas and what options he had to address them.

In terms of soil issues, his starting point was to undertake a gypsum application program primarily to counteract elevated soil sodicity and improve soil structure and moisture infiltration across the farm that had first been surveyed. He had no machinery capacity to deliver variable rate gypsum at the time but knew he wanted it applied at the right rate and where it was most needed. It took 12 months for his contractor to secure the technology to do this but since then all gypsum has been applied across his farms using VRT following EM38 surveying.

## Using VRT to deliver inputs to where they are most needed

In 2010 things changed again for Kentyn, Jill and Tyson's business with the arrival of a new Conserva-Pak Air Seeder and John Deere bin complete with the latest VR computer

technology. This gave them the capacity to deliver variable rate fertiliser inputs at seeding time, starting with phosphorus in 2010 and potassium also from 2013 onwards.

As variable rate inputs are applied, Kentyn and Tyson sit the EM38 survey map behind their VR input map on their controller to ground-truth the rates being applied. Decisions on what rate of each input to apply to predetermined zones is based on a replacement strategy for phosphorus and on the results of deep soil core testing for potassium.

Kentyn and Tyson do not apply nitrogen at seeding using VRT. They prefer to apply one rate across their whole cropping program at seeding time to achieve a base level which they have found supports a base yield potential for their crops. While they don't currently have capacity to deliver Flexi-N at variable rates during the growing season, this is an option they are considering.

In 2013 they also initiated a liming program with variable rates applied by a spreading contractor on one of their farms. The variable rate zones used in this program were decided by the results of a gamma-radiometric survey undertaken in 2011 that provided guidance for a targeted 0–20cm soil pH testing program.

## What has been the enterprise benefit?

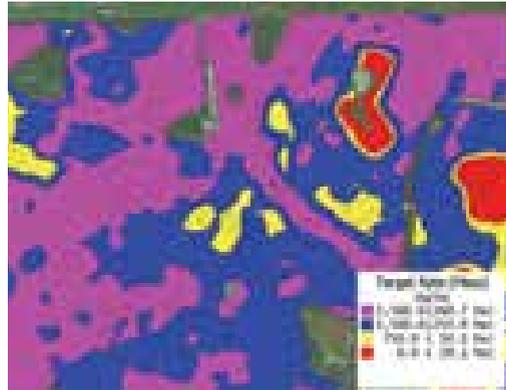
By applying variable rates of fertiliser at seeding time, Kentyn, Jill and Tyson saw a \$30,000 to \$40,000 saving benefit to their annual fertiliser bill in the first year but this saving was then absorbed by machinery purchase costs so their business did not see a direct profit increase from this strategy.

As the years have gone on, they have not seen their total input spend go down as a result of VRT use, but they have seen these dollars redistributed across their property by applying inputs to where they are needed, and have seen yield gains as a result.

Cereal yields have increased by 0.5 to 1 tonne per hectare over the last five years as a result of the enterprise improvements they have made, including their use of VRT.

## Recommendations

- Be clear and confident about why you're using the technology and how it can support your farm to maximum benefit for your enterprise. Don't use it just because others are. New technology can be expensive, so be clear what you're buying and why.
  - It's important not to lose touch with what's happening with your soil. Investment in identifying soil constraints is money well spent and VRT can help deliver targeted ameliorants cost effectively.
  - Have an EM38 map as a background screen on your monitor to help ground-truth the VR zones being applied.
  - The usefulness of variable rate technology to a business depends on the capacity of personnel driving the equipment to be able to use the technology to good effect, otherwise it creates more problems than it's worth. If you're not driving your own equipment you have to plan how employees will be trained and given technical support.
- It will get easier to use as the technology continues to improve and becomes more user friendly.
  - You need access to a 24-hour technical support hotline if you are to vary input rates at seeding time, given the machines are often running around the clock.
  - Header calibration for yield data collection during harvest is worth thinking about. While it's not vital to spend a lot of time and money on calibration it is worth trying to ensure that if your enterprise has more than one header in use that they are calibrated with each other.
  - You need to have seeder equipment that can deliver variable rate inputs efficiently.



A prescription map for gypsum to be applied at four rates rather than being blanket spread at one rate.



Measuring another year's business performance.

## LESSONS LEARNT

- New technology can be expensive, so be clear what you're buying and why.
- Investment in identifying soil constraints is money well spent.
- Usefulness of VRT depends on the capacity of those driving the equipment, or can create more problems than it's worth.
- You need access to a 24-hour technical support hotline if you are to vary input rates at seeding, when machines are often running around the clock.

# Ted & Rachel Young, Mick & Jodi Young, Matt & Ange Hill Young Hill Farms, Beaumont

## OPERATION AT A GLANCE

<b>Annual rainfall</b>	400–450mm	<b>Farm area</b>	13,000ha
<b>Soil types</b>	Heavy clay through loam to sand over clay duplex	<b>Average wheat yield</b>	2.4t/ha
<b>Topography</b>	Generally flat, gently undulating with occasional granite outcrops		
<b>Enterprises</b>	Moving to 100% cropping, wheat, barley and canola		
<b>PA &amp; Agronomy consultant</b>	Quenten Knight (Precision Agronomics Australia)		



Matt Hill.

### KEY MESSAGES

- VRT for lime and gypsum application is based on EM38 maps and soil test results.
- The primary goal is not to save money but to bring the protein level up to 10.5%, and reach potential yields.
- Nitrogen is the newest input for VRT and in 2016 resulted in cost savings of around 50%.
- Strip trials provide important information for ongoing evaluation.

**Young Hill Farms operates 90km north-east of Esperance in Beaumont. The business is a family partnership run in collaboration between Ted and Rachel, their daughter Ange and son Mick, and their respective partners, Matt and Jodi. Ange returned to the farm with Matt in 2002 and the operation today manages 13,000ha.**

The Beaumont region has varying soil types from heavy clays through to sand over clay duplexes and the topography can be described as gently undulating with the occasional granite outcrop. Annually, their farms receive 400–450mm of rainfall and the enterprise is moving towards 100% cropping made up of wheat, barley and canola. Matt says the long-term wheat average is 2.4t/ha.



Matt checking La Trobe barley prior to spraying.

Prior to joining the business Matt was an engineer and these skills have been well utilised on the farm, especially for employing variable rate technology.

## Variable rate technology

In 2010, Matt began using VRT for lime and gypsum application based on a combination of EM38 maps and soil test results. Gypsum has had a major impact on their nearby Mt Ney farm, changing the soil and lifting productivity. A year later Matt started VR phosphorus with a replacement strategy using yield maps as the reference layer.

When generating prescription maps Matt has always included trials. Yield data collected at harvest allows for these trials to be analysed and provides the ability for ongoing evaluation.

Nitrogen is the latest addition to their VR program. In 2015, protein monitors were installed on all the headers and initially Matt thought this

would produce a map which could then be used to VR nitrogen. However, after comparing the yield data and gamma radiometric potassium maps he found a strong correlation, which relates back to the soil composition and water-holding capacity. And he now plans to use the protein map to validate his methodology.

Matt's methodology for creating VR prescription maps for top up nitrogen:

1. Work out the farm's potential yield for the season.
2. Understand how a paddock sits in relation to the farm average.
3. Using the paddock's past wheat yield maps, generate a multi-year average map to understand how the paddock's yield varies spatially.
4. Using higher than normal density soil sampling (10cm) to generate correlations to the gamma radiometric K map to understand the areas that perform and require more nitrogen (i.e. the lighter soils) as well as the areas which don't perform and may not use the nitrogen as efficiently.
5. Use protein maps to make sure the whole paddock is reaching 10.5% protein.

## Managing the data

The Young Hill Farms VR program relies on good data, software and hardware. Soil test results, paddock yields and long-term averages are all managed in Excel and this information is the basis for decision making. Ameliorants are topdressed using their spreaders controlled by John Deere tractors and GS3 monitors.

For managing their spatial data, such as EM38 and yield data, and creating prescription maps they use both Spatial Management Software (SMS) and Apex, while yield data is collected by the Intelliview monitors in their New Holland headers.

This library of data continues to grow with the addition of yield and protein information after every harvest, annual high density soil sampling, and a complete EM38 survey of the farm. Yet, finding the right information so that he can make use of the data is one of Matt's biggest challenges.

Matt says he spends three to four days creating maps for seeding and in 2016 spent four to five days creating maps for top-up nitrogen.

He does see VRT as providing him with a decent saving. For nitrogen, in 2016 he estimated the saving to be around 50%, however his goal isn't primarily to save money but to bring the protein up. This is because if the wheat achieves over 10.5% protein his yields will be reaching their potential as well.

## LESSONS LEARNT

- Finding the right information to make use of a large library of data is one of Matt Hill's biggest challenges.
- Successful VRT relies on good data, software and hardware.

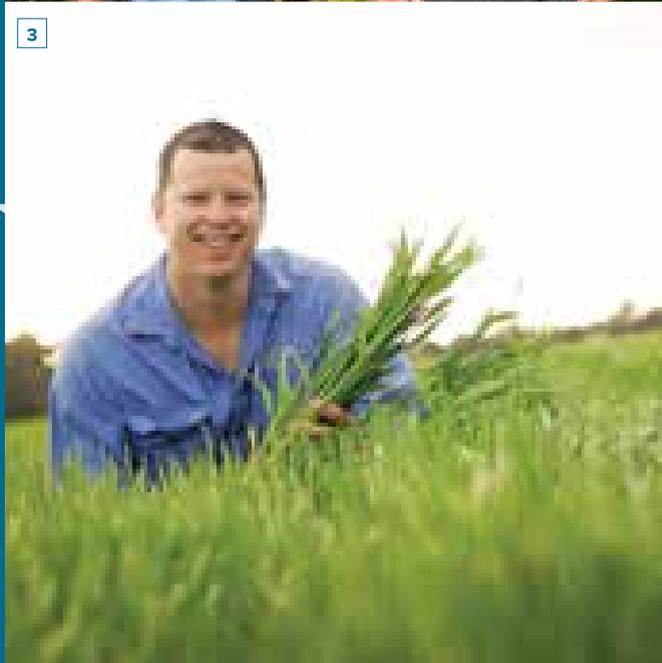
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# Julien and Tywen Coles

## Precision Technology Solutions, Esperance



Julien and Tywen Coles who run Precision Technology Solutions.

### KEY MESSAGES

- PTS provides data management to growers and consultants statewide in Western Australia.
- Variable Rate Technology work covers everything from collecting paddock information, its analysis, creating zone maps and then applying inputs to those zones.
- Demand for their services is increasing from growers who have worked out zones but want this digitised and loaded to the tractor monitor.
- With more data captured by satellites, and yield and protein sensors, they see their data management business increasing as growers seek assistance in getting information into a useable format.

**Tywen and Julien Coles started Precision Technology Solutions (PTS) in February 2013. PTS was driven by a combination of lack of precision agriculture (PA) support from machinery dealerships and demand from local agronomist and growers wanting to utilise PA information, such as yield data to help make decisions. Tywen and Julien both saw this market gap through their separate work in the agriculture industry.**

### Tywen Coles

Tywen graduated with a Bachelor of Agribusiness (Farm Management) from Curtin University and went on to work for Farmanco for five years as a farm management consultant. While with Farmanco, SEPWA subcontracted Tywen to provide an overview of the current PA situation within Western Australia, on a project funded by GRDC. The major objectives of this project were to see where the industry was currently at, and survey the rapidly evolving mobile technology market to see if there was potential application within PA.

A major challenge repeatedly voiced by growers was that dealers were not keeping up with current technology. Machinery dealerships were happy to sell the latest technology, such as variable rate seeders, but could not provide the complete package of service to such technology. And through surveying current mobile technology she saw the potential for simplifying the integration of PA within farming businesses.

### Julien Coles

Julien was trained as an agricultural engineer in the UK and then worked on various agricultural machinery from potato harvesters to straw-powered electricity stations before going on to work for his family's GPS and electronics company.



Standard base setup.

He moved to Australia in 2009 and for the first two and half years worked as a farm mechanic and soon realised that his separate mechanical and GPS knowledge could be used to do PA. Utilising these skills he went to work with an AGCO dealer predominately doing their auto steer jobs on the Gleaner, Fendt, Rogator and Massey Ferguson gear, until he and Tywen started PTS.

Today, Julien and Tywen are both fully employed by PTS and their business offers a range of services including variable rate conversions, EM surveying, yield data processing, configuring controlled traffic farming (CTF) systems and setting up Real Time Kinematics (RTK) base stations.

## VRT in PTS

Variable Rate Technology (VRT) for their business covers everything from collecting information about a paddock to analysing this information and creating zoned maps to allow for different

management and then applying varying inputs within these zoned areas.

To do all of this there is an underlying requirement of knowing multiple software and hardware systems and being able to integrate and move information between these. Therefore, PTS is split between managing data and hardware set-ups and servicing.

PTS provides data management services to growers and consultants statewide, as well as hardware sales, set up and servicing within the Esperance Port Zone.

The biggest demand for PTS at the moment is lining up machinery for CTF, however specifically for variable rate they are getting more and more jobs where growers and agronomists have worked out the zones and then their job is to digitise these zones, load them into the tractor monitors and make sure everything works.

## Complicated/simple variable rate

Julien and Tywen have helped facilitate many growers into variable rate programs. Due to the differences in information used to zone maps, grower/agronomist approach and machinery owned, they have seen all kinds of set-ups from simple to complex.

One of the simplest VR methods they have worked with is creating prescription maps for varying ameliorants using hand-drawn maps. The agronomists and growers print out a Google Earth map of the farm, draw the zones by hand and then give this map to PTS with the corresponding rates they want in each zone. PTS then digitises the map, loads it up into the monitor and makes sure everything behaves. There is no yield data or electromagnetic (EM)

survey involved; they are purely just working off the farmer's knowledge.

The most complicated VR job PTS has been involved in use a combination of EM38 survey and yield data to generate zones for variable rate. These zones are then embedded with boundary maps and two different boundary buffer zones are created with different rates and widths. The different rates and widths correspond to the direction the seeder comes into the zone. If the seeder comes in at 45 degrees, it is one rate and width, and if the seeder comes in at 90 degrees it is another.

These methods differ greatly in how zones are defined, however, both have been regarded as successful by the respective growers, demonstrating the multiple pathways to achieving a VR program.

## Future plans

In terms of planning for the future, PTS sees the data management side of their business growing. With more and more data being captured through yield and protein sensors, and satellite imagery, there is so much more information for growers to make decisions with, but you need someone to get that information into a usable format.

As for PA, they see autonomous vehicles playing a major role. The swarm farm theory of having lots of small vehicles working together means they can go slower and treat areas more individually. Combining this with new sensor technology will improve understanding of those areas.

# Quenten Knight

## Precision Agronomics Australia, Esperance



Quenten Knight.

### KEY MESSAGES

- The first step in working with a grower is to identify that there is variability that is worth pursuing, to identify the constraints and develop a strategy to measure them.
- The three biggest demands in the Esperance Port Zone are for variable rates in applying gypsum, lime and potassium.
- PAA tries to work where they have relationships with local agronomists and consultants who can provide follow-up support.
- Software for precision agriculture is becoming more intuitive and simpler to use.

**Precision Agronomics Australia (PAA) began operating in 2004 based out of Esperance. The concept of incorporating Precision Agriculture (PA) into an agronomy service came about through discussions with Warren Slater from Ratten and Slater (John Deere), as well as through Quenten Knight's personal experiences from working as an agronomist.**

Both saw the disconnect between machinery and technology and the grower frustration at not being able to properly use the machinery and hardware they had purchased to drive agronomic decisions within their businesses.

As PA was not the core business of a machinery dealership or an agronomist, Quenten started PAA hoping to provide a link between agronomy, machinery and technology/data, however knew they required outside assistance for the PA. And so, they linked up with Precision Cropping Technology (PCT), drawing on the experiences of Michael Wells and Andrew Smart based in SA and NSW, respectively. PCT gave them insight into how they implemented PA in other regions of Australia and specifically the use of EM.

Shortly after linking up, Michael came to Esperance with the EM38 and half a dozen growers were keen to have a go. Yet, it was clear that without the follow-up support all this generated was a nice map that conveyed the paddocks' variability. The ground-truthing

work that followed was crucial in validating the variability and this is a core focus of their business today.

### **PA methodology**

For each client, the transition into VR differs, however PAA generally follows the methodology below:

1. Identify that the grower has variability that is worth pursuing,
2. Identify the main constraints and develop a strategy around measuring it,
3. Once measured through data (which can be anything from yield, EM, radiometrics to satellite imagery) it must be ground-truthed via soil coring and lab analysis.
4. Once ground-truthing is complete, a zoned map can be created and loaded into the monitor.

Trials play an integral role in the ongoing evaluation of VR so they are always embedded into the zoned map. Strip trials are placed across different zones and yield data is used to analyse these trials and build an economic case around why VR is worth employing in the paddock. Once the economic case is developed the reason to implement VR becomes a lot clearer.

Quenten says: “Often you start out with a problem and then once you start investigating the data it becomes useful for so many other things.”

### **Clientele, business structure & current demands**

PAA employs seven people, consisting of two full-time agronomists and five technical staff who focus on the PA side of the business. The PA-focused staff cover everything from machinery implementation to EM survey as well as managing their extensive network of soil moisture probes, weather stations and automatic rain gauges which underpin a lot of their PA decision-making.

PAA operates statewide, however the agronomy service is focused on 45 clients in the Esperance Port Zone (EPZ). For PA work outside of the EPZ, PAA tries to work where they have relationships with local agronomists and consultants, as they rely on the local guys for ground-truthing and to provide the follow-up support.

In the EPZ, the three biggest demands for VR are gypsum, lime and potassium. Growers must have confidence that they are doing VR for the right reasons and that major constraints are being addressed.

Following those three inputs, other VR applications include phosphorus, nitrogen. Other demands include surface drainage plans and depth to clay zoning for clay spreading and delving.

### **Future directions**

Over the years, PA has become considerably easier to implement, software has become more intuitive, and updates to machinery have made the process much simpler. One challenge for PAA is keeping up to date with rapid technology change. As different areas develop it is hard to know where to invest in the business.

Today, PA plays a much larger role within the business. In the future, Quenten sees PAA playing much more of that supporting role, helping growers make sense of the data and implementing PA. To properly store and analyse data, create zone maps and implement PA there is a high time requirement and because of this a designated consultant is needed to manage this part of a grower's business. This consultant will accompany the farm management consultant and agronomist to help growers make well informed decisions.

# Luke Marquis

## South East Agronomy Services, Esperance



Luke Marquis.

### KEY MESSAGES

- Growers should start simple and have clear goals.
- Gypsum and phosphorus applications are the easiest rates to vary and you can see instant results.
- If you are using a consultant, have ownership of the data management.
- Make sure you are making the best use of yours and others' time before going down the path of adopting a variable rate system. You could have more beneficial things to spend your time on.

**Luke Marquis worked in the field of precision agriculture before setting up his agronomy consulting practice in 2000. He has seen many trends come and go and after the initial excitement about VRT, he now has a feel for what works for most people on the South Coast.**

Luke said the initial focus with VRT was on saving money on fertiliser applications back when fertiliser was more expensive. But things had moved on since then. It was important for people to have a clear goal before they started. "They need to eat the elephant a little at a time," he said.

Managers needed to have a strong focus in mind – such as soil amelioration (if they have varying soil types), or crop nutrition (based on crop removal the previous season).

Unless a person has a passion for data, simplicity is the key to establishing a sustainable program that isn't going to be too stressful at seeding and harvest when "time is money".

"I often see people spend half of their summer trying to sort out VRT maps and meanwhile they are losing sight of the many other issues happening on the farm such as weeds or just having a holiday. And then when it comes seeding time, the new system doesn't work

anyway. This can lend untold stress to a farming operation,” he said.

Gypsum was a clear application that could be easily varied and the results were easy to assess afterwards.

“I would recommend varying the rates of gypsum to start with because it’s easy to determine the different zones and you can see the results in one year especially when it comes to better crop establishment and pre-emergent activity,” Luke said.

Phosphorus replacement was another easy rate to vary based on yields.

“You just need good yield maps to work out your zones and you need to make sure that you have got the net P balance right to start with.”

Then it was just a matter of increasing the phosphorus at seeding on the higher yielding country and decreasing it in the zones which had shown lower yields in the previous year.

Applications such as lime and potassium had so many other factors going on at soil depth and varying spray rates such as pre-emergent herbicides was also tricky.

Luke recommended that if someone was going to tackle VRT, then they needed to make sure they had ownership of their data management.

“I have heard of people leaving an external PA supplier and not having any data to take with them, which isn’t ideal,” he warned.

# Chris Pinkney & Craig Topham

## Agrarian Management, Geraldton



Geraldton-based consultant agronomists Craig Topham and Chris Pinkney have helped numerous growers adopt VRT in the northern agricultural region.

### KEY MESSAGES

- Adopting VRT doesn't need to be costly and difficult but it is not for everybody.
- If growers see more than 1 tonne per hectare yield difference in a paddock they should be able to get a positive response from VRT.
- Seeking advice at the beginning of the VRT journey is vital.
- Many quiet achievers are doing VRT. They are generally good managers who understand their computers and machinery well.

**Geraldton-based consultant agronomists Chris Pinkney and Craig Topham have been working in VRT for over 10 years. They became interested in the area and its potential for WA's northern wheatbelt after seeing the results of Eastern States and Esperance experiences.**

Between them they have run five projects evaluating VRT over a diverse range of soil types, with projects run at Warradarge, Mullewa, Mingenew, Perenjori and Casuarinas. Initially their focus was on using VRT to be more cost effective on poorer areas, but it didn't take them long to realise that in many cases the potential on the higher production areas was not being realised either.

### One size doesn't fit all

"Every grower has different skills and every farm is different. When it comes to VRT it's about working out what's needed on your farm, but also what you can manage or how much you can handle," Craig said.

Some growers are only looking to vary urea or potash applications by switching their spreaders on and off. Others vary fertiliser and seed rates at seeding. Some apply fungicides for sclerotinia in canola according to soil type whilst others have taken it to the extent of using direct injection systems on their boomspray to target the more expensive herbicides across areas of high weed burden within paddocks.

Chris and Craig have helped growers create production zones for VRT in varying ways, from the simplest systems using zones drawn on Google Earth maps, to combining yield and biomass maps in a few paddocks, right through to full electromagnetic (EM38) and radiometric surveying of their farms.

EM38 surveying measures the variation in conductivity of the soils, which is influenced by clay, moisture and salt levels down to a depth of approximately one metre.

Radiometrics measures the low-level radiation levels of the soil. Variations in readings can indicate differing soil physical and chemical

characteristics that can then be used to create maps of soil types across paddocks.

Chris and Craig have found that best results often come from combining the EM38 and radiometrics data across the soil types found across the northern wheatbelt. Obtaining the EM38 and radiometric data is just the first step of the process. Ground truthing the results with soil tests and the grower's knowledge and even yield and biomass maps is absolutely critical to creating accurate production zones

"Capturing as much information as you are able will give the most detailed picture of the varying soil types and production zones. However, it's more important to pick the layers of data you need, according to your farm, soil types and even accessibility and then start as simply as you want."

Once the zones are set they don't tend to change dramatically, though they are continually refined as their performance changes over time. Zone management, on the other hand, is adjusted regularly according to crop type and seasonal conditions.

## **VRT is not for everybody**

With increasingly variable seasons the need for farm businesses to improve efficiencies is even more important. Some growers prefer to do this by increasing their scale, others try to get better returns out of the land they have. It's a personal preference and both can work.

Chris and Craig suggest that if a grower sees greater than one tonne yield variation within a paddock, then they should be able to get a positive response from VRT. Having said that, they both strongly agree that for VRT to have any

chance of being beneficial, the big things have got to be right first.

"Things such as sound agronomy, getting time of sowing right, good staff management, understanding their cost base. Without managing these areas well or getting these things right, VRT has the potential to either be another inefficiency or a distraction to dealing with the key business issues."

"If you're going to adopt VRT, you need to see it as a change in mindset. It may mean you'll need to go across paddocks more often but it also gives the opportunity to drip-feed crops and manage the risk and exposure according to each season's potential."

"There are a lot of quiet achievers who you don't know are doing VRT, but generally they are good managers who understand computers well and they understand their machines. Whilst it is certainly not essential they often run with one colour of machinery due to the ease of use when dealing with a single technology platform," Chris said.

"Talking to other growers or a consultant can help you decide if VRT is right for you and your farm. If you're thinking about VRT, go and talk to other growers first. Bounce your issues and ideas off them, ask about their experiences."

## **If you want to head down the VRT path**

As consultants, Craig and Chris see growers struggle with the three key elements of VRT: agronomy, machinery and technology.

"From our area of agronomy, we generally find that clients require support over the first

three years, setting up zones, working out and refining the strategy to manage zones, and then measuring the results each season. After the first few seasons, most are then confident enough to manage it on their own."

In terms of machinery, Craig suggests understanding the machinery you have, and its associated software and hardware programs is more important than the colour you run. The availability of machinery and technical support can also impact the ease of the process.

"A lot of growers already have the machinery with the capability to vary rates so the costs can be minimal to implement. It can be as simple as a spreader conversion or utilising the technology of your boomspray to vary rates."

The third element of understanding the technology is perhaps the biggest limiter to adoption as it can be difficult to access expertise when needed, particularly in certain regional areas.

"VRT can add an additional degree of complexity at peak times. To manage this growers need to be willing to learn and understand how their systems operate or have someone on call who will be able to respond and troubleshoot quickly."

Adopting VRT doesn't need to be costly or difficult, nor is it for everybody or every farm. Seeking advice from growers and industry expertise at the beginning will help to ensure the process is as efficient and simple as possible.

"As software becomes simpler, VRT will become easier."

# Further information and reading

## **Society of Precision Agriculture (SPAA)**

SPAA is a non-profit and independent membership based group formed in 2002 to promote the development and adoption of precision agriculture (PA) technologies.

To visit the society's website, go to:  
[www.spaa.com.au](http://www.spaa.com.au)

## **Grains Research and Development Corporation (GRDC)**

There are a number of resources on the GRDC website relating to Precision Agriculture and VRT.

Go to: [www.grdc.com.au](http://www.grdc.com.au)

## **Precision Agronomics Australia (PAA)**

Precision Agronomics Australia (PAA) was formed in 2005 with the vision to close the Precision Agriculture loop and ensure farmers obtain profit and production gains through the implementation of variable rate technology (VRT).

Go to: [www.precisionag.com.au](http://www.precisionag.com.au)

## **Precision Technology Solutions (PTS)**

Precision Technology Solutions was set up by Julien Coles to meet the requirements of farmers to increase productivity and efficiency in their businesses. PTS focus on the technical support and integration of technology into the agricultural industry.

Go to: [www.ptsag.com.au](http://www.ptsag.com.au)