Drones' activities update at IREC

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Drones have emerged as a powerful and promising tool in agriculture for over a decade. Since then, many drone applications have emerged and proved their reliability, while others are under research and development stages. The first applications of drone imagery in agriculture were to map field variability using vegetation indices like the Normalized Difference Vegetation Index (NDVI) to check crop health, detect disease symptoms, and assist in creating prescription maps to apply variable-rate N fertilizer. Drones can capture high-resolution images from fields, allowing growers to estimate crop health and see field variability. At the Intermountain Research and Extension Center (IREC), I'm testing several drone-based solutions to support growers' decisions as well as research field trials. This article touches on some of the advancements in drone applications in agriculture and IREC activities.

Figure 1: Capturing a drone image from a calibration panel at IREC.

Alfalfa yield mapping techniques:

Mapping alfalfa yield can help growers identify their field variability and improve management decisions. Growers can map alfalfa yield in three main ways: using a hay yield monitoring system located in balers (which costs about $6,000 per system), collecting ground yield samples by hand (which is hard to do and takes a lot of time), or estimating variability through satellite data (which needs a clear sky at a certain crop growth stage). At IREC, a new technique to map alfalfa yield using drone imagery was explored. This technique depends on measuring the distance between bales and forage yield was calculated using the following equation:

$$Yield = \frac{\text{Bale Weight}}{\text{Windrow Width} \times \text{Distance between bales}}$$

Figure 2 shows an example of alfalfa yield measurement using a drone image. This technique can provide an accurate estimation for alfalfa yield in the case of small bales. However, in the case of large bales, this technique loses its accuracy due to the relatively long distance between bales, which doesn't allow for accurate mapping results. Another possible technique for alfalfa yield

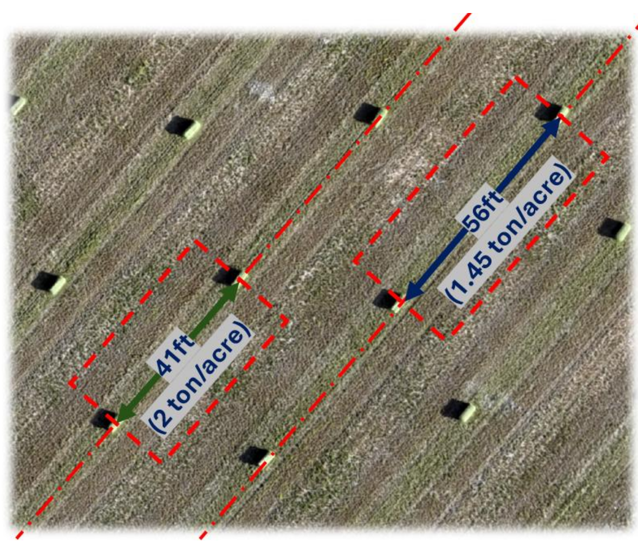

Figure 2: Measuring the distance between bales from a drone image that was acquired after baling.

mapping with drones is measuring the hay windrow volume and subsequently mapping yield variability. This technique was tested in Tulelake, and its accuracy is currently being evaluated for the next two seasons to ensure reliability. This method is better than the first because it doesn't depend on the size of the bale, requires less work from humans to process the data, and gives more yield data points. These factors should lead to more accurate yield maps and definitions for yield zones, but testing is still underway.

Weed density mapping in onions and potatoes:

Another promising drone application is detecting and mapping weed density in potatoes and onions. Last year, we explored the possibility of weed detection using multispectral drone imagery from an onion field. Figure 3 shows an example of weed detection from the onion study field. Also, we explored mapping weed patches in a 20-acre potato field using a new AI tool from the PIX4DFields software. Results matched my field observations but also had significant errors. Mapping weed density has a lot of promise, but I feel this application requires more research and investigation to ensure its reliability, define possible error sources, and maintain a clear workflow for developing weed maps. The most promising solution for mapping weed patches could be early detection of perennial weed patches and difficult to control weeds that growers could spot spray before the weeds become established, spread, and set seed. Early detection of weed patches should also allow more efficient use of the slow and expensive weed robots, and better deployment of hand weeding resources in organic farms.

We plan to test two different weed mapping techniques based on the AI tool from Pix4DFields software and a spatiotemporal analysis technique in the coming seasons. Figure 4 shows preliminary results from last season's activities in a tomato field, comparing the two weed mapping techniques, which we plan to repeat in potato fields in Tulelake.

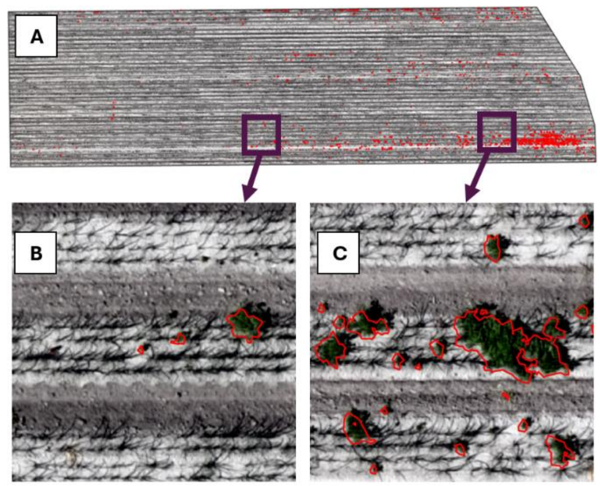

Figure 3: Example of weed detection from an onion field based on multispectral data analysis.

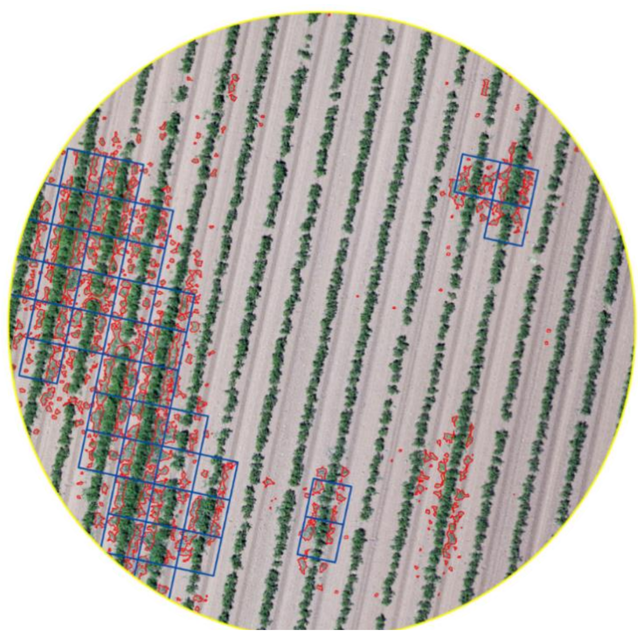

Figure 4: Example of mapping weed patches using the AI-tool from Pix4DFields software (blue grids) and a spatiotemporal analysis technique (red polygons) from a tomato field located in Woodland, CA.

Tracking potato variety trials at IREC

For the last two seasons at IREC, I used multispectral drone imagery to monitor potato variety trials, aiming to have a digital scoring system for potato performance evaluation. For instance, weekly drone images were collected, and vegetation indices were calculated for each variety at different stages of potato growth. This information was used to track each variety's performance throughout the season, which can aid in early disease detection and severity assessments. Additionally, a weekly image of each variety was clipped from drone images, resulting in a digital archive for potato varieties at different growth stages. Breeders scout fields and score each variety for its performance and disease severity, which depends on the breeder's experience. The developed digital archive can be a useful tool for exchanging field observations from field trials between researchers and agronomists, as well as digitally archiving field trials for future comparisons. Moreover, a potato row closure scoring index was developed based on drone imagery. The NDVI was calculated from drone images, a threshold was set to distinguish between soil and vegetation from a 5ft × 15ft sampling frame for each potato variety, the vegetation area in each frame was calculated, and 95% of the vegetation area in each frame was considered as a row closure stage. Figure 5 shows an example for measuring the potato row closure from a variety grown at IREC in the 2024 season. A comprehensive report on tracking potato variety trials is available for the 2023 and 2024 seasons at IREC.

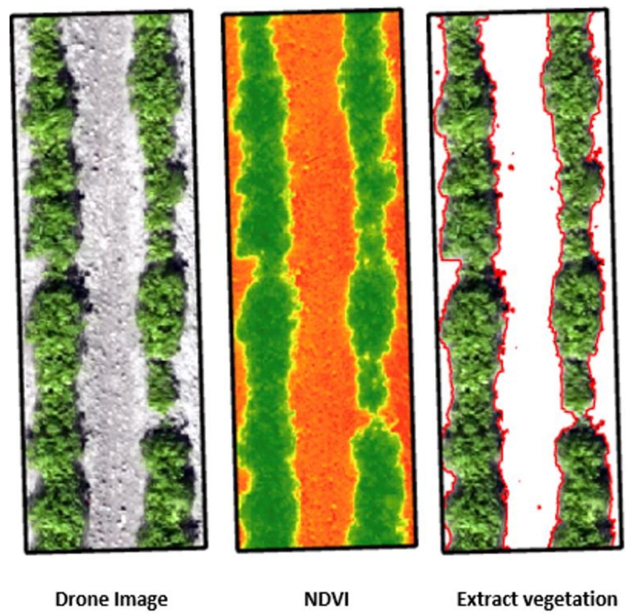

Figure 5: Example of measuring crop coverage area from a drone image acquired on 6/26/2024