Remote sensing to predict yield of vegetable crops

Background

Yield prediction has the potential to be used by the vegetable industry for yield forecasting and marketing. Predicting yield based on crop reflectance could also identify potential areas of variability, which could then be investigated further, or to generate profit/loss maps.

Yield prediction in carrots

University of New England researchers, from the Precision Agriculture Research Group (PARG), have been working with the Queensland Department of Agriculture and Fisheries across Australia to determine the potential for yield prediction from crop sensing imagery in carrots and sweet corn.

Figure 1 illustrates a comparison of high resolution satellite imagery and the associated predicted yield map in carrots. The results from these sites have shown good relationships between biomass vigour and total yield (tonnes/ha). Figure 2 depicts the process for generating predicted yield values from satellite imagery.

Evaluating the imagery

High resolution satellite imagery at crop harvest was classified into vigour zones (low, medium and high) based on biomass index values (SR or NDVI), followed by intensive yield assessments at replicated sample points in each vigour/biomass zone. It is the relationship between these measured yield points and crop reflectance data that is used to generate predicted yield values. This information is then compared alongside pack out data from the corresponding field.

From this data we can also estimate potential yield ranges and class individual fields into yield zones and quantify underperforming areas (Figure 4).

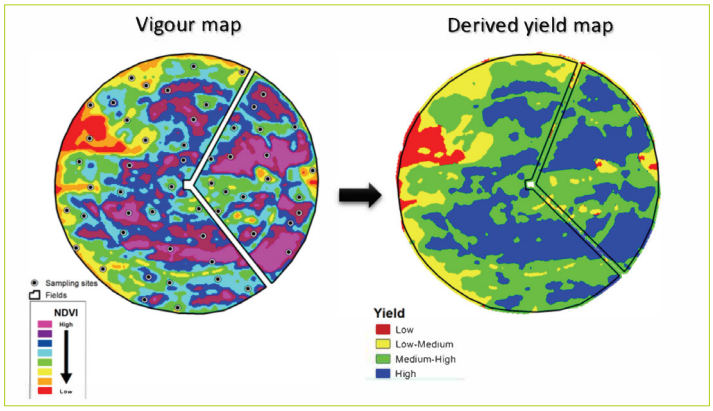

Figure 1. *A carrot vigour map showing biomass as classified with NDVI, and the sample points which were GPS referenced in the field and where yield samples were taken (left); its associated predicted yield map showing the spatial variability at the field level (right).*
Source: Angelica Suarez Cadavid, UNE (2018)

What do the results indicate?

Results have shown that there is a strong relationship between total yield and reflectance data in both carrots and sweet corn, where high biomass vigour as recorded by the crop sensing imagery tends to relate to high yield.

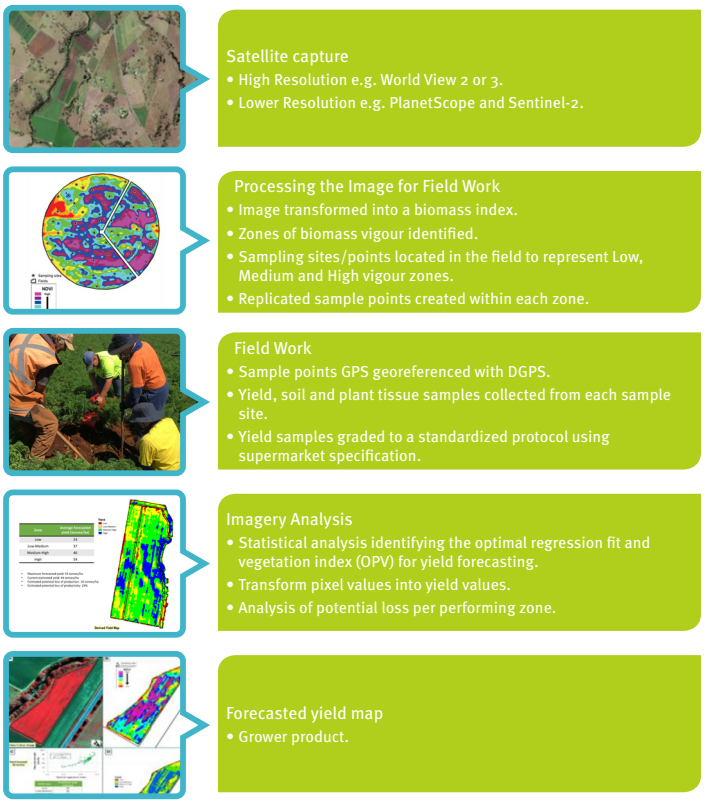

Figure 2. *A schematic of the process from satellite capture to creating the forecasted yield maps for the grower.*

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une University of New England
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tia Tasmanian Institute of Agriculture
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vegetablesWA
SPAA Society of Precision Agriculture Australia
Queensland Government

Figure 3. *A timeline of activities involved in project fieldwork for VG16009, left to right: GPS referencing the sample points, hyperspectral reflectance measurements, yield, soil and plant tissue sampling and grading.*

What is NDVI?

NDVI is the most robust and widely applied vegetation index. It is a ratio of two spectral bands (Red and near infrared (NIR)) that are highly related to crop biomass:

$$\frac{NIR - Red}{NIR + Red}$$

Zones	Average forcasted yield (t/ha)
Low	30
Low Medium	53
Medium High	64
High	74

Maximum forecasted yield: 74 t/ha
Current estimated yield: 63 t/ha
Estimated potential loss of production: 11 t/ha
Estimated potential loss of productivity: 15%

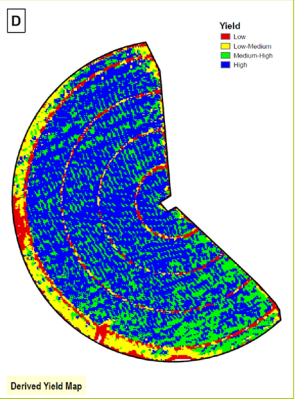

Figure 4. *Yield map of a WA carrot field showing the spatial distribution of yield variability. This information is derived from the forecasted yield maps at the field level. Source: Angelica Suarez Cadavid UNE (2018).*

To obtain an indication of how accurate the predicted yield maps are packout data was compared with the predicted yield data. Predicted carrot yields were within 10% of the packout yield across sites in WA and Tasmania. Error in predicted yield data can be attributed to various factors, such as growing conditions and markets.

As well as yield, grading data is also assessed at each sampling point in the low, medium and high vigour zones. So far, there hasn't been any relationship between crop reflectance data and grading classes. However, low vigour zones have significantly higher waste percentages than medium and high vigour zones (Figure 5).

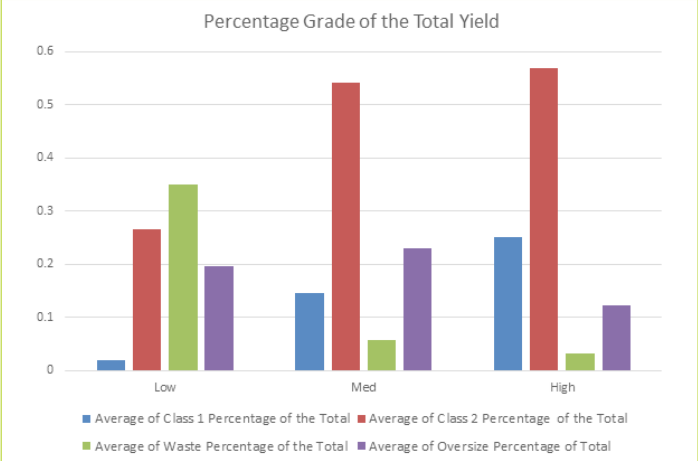

Figure 5. *Grading data from carrots in Tasmania. Note the significantly higher waste percentage in the low vigour zone.*

Why predict yield?

The benefits of using information from yield prediction include:

- Marketing forecasts
- Understanding variability
- Another source of data in the absence of yield monitoring technologies
- Using the spatial data to monitor and manage crop performance.

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