Variable rate and the 'holy grail'

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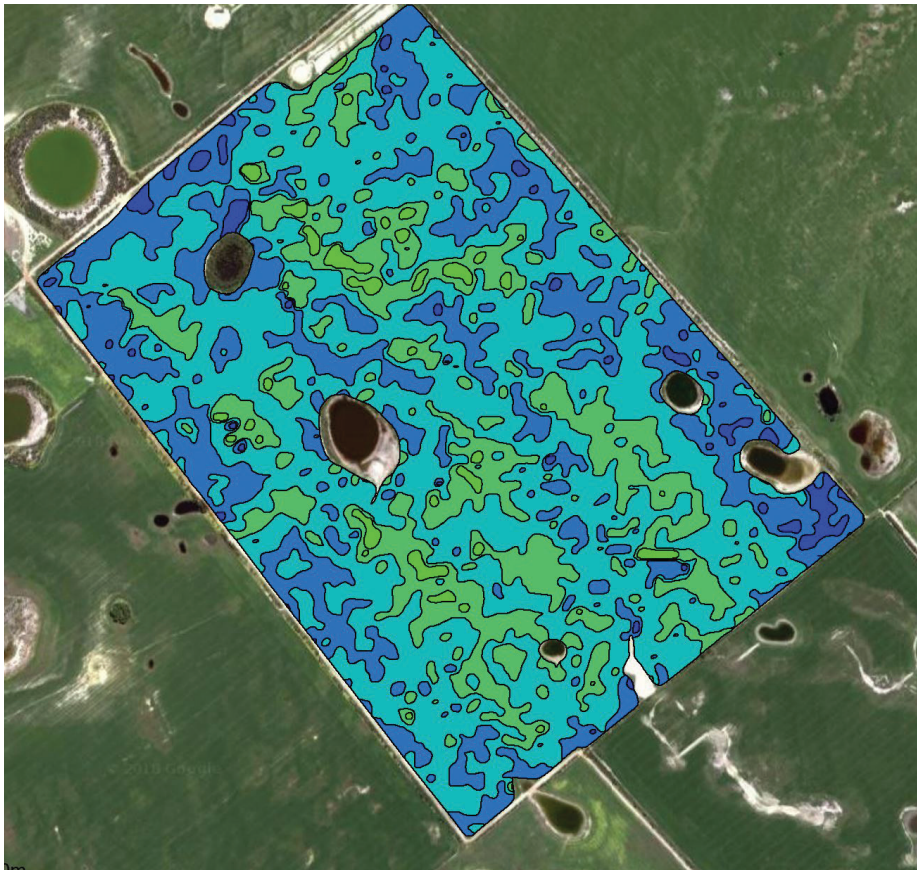
Matt Hill, of Young Hill Farms, has spent the past six years fine-tuning his family's use of variable rate technology and now has his sights set on the holy grail of targeted applications – nitrogen.

WA continuous cropper Matt Hill and his family don't do things by halves on their 15,000ha property north-east of the port town of Esperance. "In for a penny, in for a pound" is certainly a motto they live by when it comes to precision agriculture.

The family – Matt and his wife Angela, her parents Ted and Rachel Young and brother Michael Young and his wife Jodi – began variable rate applications in 2010. They started with phosphorous replacement using yield maps before 'getting serious' in 2012 with Electro-magnetic (EM38) and radiometric mapping combined with soil sampling to target lime and gypsum applications and have now bought new air-seeder bins to facilitate variable rate application of potassium.

In the past two years they have used grain meters fitted to their four headers to analyse protein levels as part of their focus on nitrogen applications.

The family's investment in mapping and variable rate technology is about optimising yield potential and thereby profit, according to Matt. "A lot of people have asked me over the years, 'how much money do you save?' and I say, 'I'm not trying to save any money, I'm trying to make money'.



PRETTY AS A PICTURE. THIS IS A PADDOCK DATA MAP SHOWING THE AREAS YIELDING GRAIN WITH HIGH, MEDIUM AND LOW PROTEIN LEVELS; INFORMATION MATT HILL BELIEVES IS THE KEY TO HIM SOLVING THE NITROGEN NUTRITION PUZZLE.

ESPERANCE GROWER MATT HILL IS MAKING PRECISION AGRICULTURE PAY.

"The biggest cost in farming is often foregone potential. That's the biggest opportunity loss we have. It's not trying to save a kilo of fertiliser here or a tonne of fertiliser there, it's trying to optimise your yield and thereby maximise your profit in any given season."

Young Hill Farms crop a three-year rotation of wheat, canola and barley, with the family becoming continuous croppers in 2015, when they sold their Merino sheep and Angus cattle. Average annual rainfall across the property spans 400mm to 445mm and their soils range from alkaline clay to sand over clay, loam and heavier clay.

With livestock out of the equation the family turned its focus to soil nutrition and defining soil types, committing to the concept of variable rate applications in 2012. They had experimented with phosphorous replacement during the previous two years before deciding to vary the rates of gypsum and lime.

"In 2012 we made the decision to get serious about variable rate applications, which was prompted by lime and gypsum. Because we've got such large areas we weren't happy with blanket rates. We knew that large areas weren't going to be responsive to the gypsum or lime so we made the decision to invest in EM38 and radiometric mapping across the whole farm," said Matt.

"We'd tested the waters with variable rate by doing phosphorous replacement,

turning yield maps into prescription maps by working on four units of P removed per tonne of cereal and six units of P removed per tonne of canola."

"At the time we didn't have enough soil testing to tell us whether what we were doing was right or wrong and whether the P levels would be maintained or decline. That's one of the other reasons we went to EM38 combined with the soil testing; to better quantify our soil nutrition levels and make sure we weren't doing the wrong thing by applying too little or too much."

Matt describes the soil testing they completed in 2012 as 'a significantly beefed up soil sampling regime' that involved taking a zero to 10cm sample across the 15,000ha property every 30ha on average. They now have an annual soil-testing regime.

EM38 mapping involves the use of geophysical surveying equipment to measure soil electrical conductivity.

"It picks up conductivity in the soil. Clay or sodic clays are far more conductive than dry sands or gravel. You get different read-outs that help you define your soil. It's not an absolute quantitative definition because a lot of soils, like sand and gravel, for instance, have a similar signal, but when you combine it with radiometric data you can differentiate between them."

Radiometric (or Airborne Gamma-Ray Spectrometer) surveys measure radioactivity in soil using natural gamma-ray emanations from materials in rocks and soils, which come from the natural decay of potassium, uranium or thorium. According to Matt, gravels have a high thorium signal, which has allowed the family to distinguish between sand and gravel zones across the property. "If you get the right maths and the right survey, you can work out that certain zones have different levels of nutrition," he said. "For example, potassium (K) is related to clay content, so high radiometric K shows where the high clay zones are, which seems to coincide with high levels of nutrition and better soil types.

"We've had sandy soil where the radio K is very low, so we've been able to use those maps to help define soil types that need different levels of nutrition. At the end of the day, the most important thing is that EM38 picks up sodicity, which responds to gypsum. It also identifies sand and gravel, that are both prone to low pH, which makes it pretty easy to generate lime maps."

It could take 10 years to get three good wheat yield maps, depending on the rotation.

Mapping their entire property emphasised the extensive variability of their soils. "It showed that our soils are a lot more variable than we thought," said Matt. "They go from sand over clay through to duplex and heavier clays. There's large variability over the 15,000ha and large variability within each individual paddock."

The family has applied lime and gypsum each year for the past six years but haven't yet completed a first-pass application over the entire property. "We haven't even been around the property once yet, although we're almost there," said Matt. "We're probably one or two years away from completing the first full application and then we'll probably turn around and start applying a second round.

"Lime is an article of faith, but our pH levels are moving in the right direction and we're really happy with the results gypsum gives us on the heavy country.

"We've noticed far less run-off, which is a bit to do with not having sheep, but there's also much better moisture retention, plant establishment at seeding time, seed bed preparation and seed placement.

"I reckon once we get around the property the first time we'll keep going with top-up amounts."

The radiometric and EM38 surveys also identified a potassium deficiency across the property's sand hills and gravel zones, which has been a recent area of attention for the family.

"We have used potassium fertilisers previously, but at a blanket rate," said Matt. "This year we've gone to a more basic compound fertiliser and started varying the rate of potassium based on the mapping.

"We made an investment in the gear – we had to buy new bins at hideous expense to get a fourth compartment on the seeder – but we've done that now and have the ability to variable rate potassium."

However, after just one year of VR potassium application, he is not expecting to see a response in the header bin this harvest.

"This will be one of those things that take multiple years to really get the levels up to where they should be, so it's a bit of a long-term investment."

With variable rate applications of phosphorous, lime, gypsum and potassium under control, the family has now shifted its focus to nitrogen (N), which is the holy grail of crop nutrition for Matt.

"It's something I've been working on for years and it's the hardest one to do. It's hard to know how much nitrogen is in the soil and how much will be mineralised from the organic carbon.

"Nitrogen is the opposite of phosphorous. With phosphorous you're just replacing something rather than trying to predict

IT TAKES A LOT OF MACHINERY TO PRECISION-CROP 15,000HA AND THERE IS NO DOUBT THE ESPERANCE-BASED YOUNG HILL FARMS BUSINESS HAS A SIZEABLE INVESTMENT IN PLANT AND EQUIPMENT.

what the crop needs. With nitrogen you've got to put it on the line during the season. You're guessing what rain you'll get and how much a crop will yield. You put the nitrogen on and hope that it all turns out the way you want it to."

Matt uses yield maps to determine the family's variable rate nitrogen applications. The first step is to generate a normalised average yield map for each paddock using data from all the good yield maps he has for each paddock. He then estimates what each paddock is going to yield, using soil moisture data and seasonal forecasts, applies the estimate to the average yield map and using a figure of 40kg of N per tonne of cereal yield generates a nitrogen requirement map.

"I use as many good yield maps as I've got. Sometimes it takes 10 years to get three good wheat yield maps, depending on the rotation. Sometimes I'll only have two maps, but I'll use whatever I've got.

"So the average of the paddock might be three tonnes, the poor parts might be two tonnes and the really good parts of the paddock might go four tonnes to the hectare. Then it's a really simple calculation: four tonnes multiplied by 40 units of N is 160 units. If testing shows there are 40 units in the soil I subtract that figure from the 160 to get 120 units of N and divide that by the N content of whatever product I'm using, usually urea or Flexi-N, and that gives me the litres or kilos per hectare.

MEMBERS OF THE HILL AND YOUNG FAMILIES WHO WORK TOGETHER ON YOUNG HILL FARMS INCLUDE ANGELA AND MATT HILL, ANGELA'S MOTHER RACHEL YOUNG [LEFT], AND ANGELA AND MATT'S DAUGHTER LUCY [CENTRE] AND SON JAMES [RIGHT].

"Potentially, my high-yielding zones will get high rates of urea, say 200 to 300kg/ha and my poorer yielding areas, like the rocky outcrops or sandy zones, might get a low rate of 50kg/ha or none at all.

"What I'm trying to do is give those areas of the paddock with high yield potential high inputs, those areas that have average potential average inputs and areas of the field with low potential little or no inputs."

However, despite the family's investment in PA technology and Matt's countless hours calculating N rates, he still wasn't completely satisfied and continued looking for ways to improve his N management.

"The question is, how do you know what you're doing is right? That did bug me," said Matt. "Your yields might go up and that's great, but yield is only one part of the puzzle. The missing piece has always been protein.

"We only considered protein when the grain got to the receival site and they told us what the protein was and at that stage it was very difficult, or impossible, to apply the protein from the truck or bin back to a paddock. The guts of it is that we were doing all of this variable rate stuff but we couldn't really measure if we were getting it right and protein was the missing link.

"When you're talking about wheat, the goal is to put enough nutrition on to achieve 10.5% protein, because when you reach that point you have optimised the yield for the nitrogen application. When a plant has enough nitrogen to express its yield, given the soil and moisture it has access to, it won't increase the yield regardless of how much nutrition you give

it. It won't turn the additional nitrogen – which means additional dollars – into extra yield but it will turn it into extra protein.

"The point is that we don't get any profit benefit when our protein goes over 10.5% because we don't get paid a lot for protein, we get paid for tonnes, so we're not really getting any money back for nitrogen we're putting on if it isn't increasing yield."

Matt concluded that the only way to measure the effectiveness of the family's variable rate urea applications was to calculate protein during the harvesting process and spent years looking for some way of achieving that before Sydney-based Next Instruments and their CropScan 3000H On Combine Analyser. The analyser, which was launched in 2013, uses Near Infrared (NIR) technology to deliver real-time protein mapping.

"Other guys in WA are using them to mix grain with different protein levels, like blending, but that isn't my primary interest," said Matt. "Mine is measuring the protein and creating protein maps to make sure the nutrition we apply is right. The hope is that in the next couple of years I'll generate some good nitrogen or protein maps and start picking out areas where I need more or less nitrogen.

"That's why we went for the protein meters, to fill in the last piece of the puzzle."

Young Hill Farms bought four CropScan 3000H On Combine Analysers at a cost of about $30,000 per unit in 2016. This season will be the second full harvest in which the family has used the technology, with 2016 considered a trial run.

"I suspect it might take two full rotations before we start to get some good information we can start using," said Matt. "What I expect is that the analysers will be more like an umpire; to show where we've applied the right amount of nutrition and fix the areas where we haven't.

"Investing in this technology was a leap of faith but I thought it was about my turn to do something a bit risky. We are certainly doing a lot better due to all the precision ag technologies and systems we've put in place over the past six years. They're certainly making our cropping enterprise a lot more profitable than it used to be.

"Of course, the more data you produce, the more time you have to spend dealing with it."

With nitrogen you've got to put it on the line during the season. You're guessing what rain you'll get and how much a crop will yield.

It has taken Matt, who does most of his own data processing and creates his own variable rate maps, years to come to terms with the technology around precision agriculture and to work out PA systems for the Young Hill Farms business. "I've spent a lot of time over the years trying to work it out but now that I've got a good system in place it doesn't take long. But getting into a position where I knew what I was doing took a long time."

He estimates that it takes three or four days to generate phosphorous removal maps, which he does over a week, in between other tasks.

"Some farms don't want to invest the time in precision ag and I can understand that. It takes a lot of work. It would probably cost $5/ha to get someone else to do it for you, so you've got to work out whether it's worthwhile. I think it is because I think there's a lot of potential out there that we forego because we don't apply the right amount of fertiliser."

Matt has conducted trials on the family's property that have highlighted the link between yield and grain protein in cereals. "My best trial was a nitrogen trial that showed a yield loss when grain protein was lower than the target of 10.5%. For example, if my protein was 9.5%, which can happen often with barley, it equates to yield loss of 750kg/ha. I had put enough nitrogen on that zone to change the grain protein from 9.5% to 10.5% I would have got an extra 750kg/ha yield.

"If we're talking about wheat, an extra one per cent of protein, from 9.5% to 10.5% would also have changed the grade from ASW to APW. If that improved the price by $10 or $12/tonne and we got another three quarters of a tonne we would have gone from a yield of 2.5t/ha to 3.2t/ha plus improved the return per tonne.

"If you're not putting nutrition on correctly, that's the real cost of farming. That's why I've been trying to optimise the nutritional inputs. Obviously, things change year by year. Yields change with seasonal conditions. If you get a dry year it might be a 1.8t/ha year, and if that's the case you don't have to put a lot of inputs on. You might put a little on your best areas to get them up to 2.5t/ha but otherwise you've probably got enough nutrition in your soil to get your 1.8t/ha average with a very small application of N.

"Being an optimist I always look at the top end, but if you have a bad season you can bring your fertiliser inputs right back and only put on what is absolutely necessary exactly where it's needed. You can save yourself a lot of money and still optimise your yield."