In-season yield prediction using VARIwise

By Alison McCarthy[1], Kieran O'Keeffe[2] and Andrew McKay[2]

AT A GLANCE…

Dr Alison McCarthy, a mechatronic engineer at the Centre for Agricultural Engineering, a research centre within the University of Southern Queensland (USQ) in Toowoomba, has developed a tool that combines in-season, spatial UAV imagery with models to provide yield prediction throughout the season. This research was conducted as been part of the Commonwealth's Rural R&D for Profit project 'Smarter Irrigation for Profit', led by the CRDC, in collaboration with the CRDC's CottonInfo led by USQ's Dr Joseph Foley.

IN-SEASON yield prediction potentially enables improved agronomic management, and planning for the sale of crops and insurance contracts. Yield is currently often estimated using rules of thumb and manual boll counts.

Data analytics approaches have been developed that link multi-spectral satellite images of the field with in-season weather conditions and yield measurements. But the relationship between spectral response and yield are site and season-specific and significant data collection and model development are required to identify relationships for each variety of the cotton and soil type.

An alternative approach is to forecast yield using known soil-plant-atmosphere interactions in crop production models and calibrated using available field data. USQ has developed software 'VARIwise' to provide yield prediction throughout the season combining these models with:

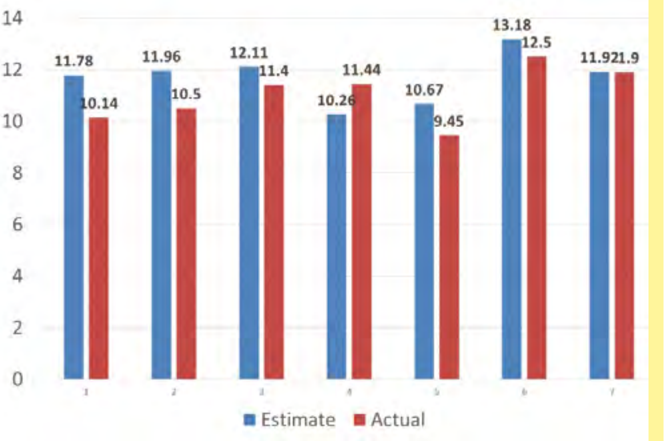
- Plant parameters extracted from UAV imagery using image analysis;
- Online soil and weather data; and,
- On-farm management information.

UAV imagery has potential to improve accuracy of yield prediction over satellite imagery as detailed crop features can be extracted and the timing of plant information collection is controlled. The cost of the sensing system is $2500 for a consumer UAV and labour which would provide data collection for each farm by the grower or agronomist.

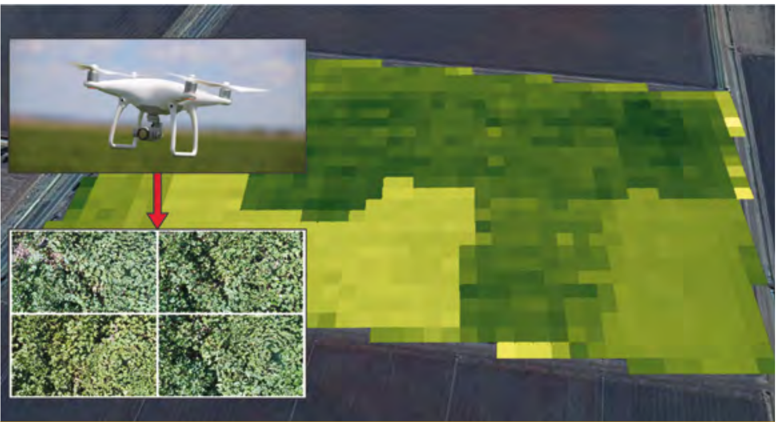
Evaluations have been conducted in Jondaryan, Goondiwindi and Griffith to:

- Identify the impact on yield prediction accuracy from the

FIGURE 1: VARIwise results in seven crops in the MIA in 2019 (b/ha)




Variable-rate centre pivot irrigation machine on the Darling Downs.



UAV and processing for VARIwise yield prediction.

source of the weather or soil data (online or infield) and frequency of UAV data collection; and,

- Evaluate the robustness of VARIwise for yield prediction in multiple regions.

The evaluations to identify impacts of weather and soil data source on yield prediction accuracy were conducted on a centre pivot irrigated field on the Darling Downs. Data was collected from an onsite automatic weather station, electrical conductivity map, soil sampling, soil moisture sensors, weekly UAV and crop assessments. The VARIwise yield prediction accuracy was compared using different combinations of infield and online weather and soil property data sources and frequency and timing of UAV data collection for plant feature tracking. This indicated that infield soil data is more important than on-farm weather data, and that the accuracy improved as the UAV capture frequency increased and season progressed.

The robustness of the VARIwise yield prediction was evaluated at one cotton site in Goondiwindi and 16 sites in Griffith in the 2017–18 and 2018–19 seasons. Management zones in the field monitored using the UAV were identified from vegetation index surveys, yield maps or satellite images. Phantom 4 UAV imagery was collected monthly at each site between January and picking for calibrating the crop model. The sites had varying levels of fruit removal, hail damage and heat stress.

In the 2017–18 Griffith trial, the percentage yield prediction errors were 10.2 per cent in January, 6.0 per cent in February, 2.5 per cent in March, and 0.5 per cent at picking. And in the 2018–19 Griffith trial the errors were 18.8 per cent in January, 4.9 per cent in February, 9.5 per cent in March, and 10.1 per cent at picking.

In the 2018–19 Goondiwindi trial, the yield prediction percentage errors were 8.7 per cent in February, 5.9 per cent in March, 7.1 per cent in April and 2.6 per cent in May. The prediction errors at Griffith were higher in the 2018–19 season than the 2017–18 season because the sites experienced hail and heat stress that are not currently represented within the VARIwise crop model.

In the future, it is expected that the yield predictor would be used by growers or consultants collecting images with UAVs during routine checks, transferring these images to an app or webpage and then receiving an updated yield prediction in mid and late season.

1. Centre for Agricultural Engineering, University of Southern Queensland.
2. CottonInfo, Cotton Research and Development Corporation.
Contact Alison McCarthy at E: mccarthy@usq.edu.au