Yield and profitability mapping in carrots

Department of Agriculture and Fisheries

Harvest Moon, Tasmania

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Key outcomes

- Yield monitor options are commercially available that can be used to map yield.
- Yield mapping data can identify underperforming areas.
- Ability to estimate the cost of lost production from underperforming areas and determine the benefit of management intervention.
- Generation of profit loss maps from yield monitor data.
- Good operators are essential for good data.

Background

Harvest Moon is interested in mapping their carrot yields to identify areas in the field that are underperforming, and also to monitor yield over time. In addition to mapping their own crops, Harvest Moon sees value in providing this information to growers who produce under contract for the company.

Various tools are available to identify spatial variability in crop performance. However, the ultimate tool is mapping yield itself. Understanding variability in crop yield, and its impact on profitability, is a powerful motivator to investigate the underlying causes of variability and assess options to address it.

Most yield monitors in vegetables are retro-fitted to harvest equipment, due to limited manufacturer options.

There are two dominant systems in use in Australian root vegetable systems.

1. The ATV™ system originally developed for grape harvesters (http://www.atv.net.au/) with wireless data transfer and vehicle tracking.
2. Greentronics™ (https://greentronics.com/products/yield-monitor/).

Both of these load cell systems have been used for yield monitoring on potato, sweet potato and carrot harvesters and offer connection to GPS systems to generate yield maps. Pea harvester bunkers can be fitted with load cells that measure the cumulative yield as peas are harvested. Yield monitors require regular calibration to ensure accurate data collection.

Grower: Harvest Moon *(pictured Mark Kable, Director and Agricultural Manager)*

Location: Forth, Tasmania

Area: Harvest Moon farm 1500ha of their own country as well as contracting over 80 growers

What they grow: carrots, green beans, onions, broccoli, baby leaf salads

Soils: red Ferrosol, alluvial Hydrosols

Topography: undulating red Ferrosols, flat alluvial soils

Average annual rainfall: 970 mm (winter dominant)

Precision technologies implemented: GPS tractor guidance, yield mapping, strip tillage, crop sensing with hand held Greenseeker®, drone imagery

"Harvest Moon's interest in yield mapping capability is so we can provide feedback to growers regarding variability in their paddocks, so they can explore options for managing it."
– Mark Kable

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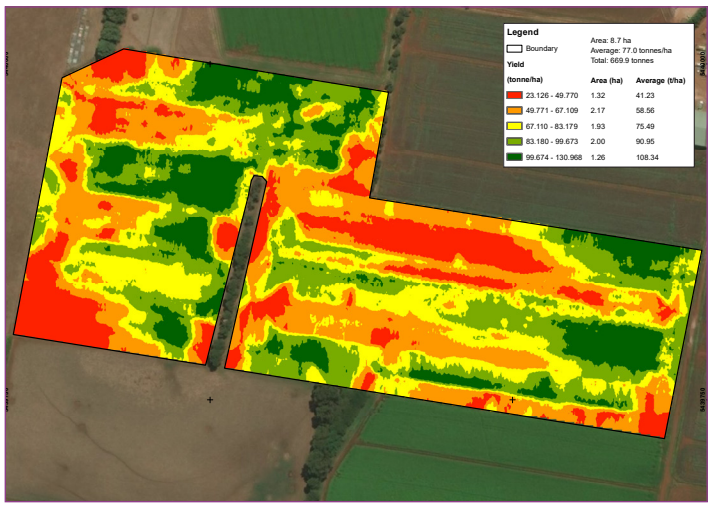
Figure 1. Twin row ASA-lift™ carrot harvester with yield monitoring technology. The load cells are located in part of the elevator that supplies the bunker. The collection of accurate yield data is dependent on a good harvester operator following protocols for yield monitor operation and taring.



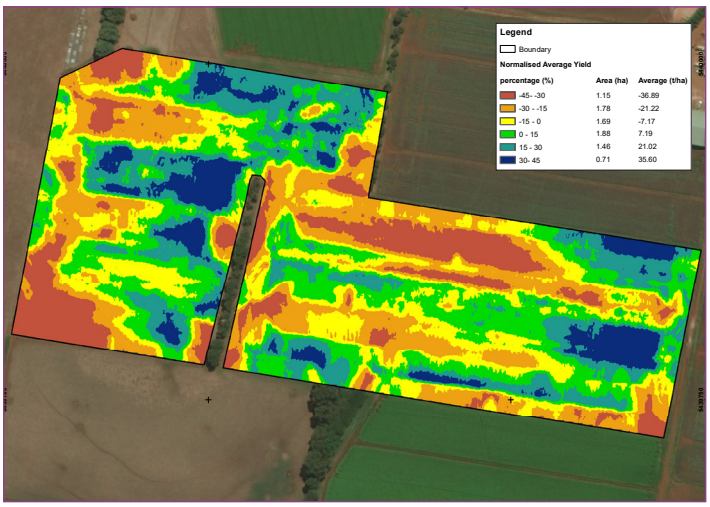


Figure 2. Left: Yield map (t/ha) from retro-fitted load cell based yield monitor on carrot harvester. Right: Normalised yield showing % deviation from the field average.

Activities

An ATV™ load cell yield monitor was installed on an ASA-Lift™ self-propelled twin-row carrot harvester. The load cell is integrated with GPS technology and logs weights as the carrots pass along harvester conveyor belts and over the load cell (Figure 1).

Data from the yield monitor is downloaded wirelessly and converted to a csv format using ATV Merger™ software and then processed into yield maps.

Yield monitoring

Yield monitoring allows for a direct assessment of how variability impacts yield. Figure 2 (left) shows variability in carrot yield from a field where the average yield was 77 t/ha based on the yield monitor data. Packout data for this same field gave a field average of just over 72 t/ha, so the accuracy of the yield monitor data was within 6 per cent of the actual harvested yield.

The yield monitor data shows significant variability in yield, ranging from approximately 25 t/ha up to 130 t/ha, where red indicates areas of lower yield and dark-green the areas of higher yield. Comparing the spatial patterns in yield maps with other spatial layers such as soil mapping can be helpful to work out what factors could be affecting yield and whether different management options could improve uniformity.

The yield data was also presented as a percentage of the field average or the normalised yield (Figure 2, right). Feedback from both Harvest Moon and other growers is that this is the most useful way of mapping the yield data. In this field, over 60 per cent of the area was below the field average, with 13 per cent of the area yielding 30 to 45 per cent below the field average.

Cost benefit analysis

The yield monitor was installed at a cost of $10,000. There are also ongoing costs associated with processing the data into spatial maps. This cost varies depending on the data processing service provider but is usually around $150/hour.

In the example shown in Figure 2 (right), the area of the field that is yielding 15 to 45 per cent below the

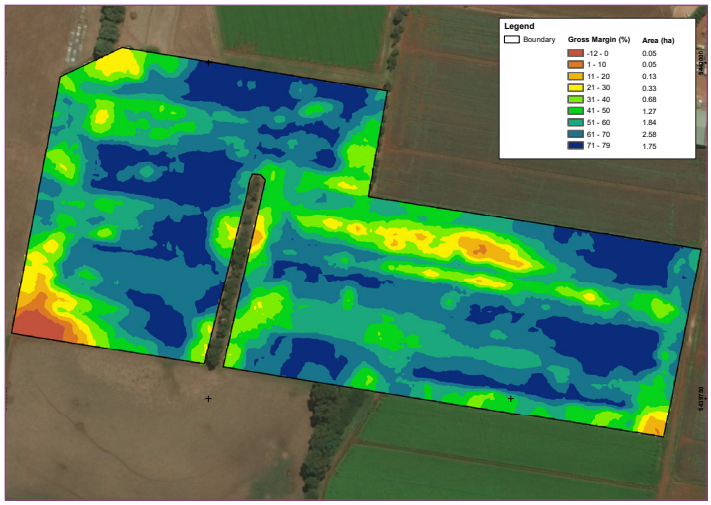


Figure 3. Gross margin percentage (%) map generated from the carrot yield mapping data. Percentage data is net income as a percentage of gross income. Note gross margin calculated based on variable input costs of $13,054/ha and a price of $500/t.

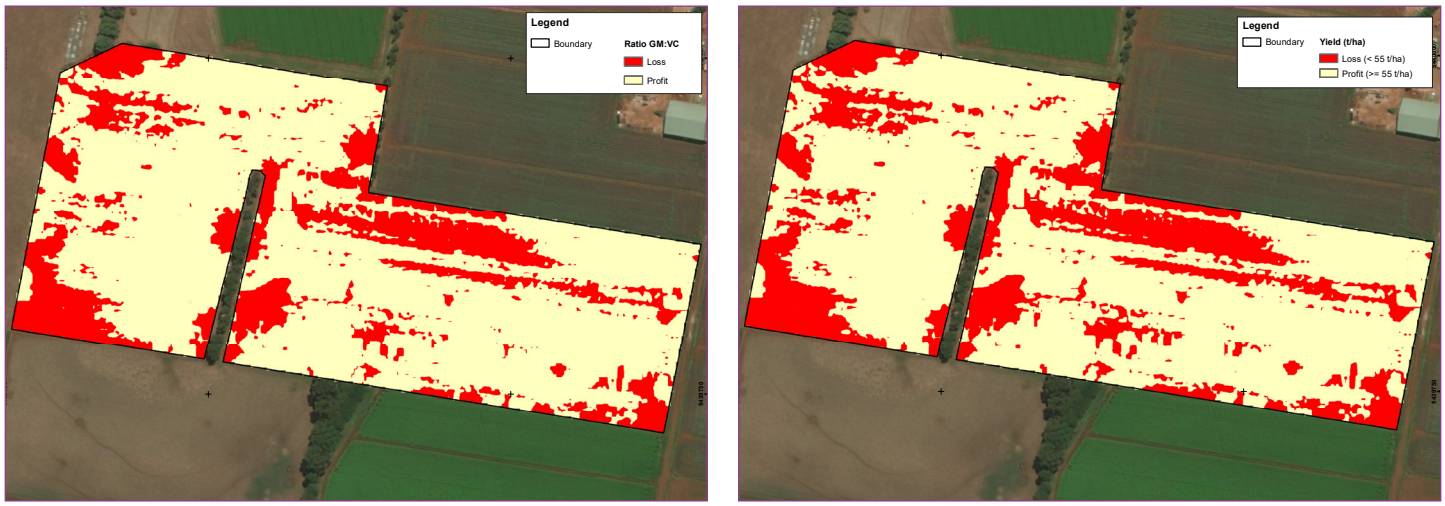


Figure 4. Profit loss maps showing (left) the ratio of gross margin:variable costs (where ratio less than 1:1 is loss (highlighted red) and where the ratio is greater than 1:1 is designated profit) and (right) profit loss map based on 55 t/ha as the break even yield.

average (shown as brown) represents 34 per cent of the field. If the cause of the reduced yield in this area could be identified and remediated to achieve at least the paddock average, the result would be an extra 145 t of carrots, worth over $72,000 (at a price of $500/t).

Clearly it is easy to justify the investment in the yield monitoring technology. The key outcome from this analysis is that opportunities for significant gains exist if the causes of low yields can be understood and managed. Consideration of product quality and the management costs to achieve any yield improvement is required.

Profit and loss maps

Yield monitoring data can also be used to generate financial indicator maps (Figures 3 and 4). Using the yield and an average price, and offsetting the calculated income against the variable costs of production, it is possible to generate gross margin and profit/loss maps (Figure 3). Figure 3 demonstrates a gross margin percentage map where the data is net income as a percentage of gross income. As expected the gross margin data closely aligns with yield data.

Similarly, profit loss maps can be produced. In Figure 4 profit loss maps have been generated as: (left) a ratio of the gross margin:variable costs with anything less than 1:1 considered loss and greater than 1:1 considered profit and (right) where the break even yield is 55 t/ha, yields less than this show a loss (red) and yields above show a profit.

This is probably the ultimate measure of how variability is impacting on financial returns, as it highlights which parts of the paddock are losing money. In a very good crop, a below average area might still be profitable, just not as profitable as the best areas.

Not all areas of the field may be capable of the same level of performance as the better areas of the field. In some cases it may be more cost effective to take some areas out of production if yields cannot be increased to above break even.

The value of the information that can be obtained from a yield map and how it can be interrogated for cost benefit analysis depends on the quality of the data (taking into account collection and taring etc) and what options are on offer from the service provider.

Challenges and considerations

Key challenges associated with yield monitoring in carrots include:

- Yield monitors need regular calibration to have confidence in the accuracy of the yield data. Harvest Moon weighs all harvested produce that goes into their packing shed, including waste, and so they have the ability to check harvested yield against the yield monitor data.
- As carrots are a root vegetable, the yield monitor requires regular taring as soil builds up on the harvesting equipment.
- The quality of the yield data is dependent on a well-trained operator who understands the need for regular taring and can ensure the technology is working properly at all times.
- As the yield monitor only logs the yield data, additional time is required to further process the data to produce maps.
- Yield mapping only provides information on tonnages and does not provide an indication of quality.
- Yield maps are most useful when they can be aligned with other data layers to determine if there are any relationships between soil or crop factors and final yield.

Service providers: Advanced Technology Viticulture; Precision Agriculture

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Costs presented in this document were accurate as of October 2019. These will change over time and between data processing service providers.

Funding and Project Partners

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