Project Catalyst Trial Report

Smarter Weed Control Using Drone Technology

Grower Information	
Grower Name:	Michael Reinaudo/Mario Porta
Entity Name:	Reinaudo Farming Company/Abergowrie Farming
Trial Farm No/Name:	F#0702A B# 5-3/F#703A B#2-7 Weed control using drone technology
Mill Area:	Victoria, Herbert Region
Total Farm Area ha:	2000ha/1384ha
No. Years Farming: (Grower Experience)	Both families have been farming over 50 years in the region
Trial Subdistrict:	Tara/Seymour/Helens Hill
Area under Cane ha:	1700ha/1350ha

Trial Status

Completed / Continuing

Background Information

Aim:
To use high resolution aerial imagery from RPAs (drones) to map weed infestations in cane and to precisely apply herbicides using drones to treat the infestations of weeds.

Background: (Rationale for why this might work)
This trial would demonstrate the effectiveness, cost savings and water quality improvements of the precision placement of herbicides on the areas of weed infestations only.

Potential Water Quality Benefit:
Reduction in the amount of herbicide applied has the potential to reduce the amount of chemical entering the environment through to runoff into waterways.

Expected Outcome of Trial:
It is anticipated that there would be a reduction in the costs associated with weed control.

Service provider contact: Megan Zahmel: 0447 317 102

Where did this idea come from: Reinaudo Farming Company/Abergowrie Sugar

Plan - Project Activities	Date: (mth/year to be undertaken)	Activities :(breakdown of each activity for each stage)
Stage 1	Establish trial 2019/2020	- Trial farm chosen F#702A B#5-3. Block was chosen after Initial flight survey. - Initial survey flight – 16/04/2020 - Ground truthing – 20/04/2020 - Image processing – 27/04/2020 - Herbicide application – MCPA @ 0.95L/ha & Starane @ 0.8L/ha was recommended but for other reasons Tordon @ 1L/ha was used instead. - Majority of the weeds were Centro & Calypo vine. -13/05/2020
Stage 2	Sampling 2020	- Walk trial block to determine success of drone spraying – 19/06/2020
Stage 3	Re-Establish trial 2021	- Trial farm chosen F#703A B#2-7. Block was chosen after Initial flight survey. - Initial survey flight – 25/10/2021 - Ground truthing – 15/11/2021 - Set up trial design – 15/11/2021 - Image processing – 22/11/2021
	Sampling 2021	- Herbicide application via spot spraying – 23/11/2021 Three different herbicide mixes are being trialled. Herbicide treatment 1 – Gramoxone @ 0.5L, Barrage @ 0.5kg, Wetter, 0.05L. Herbicide treatment 2 – Gramoxone @ 0.5L, Balance @ 20g, Wetter @ 0.05L. Herbicide treatment 3 – Daconate @ 0.7L, Barrage @ 0.5kg, Wetter @ 0.05L
	Sampling 2022	- Ground truthing of Herbicide success – 2/03/2022.

Project Trial site details

Trial Crop:	Sugarcane
Variety: **Rat/Plt:**	Q186/Q200 4th Ratoon 2019/1st Ratoon
Trial Block No/Name:	B# 5-3/B#2-7
Trial Block Size Ha:	5.96ha/1.2ha
Trial Block Position (GPS):	Refer to Google earth maps
Soil Type:	Terrace Loam/Clay

Block History, Trial Design:

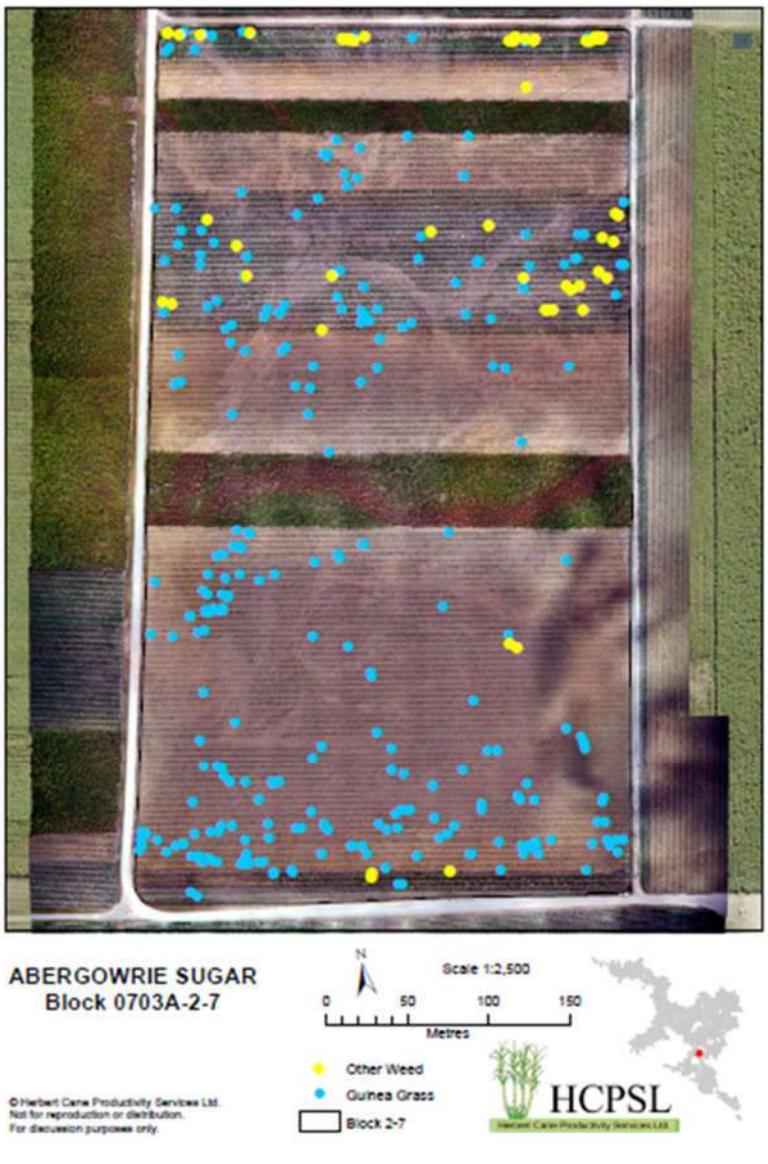
History 2020 trial site: Grower number one has a very large farming area that is spread across the district. By targeting weeds with drone aerial application this would reduce transportation of large equipment from one end of the district to another.

Initial drone flight and weed infestation points on 1st trial site.
The drone flight was conducted, and then specific areas of weed infestations have been mapped via drone imagery
Weed infestation areas within the block. See imagery below:

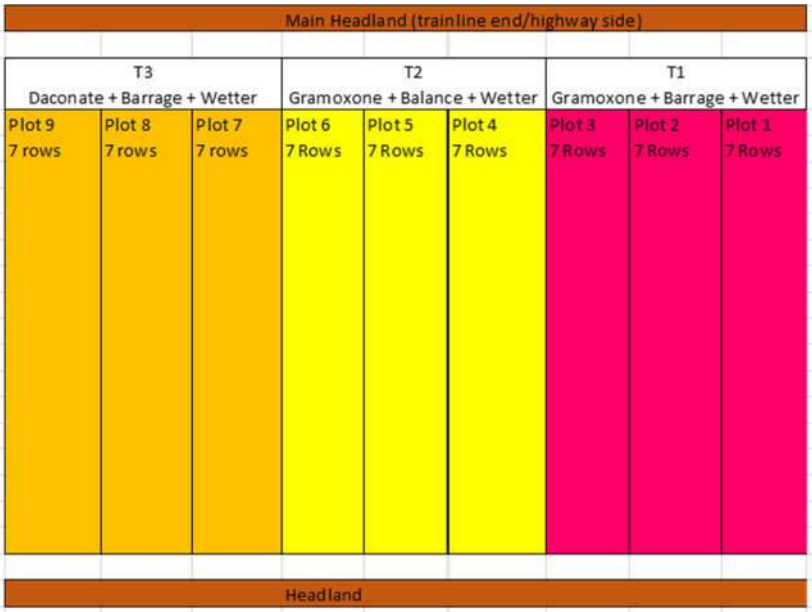
Block History, New Trial design. 2021

History 2021 trial site: Grower number two has a history of certain blocks with continuing Guinea grass issues and would like to reduce herbicide application by using drones to target these specific infestations. Different herbicide mixes are being assessed to determine which mix is the most effective at terminating Guinea grass infestations.

Below is the drone image that has captured Guinea grass infestations on 2nd trial site 2021:



Below is the Trial design for assessing herbicide mix effectiveness in trial site number 2:



Treatment	Product	50 L
T1	Gramoxone	0.5 L
	Barrage	0.5 kg
	Wetter	0.05 L
T2	Gramoxone	0.5 L
	Balance	20 g
	Wetter	0.05 L
T3	Daconate	0.7 L
	Barrage	0.5 kg
	Wetter	0.05 L

Treatments for trial site number 2:

Herbicide treatment 1 – Gramoxone @ 0.5L, Barrage @ 0.5kg, Wetter @ 0.05L. Per 50L water
Herbicide treatment 2 – Gramoxone @ 0.5L, Balance @ 20g, Wetter @ 0.05L. Per 50L water
Herbicide treatment 3 – Daconate @ 0.7L, Barrage @ 0.5kg, Wetter @ 0.05L. Per 50L water

Results:

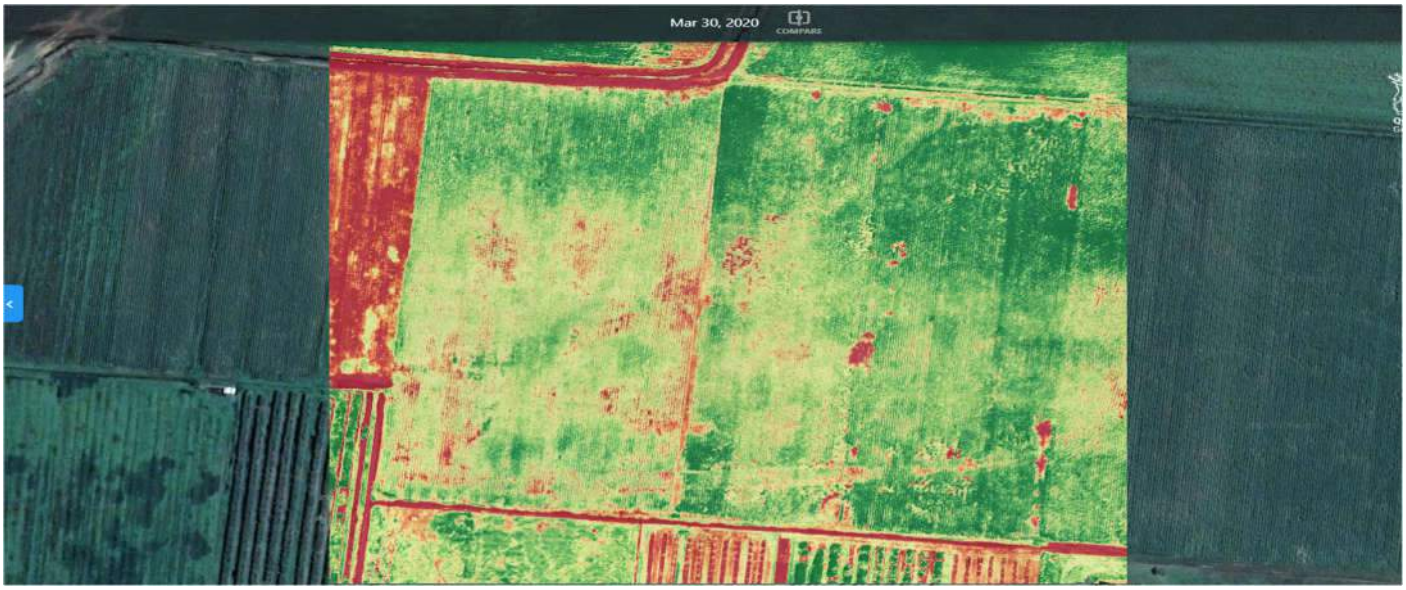
Trial site number 1 used several different satellite imagery spectrums to determine where the weed infestations were located. Below are some of the different types of imagery used on 1st trial site:

Original Imagery:

This imagery was captured by the original drone flight to understand where weeds infestations were accumulating within the trial site.

Below is - Plant Health (VARI) Imagery on trial site #1:

a "Visible Atmospherically Resistant Index (VARI) method is a vegetation index for estimating vegetation fraction quantitatively with only the visible range of the spectrum." VARI which picks up plant health may distinguish/discriminate between weed growth and cane and was used to help determine infestation areas



Below is the Google Earth Imagery from trial site #1:

The below image was used to help distinguish which areas the drone would target and when. Due to spray drone only having a water holding capacity of 10L, each area needed to be individually targeted. This was also used to manage drone battery longevity.

Below is a photo of the Spray Drone about to take off for area number 1, trial site #1:

Left: 10L spray tank is situated underneath the drone. Spray nozzles are situated under the eight blades which was used to apply herbicide to specific targeted areas.

Below is a photo of the spray drone after take off heading towards targeted area for areial herbicide application:

Before image of herbicide application with spary drone on the 1st trial site:

Darker green areas of footage are vines growing in the canopy of mature cane at trial site #1. Drone imagery was zoomed in to maximum available pixels to identify weed infestations.

After Herbicide application with spray drone on the 1st trial site:

3 weeks after herbicide application was applied, a follow up drone flight was conducted to check herbicide effectiveness. As shown below, weed infestation has been reduced but persisting which indicates poor chemical uptake of herbicide application due to several factors as discussed below in "Conclusion" section of trial report.

Below is a section of Calypo vine which after ground truthing inspection were done shows poor effectiveness of herbicide application with the drone on trial site #1: Small amounts of chemical damage can be observed with no real affects or die-off of targeted vines.

Below is an off-target area that was not captured by original drone inspection. By missing weed infestations in the original drone inspection, this has allowed an outbreak to occur which could potentially cause larger problems for the grower in the future of weed management.

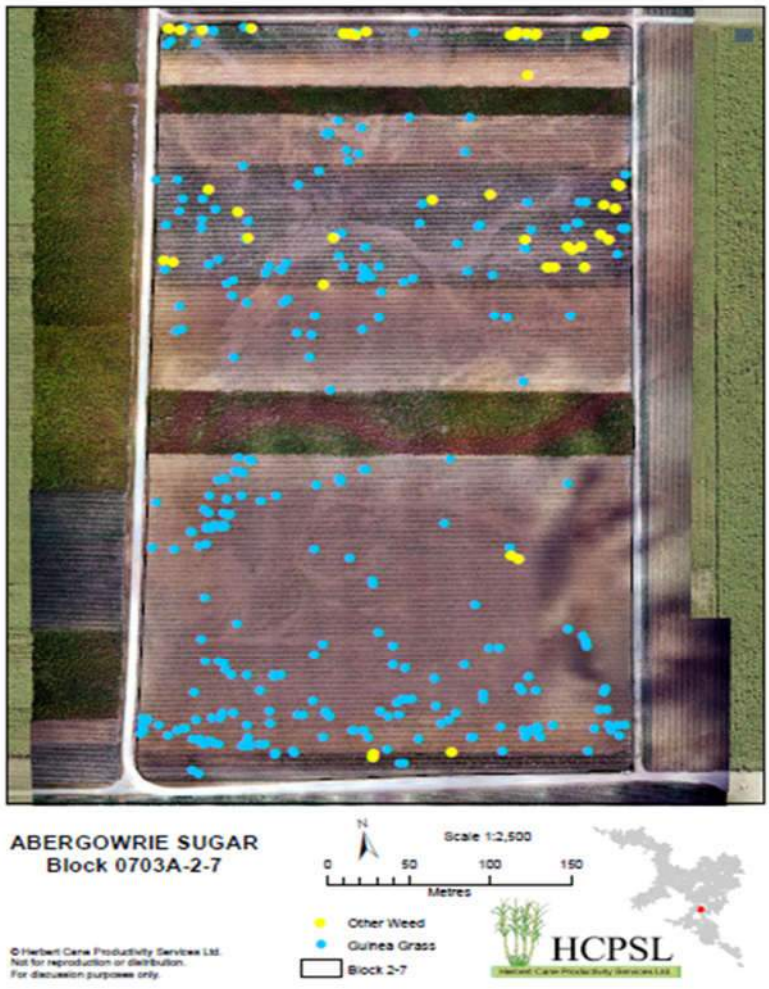

Missed this part from imaginary

Results for Trial site #2

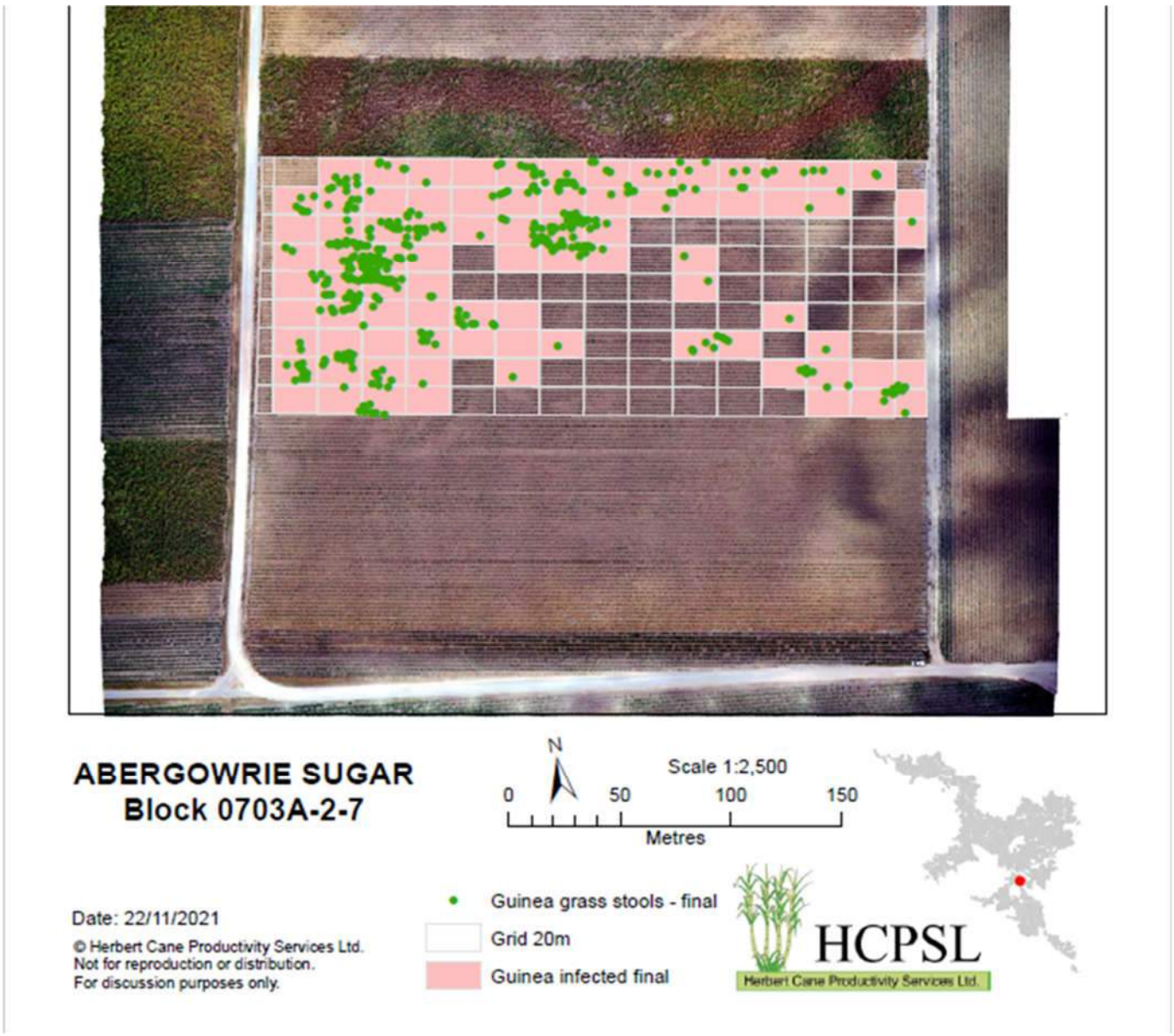
After results of the first trial were discussed it was decided that trial site #2 would have a different approach while still using the drone's capacity to scout for weed infestations. Grower number two wanted to target Guinea grass infestations in a smaller cane crop using the drone to find and map infestations, but targeting the herbicide application via ground riggs. It was decided that using the drone in a smaller crop would lessen the chance of weed infestations being missed due a closed over canopy that larger cane creates. After intial drone flights had taken place ground inspections were conducted using handheld GPS systems to locate Guinea grass stools within the trial area. Ground truthing identification was then overlaid with drone footage identification to understand how effective using the drone imagery to capture Guinea grass infestations were. Ground inspections identified 30% more Guinea grass stools then the drone imagery, suggesting that using drone footage to map Guinea grass was not overly effective and that a camera with a higher resolution and smaller pixel capcacity would be needed for future trial success.

Below is the drone image that has captured Guinea grass infestations on 2nd trial site in 2021:

Blue dots represent Guinea grass stools capture by drones imagery and yellow dots represent other broadleaf weeds identified by drone imagery.



Below is the map of Guinea Grass stools captured by groundtruthing. After ground inspections were completed a prescription was created for the tractor application of herbicides on 2nd trial site 2021:



Below is a photo of the grower spot spraying herbicide using the GPS prescription map and the treatment one herbicide mixture. Trt 1 = Gramoxone @ 0.5L, Barrage @ 0.5kg, Wetter @ 0.05L. Per 50L water

Herbicide Efficacy Results March 2022.

The other component to trial site #2 was to evaluate the effectiveness of different herbicide mixtures to see which mix had the best results in terminating Guinea grass. Ground inspections were done to rate herbicide effectiveness. A scale of 1-5 was used; 1 = extremely poor uptake of chemical, 5 = extremely good uptake of chemical resulting in a dead guinea grass stool. Below is a grid record of herbicide effects.

The trial site runs left to right, with Treatments running in columns of four left to right. Treatment one = four columns at the top of the image, treatment 2 = four columns in the middle of the image and treatment 3 = four columns at the bottom of the image. No statistical differences were recorded between herbicide mixes. (Herbicide mixes are detailed in the beginning of the report in “Treatments” section.)

Conclusions and comments

2020 Conclusion on trial site #1– The trial confirmed that the use of spray drone technology was not successful in controlling vines and weeds in a large standing cane crop.

The technology should be considered for scouting and mapping of weed populations, during fallow periods or to target specific weeds like giant sensitive plant (GSP) which occurs in patches within a field and that are easy to target.

The reasons for the use of drone technology failing to deliver appropriate outcomes was due to:

- The area that was sprayed with herbicide was still alive upon inspection with plants showing sub lethal dose affects due to poor uptake of the herbicides. The mediocre performance of the herbicide can be attributed to; the low water rates used by the drone, an inappropriate herbicide mix being used, and the growth phase of the weed being targeted (in this case Calypo).
- It is thought that the weed termination rate was low due to the recommended chemical not being applied.
- The block was treated with 1L/ha of Tordon 75D. Future work should consider using 2,4-D, Starane and Tordon 75D mixes to target problematic weeds like Calypo and Sicklepod.
- When ground truthing was undertaken it was noticed that juvenile weeds like young blue top had died within the sprayed areas. Imagery failed to identify small young weeds growing in the low canopy and these areas were therefore missed.
- By missing small young weeds with the imagery in the initial inspection, these established and became weed issues later.
- Herbicide application with drones could be potentially better utilised in smaller cane, targeting broadleaf weeds like Sicklepod and Giant Sensitive Plant (GSP) or used as a mapping system which can than relay a prescription to the tractor for precision herbicide spraying.

2021 Conclusion on trial site #2 – The use of drones to map weed infestations failed to positively identify Guinea grass stools within a block after ground truthing was undertaken.

- Initial issues with the drone's imagery being able to accurately identify Guinea grass stools.
- Ground truthing identified an extra 30% infestations compared to the drone imagery.
- Several stools of Guinea grass where still missed during spot spray applications, suggesting that a RTK GPS system to map the grass stools was needed and standard GPS systems were not accurate enough.
- Herbicide treatment #1 had the most promising results for controlling Guinea grass stools, though there were no statistical differences between herbicide mixes.

Advantages of this Practice Change:

2020 advantages for trial site #1 - Less herbicide was required for weed control. The use of drones can assist with the application of herbicides in certain situations. The technology will allow growers to gain access to a block during wet weather events and reduce the issues of transporting large equipment around the district.

2021 advantages for trial site #2 - Reduced amounts of herbicide will reduce herbicide costs and lead to an improved water quality outcome. By trialling different herbicide combinations, the most effective herbicide mix can be used to effectively manage weeds.

Disadvantages of this Practice Change:

2020 disadvantages-

- The appropriate licencing will be required for a grower to undertaken herbicide applications via a drone; this could be a barrier to adoption. The alternative to a grower undertaking the herbicide application is for a grower to hire an appropriately licenced and trained contractor to undertake the weed control activity.
- Drones have limited water holding capacity to undertake large infestations making aerial application by larger aircrafts more cost effective**.** Drones would be more effective in small infestation areas. Water volumes applied also makes it difficult to achieve effective weed leaf coverage (especially on problematic weeds like Calypo).

2021 disadvantages-

- Drone imagery used by HCPSL was unable to effectively capture a clear image of Guinea grass stools to accurately map the trial site. More accurate drone imagery will be needed for future work.

Will you be using this practice in the future?

2020 Conclusion - Yes, but with a different approach. Looking to target broadleaf weeds in younger/shorter cane. The grower is wanting to use the drone imagery to map the weed infestation then use this to create a prescription that can be uploaded to the tractors GPS system and target Guinea grass and nutgrass areas.

2021 Conclusion - HCPSL is looking into upgrading their drone imagery software and cameras. Until this time, imagery used to capture Guinea grass is not reliable enough to give confidence to effectively identify weed plants.

% Of farm you would be confident to use this practice:

2020 Conclusion - Still trialling different approaches to best use drones and herbicides.

2021 Conclusion - The idea has promise for future work and is something the grower will follow with interest. At this stage, the grower will continue to trial such ideas.