

# **Drone weed mapping for spot spraying: Know what's there before you spray – consistent weed detection driving down the weed seed bank**

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## **Key words**

Single Shot, weed, detection, drone, optical, spray, fallow, technology, IWM

## **Take home message**

The Single Shot drone-based weed detection sensor allows farmers to manage weeds more cost-effectively in fallows. Decoupling weed mapping from spraying allows more informed decision making, resulting in more effective and consistent weed detection with minimal false positives, as well as enabling future technologies such as robotic and drone spray systems.

Australian grain producers are almost exclusively reliant on herbicides for weed control in fallow situations, particularly if we want to avoid the aggressive soil disturbance from cultivation that results in unacceptable moisture loss and soil structure decline.

To remain sustainable our challenge is to overcome increasing herbicide resistance along with herbicide tolerance and weed species shift.

While the development of non-herbicide solutions for weed control, such as microwave, bio-control and novel genetic solutions may be in the pipeline, the cornerstone of cost-effective weed control is still herbicide based.

Recognising this, our family looked for solutions to enable us to carry out site-specific weed management in our fallows. One which would allow us to map individual plants so we could treat individual weeds in a broadacre farming system, giving us another tool to manage herbicide resistance and maintain cost-effective weed control.

This resulted in us building our own solution, the team, which includes our family along with robotic specialists has, over the last ten years, developed the Single Shot drone-based weed detection sensor.

Used commercially on our farm for more than two years, Single Shot is capable of mapping 200 hectares an hour, consistently picking up weeds to the size of the top of a beer can. The information is then processed locally with minimal uploads/downloads to the internet, allowing the same day production of a weed map.

These weed maps can then be loaded into any compatible GPS section-controlled sprayer, allowing cost effective spot spraying without the need for a dedicated optical sprayer.

Spot spraying is fast becoming a cornerstone of our integrated weed management program. The ability to legally use spot-spray registrations and rates helps ensure effective weed kills, minimising the use of sub-lethal broadacre rates on hard to kill weeds. Accurate and consistent weed detection minimises escapes and the area to be sprayed can be assessed prior to application, a legal requirement for many labels.

## **Weed mapping before you spray**

While a single pass with a traditional optical sprayer has the benefit of being 'turn-key' ready to drive out to the paddock, decoupling the weed detection process from the spraying process provides significant practical advantages to me as a farmer.

Firstly, you can decide whether you need to spray, you can choose how you want to spray – be that as a blanket, a spot spray or a combination, you can choose the size of weed you are targeting – with instant feedback on the percentage of the paddock you will be spraying.

We have found on some occasions there were a lot more weeds in the paddock than we thought and we were able to make the decision to use a blanket application as opposed to only finding out there are too many weeds halfway through an application with existing technology.

The technology also allows me to fly a paddock to detect if there are any surviving weeds after a spray application. Surviving weeds have a higher probability of being resistant. If weeds are detected, I then have a weed map I can use to enact control measures from a different herbicide group.

Knowing how much of the paddock I am going to spray before I mix the chemicals allows me to adjust herbicide choice and rates to manage costs. It also decreases waste and increases efficiency.

Mapping ensures you are meeting regulatory requirements – as you know what percentage of the paddock you will be spraying at the labelled optical spray rates.

A big advantage of the Single Shot system is that you are not limited in nozzle choice compared to existing optical sprayers. This makes it far easier to meet regulatory requirements and maximise spray efficacy.

Decoupling the mapping from the spraying means the prevailing light conditions have no influence on application timing, increasing flexibility.

### **Ancillary uses – the sky's the limit**

As with most new technologies, ancillary uses are still being discovered. A recent commercial example was mapping surviving weeds in autumn, that had set seed, so only the areas with weed seed set could be spot sprayed in spring with a pre-emergent herbicide.

It is also possible to make a map from multiple passes so that every weed detected from multiple passes in one season could be combined in a map and used to apply pre-em's at the beginning of the next season.

From a green-on-green perspective the system has been used to identify large surviving weeds in early-growth stage wheat crops, opening up control options that wouldn't normally be viable on a broadacre scale.

The system is currently being developed to measure cotton establishment with the aim of developing a tool to determine if and what areas of a paddock would be justified replanting. It has also been used to create Digital Elevation Models (DEMs) of irrigation paddocks quickly and cost effectively.

There are opportunities in terms of identifying weeds in skips of row crops, which can then be effectively used as a green-on-green application.

After mapping all the weeds in a paddock we can apply the travelling salesman algorithm to calculate the shortest path between weeds in the paddock. This is the enabling technology needed for novel weed control systems that can be robot mounted, without the need to travel the whole paddock in rows.

It will also enable spray drones to be used more effectively, significantly reducing the flight length and spray volume required to cover all weeds as opposed to the whole paddock.

## Barriers to adoption

As with any new technology, there are some hurdles to overcome. To operate many drone based systems, an easily obtainable drone pilot licence must be held.

Organisation is important, while producing a spray map the same day as the drone flight occurs is possible, you do need to plan ahead and have the maps prepared before you start spraying.

To successfully adopt the system, the user also needs to have access to a boom spray compatible with the software used on the drone system – including having a compatible GPS section controller and the ability to maintain spray rates when sections are turning on and off for brief moments.

However, on our farm we have found these hurdles easy to overcome and well worth the time invested. This technology is very new, we are still finding new ways to use the information generated to benefit our farming system.

## Case Study - Tigah Farming

To date on Narratigah, we have only used Single Shot for stand-alone spot spray applications, using our existing 36m Goldacre's trailed sprayer without making any modifications. Table 1 summarises applications we have made using our booms. These booms only have 7 sections and require a significant lead in time to ensure the section is fully open when it passes over the weed. Other users with more suitable booms have reported significantly higher savings and efficiencies.

The table is not completely valid in that we potentially would have chosen different herbicide mixtures if we were making blanket applications, but it does give an idea of the savings that can be achieved without making any modifications to the boom.

**Table 1.** Savings with current unmodified booms

Total area covered	Total area sprayed	Percentage spot sprayed	Average chemical cost if blanket per ha	Average herbicide cost saved per ha	Total savings before drone costs
4837ha	1018ha	21%	\$15.95	\$12.20	\$58,197

Recently we have added a dedicated spot spray line to one boom with 18 x 2m sections, incorporating valves that turn on and off virtually instantly. This will give us the ability to spot spray and blanket spray simultaneously. Using the spray simulation function on the Single Shot software, Table 2 summarises the savings we expect to make with the new spray line compared to using the booms without modification.

The figures are from a real life example of a paddock we flew in March 2021. Using our boom without any modifications to the existing 7 section line, we spot sprayed 14% of the paddock. By going to 18 sections with fast acting valves we would have sprayed 9% of the paddock representing a 35% chemical saving.

When these additional savings are added to the savings in Table 1 and coupled with a much higher use pattern compared to stand alone applications only, it highlights the significant value this system will provide to our operation.

**Table 2.** Expected additional savings with boom modifications

Paddock size	Area to spot spray		Percentage of paddock to spray		Percentage reduction from modifications
	7 Section	18 Section	7 Section	18 Section	
189ha	26.7ha	17.3ha	14%	9%	35%

I anticipate the majority of future fallow spray passes will be made using a blanket and spot spray simultaneously. This will be extremely cost effective in terms of maximising efficacy, minimising herbicide cost and minimise the number of passes we make over a paddock.

By mapping existing weeds, prior to a germination event, the spot spray application can be tailored to the larger weeds, while cost-effectively applying a blanket targeting newly germinated weeds.

Even with relatively high densities of existing weeds the sensitivity can be adjusted to only target larger weeds, with a target of spot spraying 15 per cent of the paddock as an example.

### **Conclusion**

Ultimately to achieve sustainability, as a farmer I want tools that make it cost-effective to achieve as close as possible to 100 percent season-long weed control in fallow before seed set with greater diversity of control options. The combination of being able to spot spray and knowing the percentage of the paddock I'm going to spray, allows the utilisation of modes of action at rates not viable as blanket applications.

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