Automated plant counts in broccoli using UAV imagery

Background

Applications for unmanned aerial vehicles (UAVs) or drones are increasing across the vegetable industry. Automated plant counts for crops such as broccoli, cauliflower and lettuce, where individual plants represent a unit of produce is an easily achieved application of UAV imagery in vegetable production.

What did we do?

- Identified a commercial broccoli crop.
- Established 5 small validation plots (5 linear metres x 2 beds wide) within the broccoli crop to check accuracy of plant count algorithms against manual counts.
- Deployed a UAV flight with a:
  - » 21 megapixel digital camera (RGB)
  - » 35m above ground level (AGL), 80% image overlap
  - » Ground resolution 0.8 cm
- Completed commercial algorithm analysis of UAV imagery using Agremo™ https://www.agremo.com/

Commercial plant counts

Plant count analysis was applied over a single planting in a commercial broccoli field (See Figure 1). The red area highlighted outlines the particular planting area to be analysed. Automated plant count analysis indicated that there were 48,817 plants in this 1.13 ha area.

Based on the small validation plots, the accuracy of this plant count is within 98%.

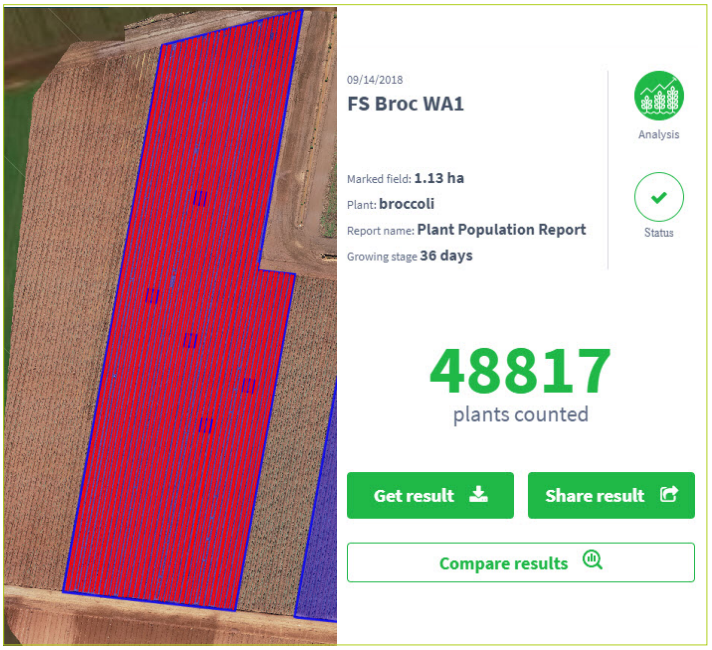

Figure 1. *Example of output for automated plant counts of broccoli in Victoria by Agremo™. Area of automated counts is highlighted in red. Note the 5 small validation plots within the large red area. *Note: subscription charges apply to Agremo™ analyses for areas greater than 10 acres per individual analysis.*

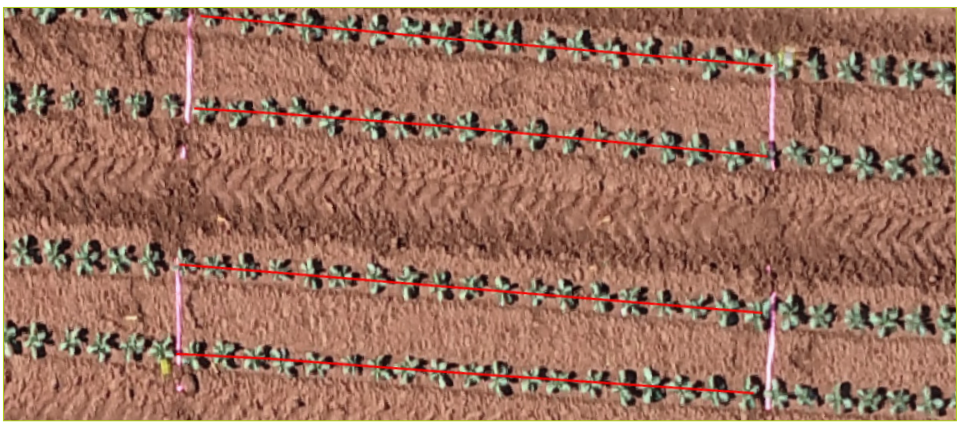

Figure 2. *Small plot to monitor accuracy of automated plant counts in broccoli.*

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The small plot comparison of manual and automated plant counts demonstrated that commerical algorithm analysis of crop imagery can give plant counts that are highly accurate.

Table 1. Comparison of manual and automated plant counts from small plots in lettuce, broccoli and cauliflower.

Reps	Lettuce		Broccoli		Cauliflower	
	Automated	Manual	Automated	Manual	Automated	Manual
1	92	93	72	72	55	55
2	88	89	71	71	56	56
3	91	92	76	75	51	51
4	98	98	72	72	52	52
5	86	86	73	73	54	54
6	85	85	NA	NA	NA	NA
Accuracy	**99%**		**99%**		**100%**	

Accuracy of automated counts

The small plot comparison of manual and automated plant counts demonstrated that commercial algorithm analysis of crop imagery can produce highly accurate plant counts (see Table 1).

Economics

Current UAV operator costs for automated plant counts are approximately $90–100/ha (*as at Dec 2018), plus service provider travel costs. However, new sensors are coming online that capture crop imagery and carry out onboard processing and plant count analyses, which could reduce these costs by up to 50%. However, these new sensors have not yet been validated.

* Note: costs will vary between operators, always ask for a quote.

Limitations

Automated counts by commercial algorithms are generally based on differences between green (plant) and brown (soil) pixels. For accurate counts individual plants cannot be touching and fields must have low weed density.

What does it mean?

For hand harvested crops without yield monitoring capability, accurate automated plant counts have the potential to provide yield estimates. Comparison of these automated counts with packout data may also provide an indication of field recovery and losses in the field.

For more information about 'Adoption of precision systems technology in vegetable production (VG16009)', contact the team:

- Julie O'Halloran: (07) 5346 9528 or julie.o'halloran@daf.qld.gov.au
- Celia van Sprang: (07) 5346 9507 or celia.vansprang@daf.qld.gov.au

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