Yield mapping
An essential component of site specific management

The Issue

• There is evidence to suggest that some grower practices within the sugar industry do have a negative impact on water quality entering the Great Barrier Reef
  – Excess of Dissolved Inorganic Nitrogen (DIN)
  – Phosphorus
  – Suspended sediment
  – Herbicides

• It is unrealistic to expect that the industry will meet current water quality targets using current industry endorsed guidelines
Background

- The BPS001 and Moses projects conducted investigations into the understanding and identification of the complexities of soil and yield variability
- There are essential datasets required to identify variability
  - EC or EM maps (soil variability)
  - Yield maps (block and zone - Management unit yield potential)
  - Elevation maps – the effect on yields relating to the position in the landscape
  - Site specific soil sampling and analysis
  - Grower knowledge and management

*No one dataset by itself is enough to understand the complexities of yield variation*

Crop Variability

- Variability in crop production exists within all sugar cane paddocks/farms
- Variability in cane production can range from minor (< 5 t/ha) to extreme (>100 t/ha)
- Often there are multiple causes as to why crop production varies but predominately it starts with changing soil properties
  - *In the majority of cases it is more than just N management*
Identifying yield variability

• The Mackay region has used satellite data to predict crop yields from 2000 to the present
  – First step is to convert satellite data to a calculated vegetation index (e.g. – NDVI)
  – Secondly, individual algorithms created for different cane varieties are used to convert calculated NDVI values to crop yield
    • *This step is required to account for the different shape, size and density of the canopy of the individual cane crop varieties.*

Using satellite yield data to identify yield zones

• Yield data is filtered to only include cane paddocks that contained either plant, 1st or 2nd ratoon in any given year
  – integrity of yield data from older ratoons may be compromised
    • Pest and disease incursions
    • weed pressure
    • crop damage from harvesters
    • soil compaction

• Normalisation process is used to reduce the influence of the different growing conditions for each individual year
  – Yield point data for all sites are converted into a yield ratio by dividing the actual value for each point by the site average
Creating a yield ratio from satellite imagery

Identifying yield zones and their stability over time

- For each year the yield ratio data points are grouped together to determine three yield zones
- A mosaic of yield ratio data points is then created by joining all years into one dataset
  - One year’s data in isolation is not suitable for creating yield variation maps
  - Need a minimum of 4 years, preferably 6 years worth of analysis to be confident of yield trends

<table>
<thead>
<tr>
<th>Yield zone</th>
<th>Yield category</th>
<th>Yield ratio parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Low</td>
<td>&lt; 90% of block average</td>
</tr>
<tr>
<td>2</td>
<td>Average</td>
<td>&gt;= 90% and &lt;= 110%</td>
</tr>
<tr>
<td>3</td>
<td>High</td>
<td>&gt; 110% of block average</td>
</tr>
</tbody>
</table>
Yield zones
• 13.5 ha
• 4 ha considered high yield
• 4 ha considered low yield
• Remainder considered av

<table>
<thead>
<tr>
<th>Year</th>
<th>Low zone Av</th>
<th>Med Zone Av</th>
<th>High Zone Av</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>66</td>
<td>79</td>
<td>93</td>
</tr>
<tr>
<td>2004</td>
<td>74</td>
<td>88</td>
<td>105</td>
</tr>
<tr>
<td>2005</td>
<td>71</td>
<td>85</td>
<td>100</td>
</tr>
<tr>
<td>2008</td>
<td>62</td>
<td>74</td>
<td>87</td>
</tr>
<tr>
<td>2009</td>
<td>70</td>
<td>84</td>
<td>99</td>
</tr>
<tr>
<td>2010</td>
<td>69</td>
<td>83</td>
<td>98</td>
</tr>
</tbody>
</table>

Yield Legend
- Below Av yield zone
- Average yield zone
- Above Av yield zone

Whole of farm yield ratio mapping layer

Yield ratio map - 2012
• Spot 5 image

Yield ratio map – mosaic of all years
• ± 10 years satellite imagery
Harvester yield monitors

- Yes we can use yield sensing devices on harvesters
  - Recent projects have concluded that when the data is consistently handled, each yield sensing device is capable of producing legitimate yield information
- However, there are still issues to be addressed
  - Reliability of the sensors
  - Who is responsible for repairing when faults occur
    - Often the harvester operator has no connection with the farm
  - Data needs to be processed – large datasets
  - Time constraints
    - Low level of confidence in using one year's data collected in isolation - Need several years of data collection

Block yield potential

* Yield potential of the block is based on satellite data and statistical calculations

**Distribution of BYT**

- Water quality issues are most likely the result of over application of nutrients on areas with low yield potential
- Is there a possibility that we are restricting production on areas with high yield potential?
Variation in block yield potential within a farm

Block yield potential map
**Yield and EC – variable yield sites**

- Evidence suggests that approximately 30% of all blocks have significant variability (> 30 t/ha within block)
- Another 30% of cane blocks have moderate variability (20 – 30 t/ha within block)

- A strong relationship in mapping patterns is evident where significant variability in both yield values and deep EC values exist: high yield zones are evident where EC values are low and conversely low yield zones correspond with high EC mapping patterns.

**Minimum variability sites**

- Approximately 40% of all cane blocks are relatively stable both in yield and EC (soils)
  - *However there is often significant variations in yield potential between blocks*

- It is unlikely that these blocks would be candidates for VRT applications.
Nitrogen Use Efficiency (NUE)

- NUE is a relatively new term for the Australian Sugar industry
  - Possible agro-environmental indicator
- NUE is basically the ratio between the amount of fertiliser N removed from the field by the crop and the amount of fertiliser N applied
- No simple analytical method available to calculate the amount of N removed by the crop
  - Value is estimated between 1.0 and 1.4 kg N/tonne of cane harvested.

**Assumption:**

- 1.2kg N/tonne of cane is removed by the crop
- This is a general overview, individual locations will vary according to soil and climatic conditions
### The next step – full VR application

<table>
<thead>
<tr>
<th>Yield Target (t/ha)</th>
<th>Application rate (m³/ha)</th>
<th>Area (ha)</th>
<th>Total Volume (m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>110</td>
<td>4.3</td>
<td>3.5</td>
<td>15.05</td>
</tr>
<tr>
<td>85-110</td>
<td>3.9</td>
<td>5.7</td>
<td>22.28</td>
</tr>
<tr>
<td>&lt;85</td>
<td>2.7</td>
<td>8.3</td>
<td>22.41</td>
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<tr>
<td>Total VR application</td>
<td></td>
<td></td>
<td>17.5</td>
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<tr>
<td>Standard Application</td>
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<td></td>
<td>17.5</td>
</tr>
<tr>
<td>Saving (m³)</td>
<td></td>
<td></td>
<td>6.56</td>
</tr>
</tbody>
</table>

* It is not always about reducing nutrients – it is matching nutrient to crop potential

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### In Summary

- Yield mapping is an essential component of developing a well-balanced nutrient program.
- Yield mapping is achievable for most sugar cane regions.
- If you always do what you’ve always done, you will always get what you’ve always got.
- VR applications is no longer fiction – An increasing number of growers are moving down this path – Not just N but for all nutrients.

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**Practical Precision Agronomy**

*If you always do what you've always done, you will always get what you've always got.*

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Henry Ford