Dairy Australia

Drones and Australian dairy farms

Precision dairy technology

Reality check: using drones and cameras to measure pasture growth

Many farmers regard monitoring and measuring pasture growth a time-consuming process. There are a number of ways to do it, such as rising plate meters, pasture rulers, handheld optical sensors, C-DAX bike readers, using your eye and experience … but could flying a drone with a camera do the job faster and more accurately?

In this fact sheet, a dairy farmer and researchers from the Tasmanian Institute of Agriculture (TIA) provide their perspectives. Why is measuring pasture important, and at what point can we rely on drones and sensor technology to do it for us?

At a glance

- Regular pasture monitoring and measurement is not done on many farms, although the benefits of this information are known to be high.
- Drones carrying cameras with special sensors can be used to measure pasture growth, but this technology is still in an early stage of development.
- The biggest challenge for using drones for pasture measurement is having suitable sensors for estimating pasture mass and composition and a simple workflow for the complex image and data processing.
- Current R&D in pasture measurement is exploring new sensor technology such as Active Optical Sensors and measurements of Normalised Difference Vegetation Index (NDVI) combined with machine learning.
- No matter the tool used, correct calibration (relating the measurements made to the actual biomass) is essential.
- While using sensors on drones to estimate pasture biomass in dairy pastures is promising, at present, more traditional methods are as accurate and more time and cost effective.

How many dairy farmers use tools at all?

Effective pasture management is one of the most important aspects of successful dairy production, yet many dairy farmers are not using equipment to measure its growth.

Results of studies conducted by Alison Hall, PhD candidate at the Tasmanian Institute of Agriculture (TIA), and others in New Zealand have found that farmers who intensively measure pasture with a tool over 12 months or so, actually develop their knowledge and skills to a point where they can assess their pasture by eye and rely less on tools.

Flying drones for dairy

Duncan Macdonald, dairy farmer at Yolla in North-west Tasmania and 2017 Nuffield Scholar, is a strong advocate for good pasture management and using the right tools for the job.

'Technology is useless – unless it is being used properly,' he said. 'If you're going to invest in technology, plan how you would use it to help make decisions about pasture management, and then make sure it is used to make it a profitable investment.'

'And that applies whether it's simple or high-end technology.'

In late 2015, Duncan bought his first round of equipment to test the potential of measuring pasture growth using drone sensor technology, at a cost of $5,000 ($2,000 for the drone, plus $3,000 for software and sensors).

Over the last few years Duncan has learned to fly the drone, experiment with the technology, and adapt the software that processes the images. He's developed a workflow that uses data from drone and satellite images for a whole-farm measurement of his pasture cover, and calibrates that with on-ground measurements.

He uses a plate meter to measure the cover of the paddocks the cows are

about to graze, and what's left behind in the paddocks afterwards.

'When you've got the pasture growth data, you sort of relax and know where you are,' he said. 'When you don't, it's a constant daily assessment to try and figure out where you're actually up to.'

R&D associated with measuring pasture biomass

Traditional tools like plate meters or C-Dax measure pasture growth from the ground to the top of the leaves, or 'canopy height'.

Optical sensors carried by drones or satellites can detect specific wavelengths of light reflected from the pasture to get the same information.

Working with farmers like Duncan Macdonald, Gus Alckmin, a PhD candidate at TIA and a member of the TerraLuma 'drone lab' at the University of Tasmania, is exploring which wavelengths of light have the greatest information about the weight and quality of the pasture. This should lead to custom-designed sensors for measuring ryegrass or particular pasture types.

'Just as farmers learn how to eyeball their paddocks to estimate pasture growth, using machine learning and artificial intelligence, our sensors could also 'learn' to do the same.'

But while optical sensors are becoming more reliable, there remains a gap between the data from the sensor and information that's useful for the farmer.

As a member of the TIA pasture research team, Tony Butler wanted to better understand if Active Optical Sensors (AOS) provide an accurate measure of pasture biomass, and how they compare with more traditional monitoring tools such as rulers, plate meters, satellites, and 'eyeballing'.

Working with producers and with funding from Meat and Livestock Australia, he tested the Holland Scientific Crop Circle and the Trimble GreenSeeker. Each of these handheld devices use an optical sensor with its own light source, to detect reflectance of red and near-infrared light from the pasture.

The devices use the light measurements to calculate the Normalised Difference Vegetation Index (NDVI), an indicator of the amount of green biomass. The higher the NDVI number, generally the larger

Benefits of drones

Speed

As the drone can fly at about 40km/hour over paddocks, it's a faster method than using a plate meter or C-Dax. When measuring a transect of each paddock, Duncan can fly over 180 hectares in about half an hour, but then there's the time needed to process all the images.

Ease

Measuring pasture growth using drone sensors is less physically intensive, as the operator can sit in a vehicle observing the drone while it flies, out of non-ideal weather conditions.

View point

When viewing the aerial imagery, he can identify additional management issues or areas to focus on, like patches of thistles, or pivots that are not irrigating properly.

Mud-free

Unlike on-ground methods of measuring with sensors (like using the C-Dax), drone sensors are not physically affected by wet or muddy ground conditions. Light reflectance however might be different under these condition, impacting on the results.

Less bias

Drone sensors remove the human bias associated with selecting the measurement path, as all areas within the images taken along the predetermined path are processed.

Limitations of drones

Colour truthing

Duncan found it difficult to get accurate measurements of dryland vegetation, given that the sensors pick up reflectance from live green vegetation, not from died-off brown vegetation. Readings are also influenced by intensity of colour — for example, bright green growth at end of a regrowth cycle and the brown colours of muddy conditions interfere with accuracy.

Weather

The drone Duncan was initially experimenting with could not be flown in the rain. More advanced drone/sensor combinations that can be flown in rain cost $25–30,000 (compared with the $5,000 he initially invested). Cloud cover and variable light conditions also influence reflectance and therefore the accuracy of pasture growth measurements. Drones should not be operated in high wind conditions (i.e. above 30km/hour). Even in moderate wind conditions, the extra power required to maintain flight must be factored into distance calculations, and flight paths shortened accordingly.

Flight path

Current recreational drone rules specify that an operator must fly the drone within a direct line of sight (about four or five hundred metres).

Technical expertise

Operators need a base level of technical competence to successfully operate the drone and run its updates, as well as interpreting the data processing stage. Duncan understands and adjusts the equations underlying the resulting pasture growth measurements, and continues to problem-solve on his farm.

the amount of vegetation, or in the case of pastures, dry matter yield.

Both the Crop Circle and GreenSeeker showed a high level of potential in accurately measuring biomass for both sward types. The project also demonstrated the need for regular calibration of all pasture tool types as seasons change.

However, at times AOS tools can be saturated with too much green biomass. Sensors that measure 'greenness' can accurately assess pasture cover up to about 2,500 kg DM/ha. Beyond this point however, the changes in 'greenness' are too small for measurements to be accurate.

Sensors struggle with this 'saturation effect' and have difficulty distinguishing between lush green rotationally grazed paddocks, say of 2,800 or 3,200 kg DM/ha. For this reason, the current AOS sensors are potentially not ideal for dairy pastures.

Pieter Raedts is a research fellow at TIA. He's worked as a consultant for dairy farmers and their service providers in Western Europe, and has experience with a variety of farming systems. He says that using drones to estimate biomass in dairy pastures is promising, but not yet more time-efficient or cost-effective than other methods.

'I think it is important to remember that the drone itself doesn't 'measure' anything,' he said.

'The drone is just a machine with a GPS that carries a camera that takes an image using a sensor, and hopefully from that image and the GPS location we can estimate how much grass is in a paddock.'

This requires the use of complicated location and image processing software, calibration data and algorithms, and an efficient work-flow to do so.

'It is challenging to estimate good biomass results from an image. Besides using the right quality sensor, we need the sensors on the drone to measure more than just the 'greenness' of a paddock.'

Research and development is progressing, and improvements are being made both for hardware (drones and cameras improve and becoming more affordable) and software (machine learning for image processing, calibrating algorithms and workflow). The use of internet cloud-based data processing systems helps too.

The future looks promising, and a system that uses images to determine biomass can potentially also open up other opportunities, such as determining pasture quality and soil moisture.

Calibration is critical to achieving meaningful numbers.

TIA's senior extension officer Peter Ball has several decades of experience in advising farmers about pasture and grazing management. He emphasises that any calibration may need to be specific to pasture type, stage of growth and time of year.

Without a working calibration, the numbers an assessment tool generates can quite easily have little value. Calibration gives confidence the measurement has meaning and makes the effort worthwhile.

'If the calibration does not suit your pasture conditions, the numbers any tool yields may not suit your purpose. You may have an expensive, exciting and technically sophisticated tool, but without calibration, the numbers are no better than a guess.'

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