Practical applications for drones in vegetable production

Department of Agriculture and Fisheries

Mulgowie Farming Company, Victoria and Queensland

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Key outcomes

- Drone crop sensing imagery was used to identify variability and direct field scouting in both green beans and sweet corn.
- Ground-truthing through field sampling revealed differences in biomass, yield and quality in sweet corn and green beans.
- Commercial image analytics were used to estimate maturity in tasselling corn.

Background

Mulgowie Farming Company was interested in drone applications in vegetable systems and how this imagery could provide value to their agronomy team and decision making. In particular, Mulgowie was interested in how various drone imagery can be used for crop scouting and to assess field variability. Mulgowie was also interested in whether this imagery could be used to forecast yield and maturity in sweet corn.

Activities

Drone flights with both RGB and multispectral sensors were undertaken in green beans and sweet corn. RGB imagery was captured using a 21 megapixel digital camera. RGB images of sweet corn were stitched into an orthomosaic and analysed using the commercially available 'Flowering Estimator' algorithms to estimate crop maturity at tasselling. The tasselling field was captured at approximately 7–9 leaf (V 7–9) with a flying height of 22 m AGL with a GSD of 0.5 cm (each pixel is 0.5 cm by 0.5 cm or 0.25 cm^2).

High resolution multispectral crop imagery of both sweet corn and green beans was captured using a drone mounted sensor flown at 120 m AGL with a ground resolution of 8.4 cm GSD (each pixel is 8.4 cm by 8.4 cm, or 70.56 cm^2).

Field sampling was conducted to ground-truth the drone imagery. This included cob sampling for maturity at harvest and yield assessments between high and low vigour areas.

Grower: Mulgowie Farming Company *(pictured is Andrew Johanson, Sustainable Farming Practices Manager)*

Location: Mulgowie, Gippsland, Victoria and Bowen, Queensland

Area: >5000 ha in Queensland, New South Wales and Victoria

What they grow: green beans, sweet corn, broccoli

Soils: alluvial clays

Topography: alluvial flats

Average annual rainfall: 430 mm

Precision technologies implemented: GPS tractor guidance, minimum tillage, drone applications to vegetable systems

"The commercial applications of drone use in farming is exciting and Mulgowie will continue to explore the possibilities."
– Andrew Johanson

Sweet corn tasselling estimation

Commercially-available analytics for estimating flowering was assessed for whether it could be used to count tasselling corn plants at first tasselling, as an aid to estimating yield and maturity. While flowering estimator analytics was not capable of counting tasselling corn plants, it did estimate the area of tasselling across the field.

This tool can indicate differences in maturity, however, it does not indicate how delayed the non-tasselling plants are. At maturity, hand harvested yield samples demonstrated a 25 per cent lower yield (husk off) across the non-tasselling areas. Mulgowie is now interested in this tool to assist in scheduling tasselling sprays.

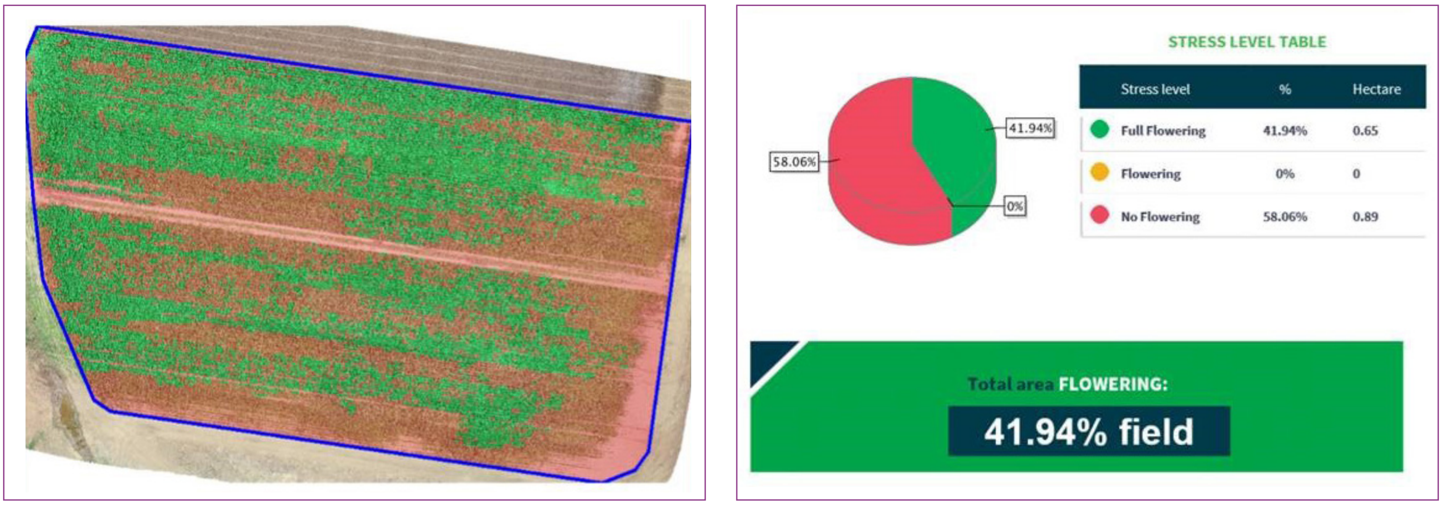

Figure 1. Flower Estimator analysis results in a sweet corn crop at first tasselling. Flowering (tasselling) plants are highlighted green and non-flowering (no tasselling) highlighted red. This analytic tool works by estimating the area of the field that is flowering (tasselling) rather than counting number of flowering plants.

Figure 2. Corn from 1 m length of row from each of the non-tasselling (left) and tasselling (right) areas.

Crop sensing imagery

Multispectral crop imagery of green beans indicated that there was crop variability within planting dates. Ground-truthing by sampling crop biomass from high and low vigour areas revealed that the low vigour area had 60 per cent lower biomass (Figure 3). There was a significant difference in bean set, even at this stage of the crop, which would certainly impact on final yield.

Similarly, multispectral crop sensing imagery of sweet corn also indicated that there was crop variability within planting dates (Figure 4). Ground-truthing in this crop prior to harvest quantified a 30 per cent reduction in biomass between high and low vigour areas and 40 per cent yield reduction between high and low vigour areas. A key difference between cobs from the high and low vigour areas was that those from high vigour areas were more consistent in size and this inconsistency in size likely contributed to the yield variability.

Cost benefit analysis

Costs for the drone imagery and analysis came to $3500, including travel and imagery analysis. This included multispectral imagery for three planting dates of green beans, four plantings of sweet corn, RGB imagery of one sweet corn field for automated plant counts and one sweet corn field at tasselling. In total, 45 ha were mapped, averaging $77/ha.

Challenges and considerations

While crop sensing imagery can provide an indication of variation in crop health and vigour, as well as make use of a range of other image analytics, there are some challenges that need to be considered. These include:

- Consider what you want from the drone imagery as this will determine what sensor needs to be used.
- Ground-truthing is critical to quantify and identify causes of variability.
- Imagery cannot differentiate weeds from crops to provide an accurate estimation of crop biomass, so weed control is important.
- The timing of image capture influences the type of imagery and analysis. For example, in this case study imagery was carried out at 7–9 leaf for the multispectral crop sensing imagery and at tasselling (flowering) for the maturity estimation. If capture is too late in the crop, the crop biomass may saturate the vegetation indices, making it difficult to measure variability. Similarly, too early in a crop and the plants may be too small to gain a good indication of variability or complete different image analyses.

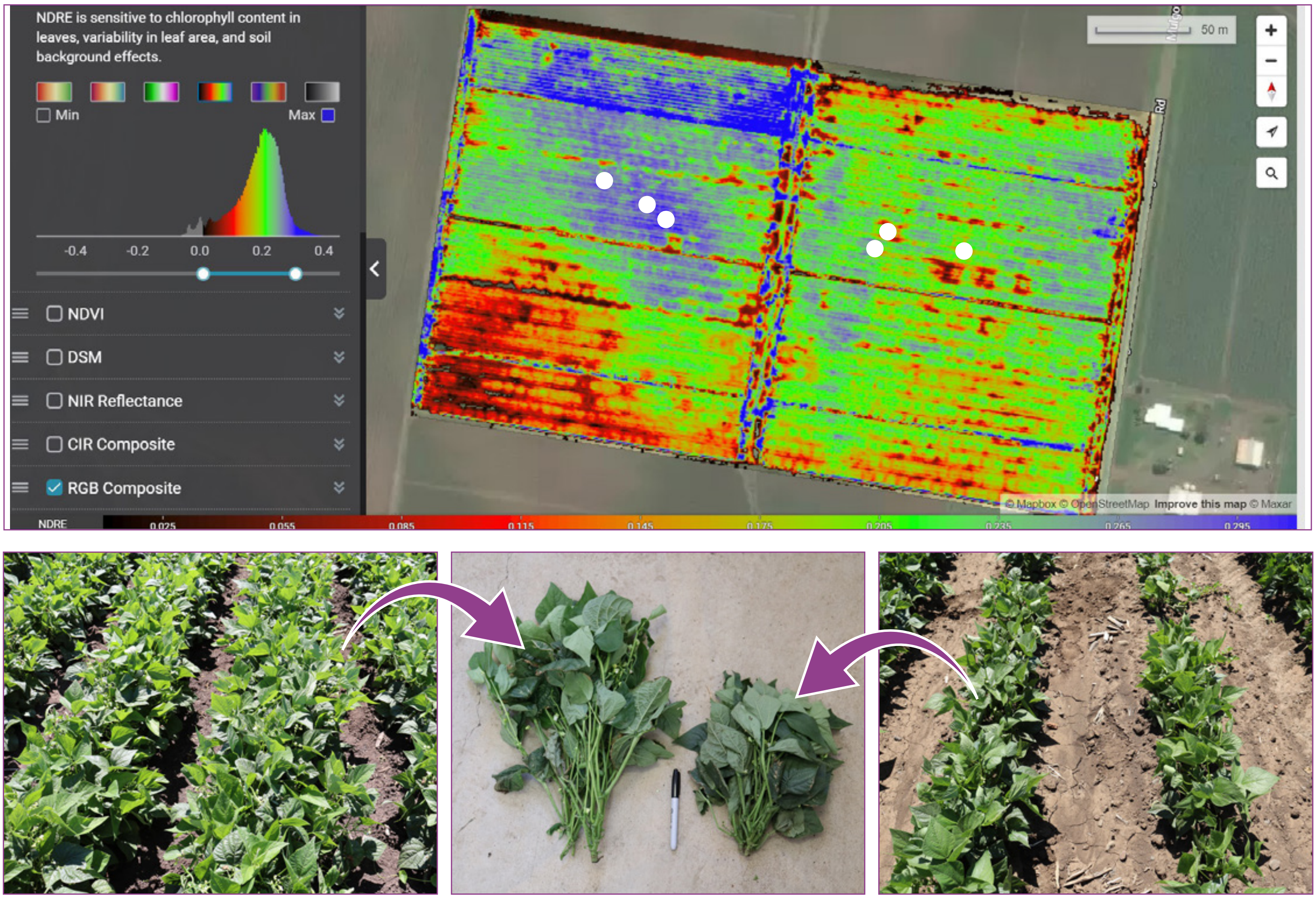

Figure 3. Multispectral crop imagery of green beans (top) with ground-truthing of biomass from high (blue, lower left) and low (red/green, lower right) NDRE areas. White circles denote sampling sites.

Figure 4. Top: Multispectral crop imagery of corn with ground-truthing of biomass from high (red/yellow) and low (blue) NDVI areas. White circles denote sampling sites. Lower left: Corn from 1 m of crop from high vigour areas. Note greater uniformity in primary cobs from high vigour areas. Centre: Plants from high vigour (left) and low vigour (right) areas. Note shorter plants in lower vigour areas. Right: Corn from 1 m of crop from low vigour areas.

Service providers: Airborn Insight

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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.

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