

Variable rate gypsum reduces costs, improves yields on Queensland sugarcane farm

Denis Pozzebon is a second-generation sugarcane farmer in northern Queensland and a SPAA Committee member. He produces about 15,000 tonnes/year of sugarcane over 128 hectares in the Burdekin. Denis has a reputation for being an innovator, including using precision agriculture (PA) technologies in sugarcane production. Written by **Laura Jade**.

FARM DETAILS

Location: Mount Kelly, Queensland (14km west of Ayr)

Farm size: 128 ha

Rainfall: 680 mm average annual rainfall (the water demands of sugarcane and the evaporative demand of the Burdekin means irrigation is also required)

Soil/s: Denis describes it as “Good delta soil – from a delta silt to a clay-silt and medium silt.” The fine sandy clay derived from sediments of the ancient Burdekin River floodplain.

Enterprises: Sugarcane production

Personnel: Denis Pozzebon

PRECISION AG TIP

You’ve got to move ahead with the times or else you’ll get left behind



Figure 1: (left) Denis Pozzebon is a north Queensland sugarcane grower, passionate about improving productivity and sustainability. (right) Lisa Pozzebon helping Denis with irrigation on the farm.

DENIS Pozzebon followed his late father Ugo into sugarcane production. Denis credits Ugo for encouraging him to try new things on the farm, to make it more efficient and sustainable.

‘He would say “You’ve got to move ahead with the times or else you’ll get left behind”.’

One way Denis has innovated is using precision agriculture (PA) technologies in sugarcane production.

Challenges to address

The original farm that the family settled had consistent, good soils. When they purchased a neighbouring farm to expand their operations, the new paddocks had variable soils – including some areas with sodic issues.

‘That area was 27 ha and of that, there

was about six ha that was highly sodic. I could visibly see the difference in the cane in that area, over the years,’ Denis said.

He said applying gypsum helped to address the issue but was very expensive.

‘That was one of the reasons I started with PA.’

Getting started with PA

Denis had been doing rudimentary variable rate applications based on his visual observations of the crops. He would put out drums in the paddocks to show contractors where they should apply different rates of gypsum.

Denis wanted to better understand the soils on the more variable paddocks, so in 2009 he had a commercial operator survey the soil with a VERIS sensor to

map the soil electrical conductivity (EC), and had soil testing done.

‘Before that, you never knew what was going on underground.’

He said the results correlated to what he could see in the crops. High yielding areas tended to have low EC and lower yielding areas tended to have high EC.

The results from the EC maps and soil tests helped Denis decide where to apply gypsum to counteract the sodic issue.

He was able to have variable rate application maps created, and found a contractor who had the technology apply the gypsum variably in 2010.

Research to develop PA approach

A team of researchers, led by Dr Rob Bramley of CSIRO and which included agricultural engineer Dr Troy Jensen of the University of Southern Queensland,

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conducted a Sugar Research Australia project (and follow up activities) on the property. This research became a case study of the application of PA to sugarcane production.

The team sought to map the sugarcane yield. However, as *Figure 2* shows, sugarcane harvesting can be complex. In the 27.6 ha field, the 2011 harvest included 21 separate harvest events done over a 45-day period. In 2011 this field also contained nine variety/crop age combinations.

The researchers combined maps from three seasons to generate a map reflecting average productivity. Rob explained that the quasi-perennial nature of sugarcane coupled with the use of fallow paddocks made creating multi-year yield maps difficult because a paddock might comprise sections of crops of different ages (years since planting and weeks since last harvested) and different varieties (*Figure 2*).

To overcome these and other challenges, the researchers created a yield map representing the mean of three years' production, adjusted to the mean yield obtained by a 'marker variety' in a season of interest and that eliminated the effects of fallow and variety/crop age (*Figure 3*).

The researchers also used remote and proximal sensing to further their understanding of production. In 2010-12, they obtained imagery from the IKONOS satellite (4 m on-ground resolution) and in 2013 from the GeoEye platform (2 m on-ground resolution). They displayed data as either the normalised difference vegetation index (NDVI) or the green normalised difference vegetation index (GNDVI). Both of these indicate the amount of photosynthetically active biomass in the crop. See the results in *Figure 4*.

They were able to determine that GNDVI was more useful for sugarcane. This is because the sugarcane plant has a large biomass and leaf area, which leads to a saturation of NDVI values, reducing capacity to measure spatial variation. Fortunately, GNDVI is less susceptible to this saturation.

They found that the remotely sensed imagery provided similar information as the yield maps.

To further understand the soil, the researchers followed up Denis's VERIS 3100 survey with an EM38 instrument to estimate the EC of the soil. They did this because of concern about poor contact between the VERIS sensor and the soil – which in this case proved unfounded.

Draping the EC map over an elevation

model also showed that high levels of EC occurred in the areas with the lowest elevation (*Figure 5*).

'Because Denis's irrigation lines run east

to west, with a slight slope, the westernmost areas tend to be wetter and that's where salts tend to concentrate and sodic soils develop,' Rob said, adding this

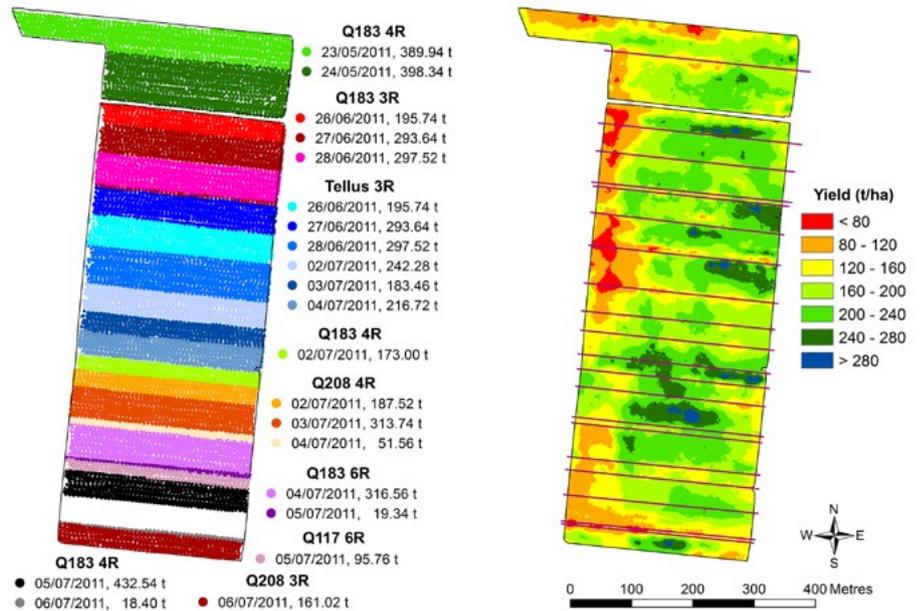


Figure 2: Harvester trace in the 2011 season and the yield map obtained when the yield monitor data are adjusted to the tonnage measured at the mill on a per-harvest event basis prior to map interpolation. The lines going across the yield map represent boundaries between the 21 harvest events. Data of Bramley and Jensen (2013).

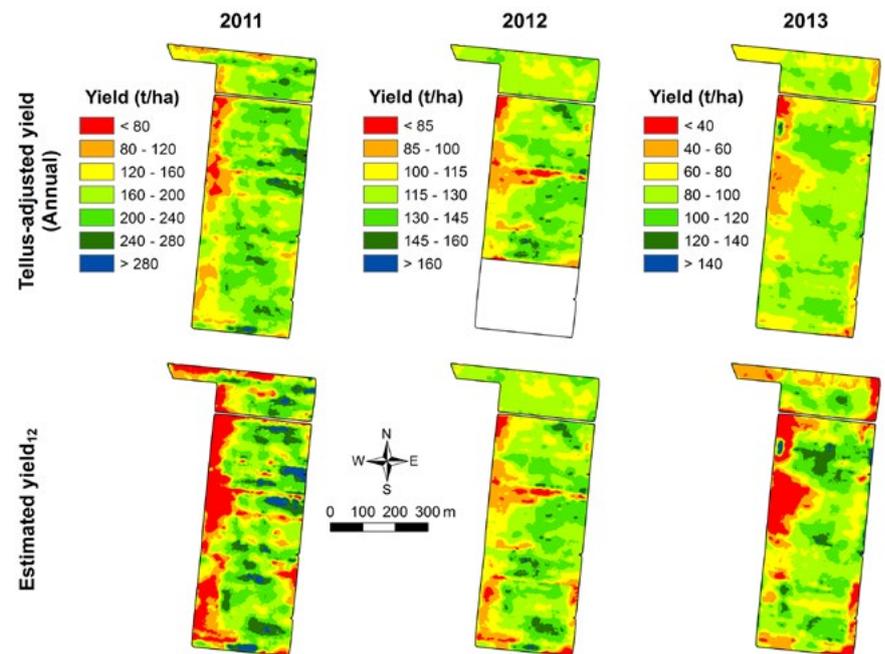


Figure 3: Adjustment of yield maps obtained over three seasons for a field planted to mixed varieties with differing crop age and with one section left fallow in one season. Data of Bramley et al. (2018). In the top row of maps, the yield data for each variety/crop age combination have been adjusted so that, in each year, the mean yield in the field as a whole is the same as the mean yield in the section planted to the variety 'Tellus' (see Figure 2). The bottom row of maps shows the result of adjusting those in the top row to the mean yield of 'Tellus' in 2012. Because these maps were generated using normalised yield monitor data before being back-transformed to a t/ha basis, the yield in the area that was fallow in 2012 can be estimated as though it did contain a crop using the average of the normalised yield from 2011 and 2013. More detail on this process – which has been found valuable for whole-farm yield mapping in the grains sector – can be found in Bramley et al. (2018).

was to be expected in the salt-affected landscape of the Burdekin.

To ground truth the results of all these data inputs, the research team conducted soil samples to understand specific properties. Across the 27 ha, they took 35 soil core samples to cover the range of variation in EC and conducted a wide range of soil analysis. These provided strong evidence to give Denis and the researchers confidence that saline and sodic subsoils were the main driver of the high EC values.

Before this data collection and analysis, Denis knew the field was variably affected by soil salinity and sodicity, but he was estimating the boundary of these different areas based on his visual observations.

The researchers interpolated these map layers to identify zones that shared characteristics and could receive the same targeted management.

Developing variable rate application map for gypsum, with cost-benefit analysis

Before this research, Denis was applying gypsum at a blanket rate of 3.5 t/ha. At the time it was costing him about \$150/t for a total cost of \$14,018 for the field.

Using a variable rate application saw him apply six t/ha to the low-yielding sodic areas (6.4 ha in total) and a maintenance application of one t/ha to the rest of the field (20.3 ha). The total cost of this variable rate application was \$8,805, saving Denis about \$300/ha.

Rob said that the cost-benefit analysis should also include the yield benefit which derives from ameliorating the sodicity. Rob acknowledged that these benefits must be offset against the cost of acquiring data and variable rate maps – but in this instance the costs were covered as part of the research.

‘It was certainly cost effective – instead of just applying gypsum based on visually looking at the cane and then putting drums out [in the field] to show where to apply different rates. It was hit and miss, you never knew what was going on underneath the ground, what was really happening,’ Denis said.

‘The EC mapping picked up the sodic issues in the soil. So instead of applying the full rate [of gypsum] across the whole field, we’ve varied according to the EC mapping and the zones.’

Denis said that Rob, Troy and their team helped him understand why the yield varied so much across the field.

For a follow up activity, the researchers examined variability in sugar content in the cane (CCS) in addition to yield and

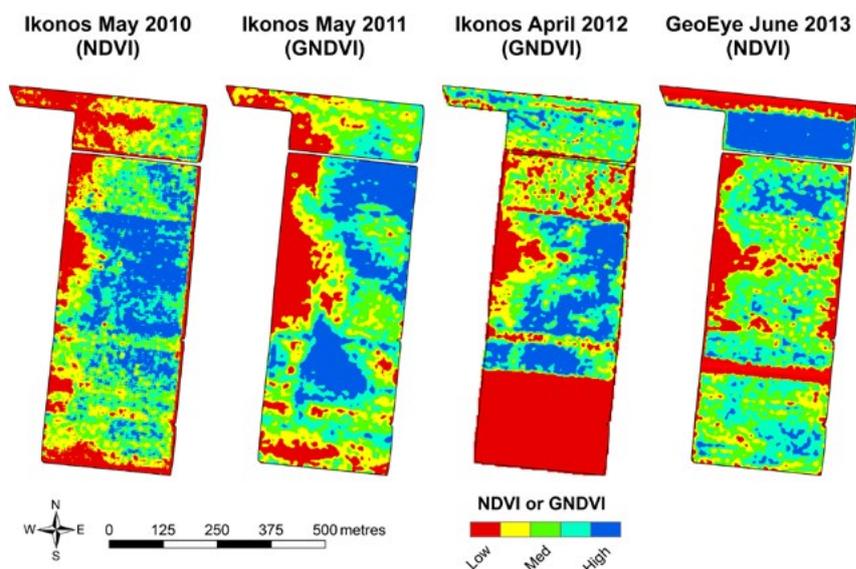


Figure 4: Remotely sensed imagery obtained over four seasons from either the IKONOS or GeoEye satellites. Data of Bramley et al. (2018).

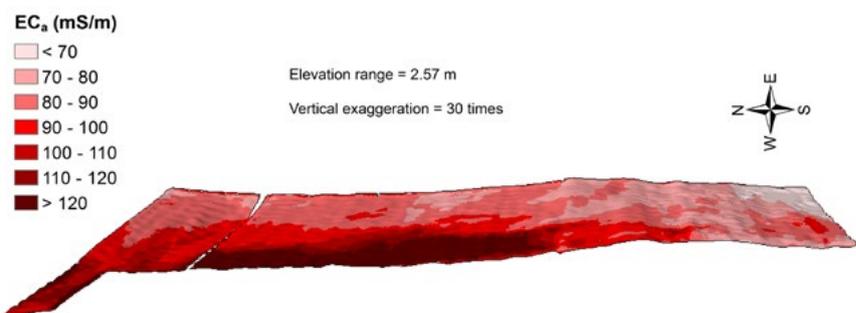


Figure 5: EM38 soil map draped over a digital elevation model of the Pozzebon field. Note that the direction of the north arrow is approximate only and that the irrigation furrows run from the top of the page towards the bottom. Data of Bramley et al. (2012, 2018).

found that about 20-25% of the variation in income from growing sugarcane was due to variation in CCS.

Denis and Rob both expressed that neither yield mapping nor CCS sensing are widespread in the Australian industry, but both could be very beneficial.

Since the SRA research, Denis has since expanded the variable rate application across the farm (see example of a paddock’s map in Figure 6, and a map being used in a tractor in Figure 7).

‘Now my whole farm has been EM38 mapped by a commercial provider Farmacist, who have used that data to create a variable rate [application map for] gypsum.’

He said the variable rate application of gypsum had evened out production, so what had been low yielding areas were now producing similar yields to other areas of the paddock.

Denis said the biggest challenge of implementing variable rate applications

was getting used to the new technology. In the early days, a lot of the equipment didn’t “talk to each other” and farm machinery sellers were not across the functionality.

‘That’s changed now, it’s a lot more farmer friendly and there is more knowledge and expertise available.’

He said equipment capable of variable rate applications had also become a lot cheaper in the past decade.

Precision ag is part of using inputs, water sustainably

‘Government regulation now means that everything I do, in terms of fertiliser application, chemical application, variable rate gypsum and more, everything gets logged on my GPS units in the tractor and we download those records onto the computer for when we get audited.’

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8.1 - 2022 fallow: Application
Gypsum

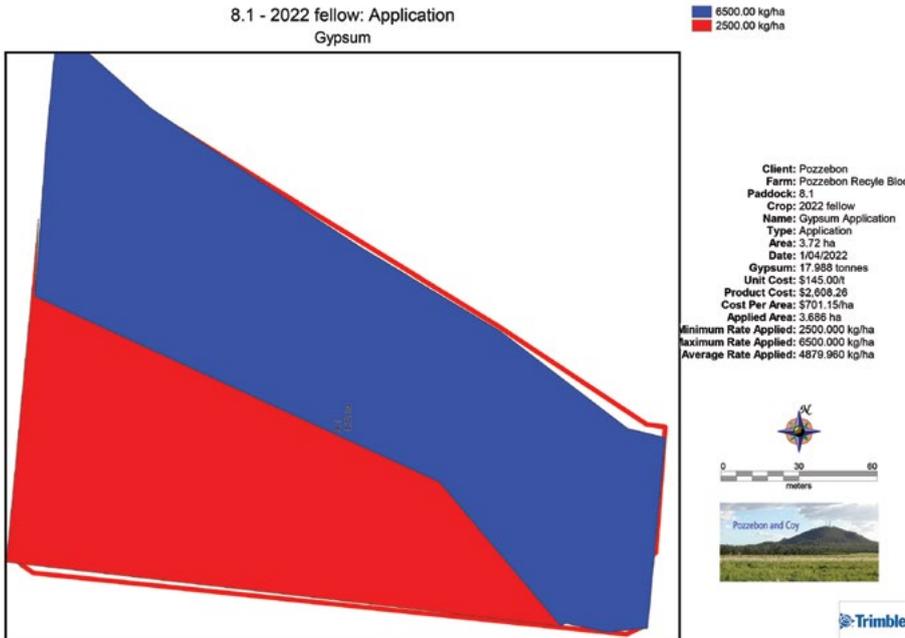


Figure 6: Variable rate application map for gypsum on one paddock.



Figure 8: In fallow, Denis plants mixed species including legumes. He incorporates these into the soil before the next planting, to boost its health.

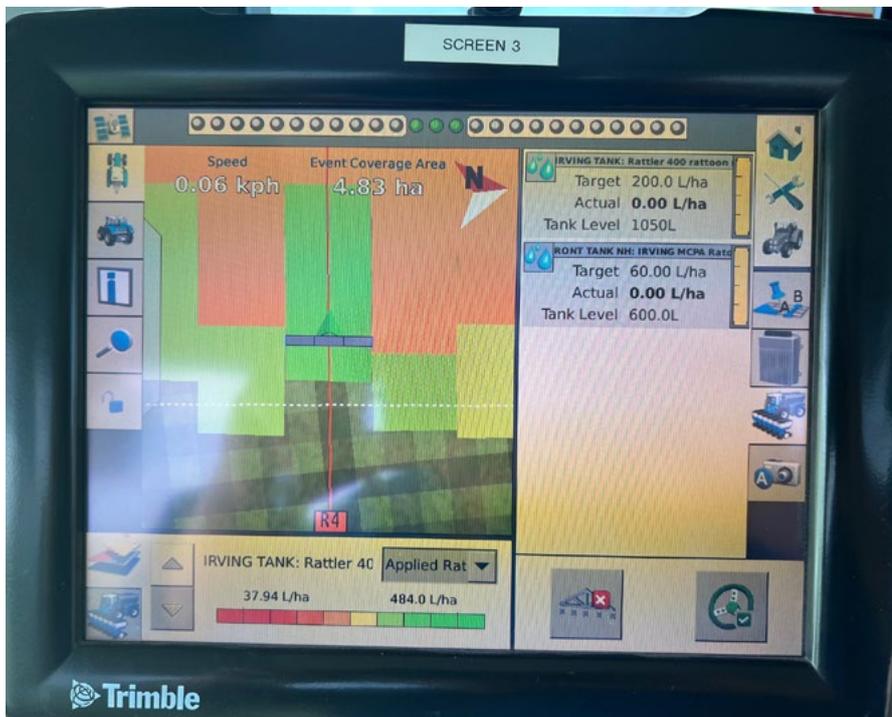


Figure 7: A chemical application map. This is how Denis records his spraying and fertiliser applications. The contractor who spreads gypsum on the farm uses the same technology.

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Denis said that he had tried to apply fertiliser using variable rate but the technology required was not yet readily available. Some machinery brands have released sugarcane yield monitors and growers and contractors (who harvest most of the sugarcane in Australia) were looking into their accuracy and benefits to their businesses. 'Generally here in the Burdekin, fertiliser is not the main cause of variable yields

in cane. It's usually a soil issue, water logging or soil health.' To boost soil health, Denis has planted legumes such as cowpea during the fallow (Figure 8). He incorporates these into the beds before planting. This helps reduce input costs and nutrient runoff. Denis would also love to have an accurate CCS monitor, to help him refine his operations further. Denis is driven to improve efficiency and

productivity. He has also fully automated the irrigation on his farm. Data from soil moisture probes informs when gates and pumps turn on, at variable speeds, to ensure water is used most efficiently. Denis gave the example of saving 23 per cent water into one of the furrows.

Denis is passionate about sugarcane farming and is actively involved in all manner of projects to improve its productivity sustainability. He participated in Project Catalyst and received an Extension Achievement Award. He is also accredited through Smartcane BMP, a voluntary, best-practice system for sugarcane growing in Australia, that includes standards for productivity, profitability and sustainability. Denis has also hosted 'GameChanger' replicated Enhanced Efficiency Fertiliser Trials.

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