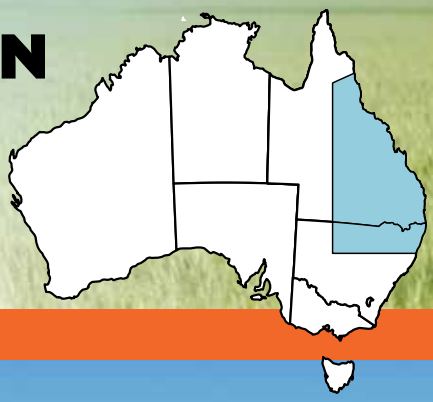
WEED smart

every weed every seed
every farm every year

NORTHERN REGION



EVERY WEED. EVERY SEED. EVERY FARM. EVERY YEAR.

Herbicides have delivered vast improvements in weed control for Australian farmers, improving yields, boosting profits and making no-till farming possible.

But herbicide use as we know it is under threat. Conservation farming has made us overly dependent on herbicides, and resistant weeds are threatening over 20 years of productivity gains.

It is time to act and protect the good work of Australian farmers in combating weeds.

Herbicides might seem like a fool-proof solution, but weeds can become resistant, which threatens herbicides' effectiveness on individual properties and more broadly throughout the northern cropping region.

Although growers have a range of options at their disposal for slowing down herbicide resistance, combining strategies in a long term plan is the key to success.

Crop rotation, weed monitoring, pre-emergent sprays, herbicide rotations and sowing weed-free seed are all measures that can be used across different farming systems to attack weed populations from different angles and prevent weed emergence, preserving herbicide effectiveness for the future. However, using different and varied techniques means that growers and their advisors need to accept a broad approach to farm planning.

That is why farmers in Australia's northern cropping region need to draw on the range of measures available in their anti-weed tool box. Driving down weed seed banks and maintaining a sustainable long term strategy is the key. A mix of chemical and non-chemical measures can help keep crops clean and productive – herbicides can't do all the heavy lifting.

TOOLS FOR HERBICIDE SUSTAINABILITY

This booklet sets out a number of tools that growers in northern New South Wales and southern and central Queensland have at their disposal to tackle weeds effectively and halt the spread of herbicide resistance.

- PLANT CLEAN SEED
- CROP COMPETITIVENESS
- STOP WEED SEED SET
- CAPTURE WEED SEEDS AT HARVEST
- TEST FOR RESISTANCE
- ROTATE HERBICIDES
- AIM FOR 100% CONTROL
- DON'T AUTOMATICALLY REACH FOR THE GLYPHOSATE
- NEVER CUT ON-LABEL HERBICIDE RATES
- DOUBLE KNOCK

PLANT CLEAN SEED INTO CLEAN PADDOCKS WITH CLEAN BORDERS

Ensuring that the seeds you retain for future planting are weed free is fundamental to ensuring a pure seed bank. Preventing weeds from making it to your next crop is vital, and, should they endure in-crop, your last line of defence is the use of gravity tables, rotary screens and sieves before sowing. Take special care when cleaning seeds that are more vulnerable to weeds – like wheat – to keep the odds of weed infestation low.[1]

Keeping your paddocks weed-free is also important as part of your long-term strategy. One method of ensuring this is using fallow periods to get on top of weeds. Without competition from crops, weeds can thrive. While non-selective herbicide can be a tempting first response to address weeds during a fallow period, this can lead to certain weed varieties growing more resilient in the long-term. Residual herbicides can be useful, especially when pre-plant tillage is not an option, but application will vary between crop types. Tillage, burning, mulches and cover crops are also weed control options, but will not be viable in certain conditions.[2]

Weeds often thrive along fencelines, where herbicides can be over-used. By slashing and mowing along fenclines, cropping as close to fences as possible and removing redundant fencelines, you can reduce your reliance on herbicide to keep fencelines weed-free.[3]

Keeping track of where different weed species emerge around the farm is also important, so weed scouting during a fallow period and beyond

can be useful for knowing where different species are moving in and planning your response to limit the spread. Above all, it is important that you are not planting into fields which have established weed problems – doing so increases the likelihood of weed populations continuing to thrive and spread herbicide resistance.[4]

EMPLOY CROP COMPETITIVENESS TO COMBAT WEEDS

Making it harder for weeds to establish is something that will need long-term commitment and adherence to certain practices, but will be well worth the effort. Such measures include:

- Increasing crop density with higher seeding rates and narrower row spacing
- Selecting cultivars that are naturally competitive with weeds
- Using early or late plantings, depending on conditions, to give your crops an edge
- Rotating crops to prevent dominant weed types emerging
- Combining irrigation and tillage or herbicide before planting
- Using cover crops or mulches to smother weeds

By adopting competitive measures into your cultural approach to cropping, you can reduce the weed seed bank by making conditions as tough as possible for weeds to establish. Some weed species, like common sowthistle and fleabane, are particularly vulnerable to a competitive crop.[5]

ACT NOW TO STOP WEED SEED SET

Once resistant weeds have set seed, the seed will deposit into your seed bank, which will cause problems in future seasons. Your goal should be to stop as many weed seeds from setting as often as possible. This means using a wide variety of tactics, including: pre-emergent herbicides, crop competition and 'double knocking' tough weeds, before weed seed-set.

Using pre-emergent herbicides – Spraying herbicide before weeds emerge, before or straight after sowing and during fallow, can be useful in preventing weeds establishing. Pre-emergent herbicides reduce the number of weeds germinating in the crop and fallow and take pressure off post-emergent herbicides and other tactics.

Most pre-emergent herbicides require moisture from soil or rain to activate. Some need to be incorporated into the soil to reduce losses. Pre-emergent herbicide will be most effective if the soil is disturbed as little as possible prior to seeding, which leaves weed seeds on the surface, ready to take up the chemical as the weed emerges. Using residual herbicides in fallow can also be an effective option, and could save you from having to spray while in-crop later on.[6]

Pre-emergent herbicides can be added as a mix partner in a double knock to provide longer-term control of weeds. This approach has been used successfully to control fleabane in summer fallow prior to winter crop sowing.

CAPTURE WEED SEEDS AT HARVEST

Killing weeds when they emerge is one thing, but making sure they never emerge is even better. By eliminating weed seeds from your soil, you are already working to get rid of established weeds. Although capturing weed seed at harvest will not minimise any damage already caused, it will add to your long-term goal of reducing the weed seed bank.[7]

Getting the most out of manure – Green and brown manure offer a handy tool for tackling weeds while adding more nitrogen to soil.

Both green manure – where plant material is cultivated into the soil – and brown manure – desiccating a crop with a non-selective herbicide – are viable weed management tactics, as well as a valuable non-chemical option. The aim is to achieve 100% weed seed set control.

Using manuring in its cultivated or no-till form will greatly reduce the seed set, and while not as practical as herbicide, is an effective way to deal with weed patches. The best time to apply this tactic is when the weed is between mid-flowering to early seed-set. Green manuring needs to be incorporated slightly earlier than brown manuring, before the maturing seed finishes its milk stage, as seeds can continue to mature after desiccation or cultivation.[8] You need to ensure any new weed germinations are controlled by a follow-up spray or other control technique.

Silage and hay – Making silage or hay can greatly reduce your weed seed bank and prevent weed blowouts. This measure is not only an effective control technique, but can turn certain weed varieties' nutrients into a benefit.

Before cutting for silage or hay, two important factors you need to consider are weed type and timing.

Whether or not you will be able to make beneficial hay or silage will depend upon what weed variety you are targeting. For instance, annual ryegrass and wild oats are ideal candidates for hay or silage, although you need to ensure that there is no toxicity present in your ryegrass.

An advantage of cutting for hay or silage to control weeds is that you can vary it according to how weed types in your paddock mature. That means tracking weed growth rather than cutting according to what time of year it is. If you cut too early, certain varieties can regrow and set seed. If you cut too late, then mature weeds may well have already set seed. You need to time it just right.[9]

Although cutting silage and hay can be highly effective, it also presents a risk of weed seeds spreading. You need to ensure that the transport used to deliver your feed is cleaned in a designated area after it has been unloaded. If you are receiving hay or silage, make sure that you feed your stock in a confined area, monitor your feeding areas for unfamiliar plants and keep records of your hay and silage purchases.[10]

Managing chaff fractions to target weed seeds – Capturing weed seeds at harvest and burning, crushing or baling the chaff fraction, are common and effective practices for reducing weeds in the seed bank in the western and southern cropping regions of Australia. Recent northern region weed surveys at crop harvest have shown many weed species are surviving in-crop treatment and setting seed at harvest time. Managing chaff fractions may play a future role in reducing these weed seeds once the practice is defined and tested in this region. By targeting the weed seed that ends up in a chaff fraction at harvest, you can do a great deal of damage to the weed seed bank, making for a great non-chemical option in your long-term toolbox.

Chaff, along with weed seeds, often ends up heaped in paddocks to be burnt the following season or used for feed. However, there

are more efficient measures that growers can take to maximise the opportunity chaff fractions offer to break the weed seed bank.

Windrow burning, by funnelling chaff into windrows at harvest, can set up prime conditions to destroy weed seeds when burning residue in autumn. This practice concentrates fuel and heat during a burn, which means it is more effective than burning chaff piles.

Systems for baling and chaff grinding are available for purchase in Australia. Baling removes weed seeds and provides a significant feed source. Chaff grinding with a device like the Harrington Seed Destructor crushes seeds at harvest, leaving seeds unable to grow and removing the need to bale or burn straw or chaff.[11]

However, if you use burning, baling or chaff grinding in your anti-weed arsenal, be prepared for the fact that these measures will not return any benefit to your soil. Using chaff carts or windrow burning will remove crop residue, which will mean less nutrients, like potassium, and carbon will be available in the soil for your next planting.

TEST FOR RESISTANCE TO ESTABLISH A CLEAR PICTURE OF PADDOCK-BY-PADDOCK FARM STATUS

There are many ways you can react to herbicide resistance when it arises, but it is important that you take a proactive approach and monitor your weeds. Weed scouting and testing to see what herbicides are going to be effective is critical. If you encounter an uncontrolled weed patch – be sure to check that your herbicide program is effective against the weed types you come up against – then testing at the earliest opportunity is advised.

TABLE 1. TYPICAL NUMBER OF YEARS OF HERBICIDE APPLICATION BEFORE A POPULATION IS RESISTANT (BASED ON PRESTON ET AL 1999)

HERBICIDE GROUP	TYPICAL YEARS OF APPLICATION	RESISTANCE RISK
A (fops/dims)	6-8	High
B (SUs, IMIs, sulfonamides)	4	High
C (triazines)	10-15	Medium
D (trifluralin, dinitroanilines)	10-15	Medium
F (diflufenican)	10	Medium
I (phenoxys)	10+	Medium
L (paraquat/diquat)	>15	Medium
M (glyphosate)	15	Medium

TABLE 2. KNOWN HERBICIDE-RESISTANT POPULATIONS IN THE SOUTHERN GRAINS REGION.

Weeds appearing in this table have had herbicide resistance confirmed through testing. Therefore, if a weed does not appear in the table, it does not necessarily mean that it is not herbicide resistant.

Weed species	Herbicide group (See Table 2)	Example herbicide
Grass weeds		
Annual ryegrass	A – 'fops'	diclofop
	A – 'dims'	clethodim, sethoxydim
	B – sulfonylureas	chlorsulfuron
	B – imidazolinones	imazapic, imazapyr
	C – triazines	simazine, atrazine
	C – ureas	diuron
	D – dinitroanilines	trifluralin
	L – bipyridyls	paraquat
	M – glycines	glyphosate
	Q – triazoles	amitrole
Barley grass	A – 'fops'	haloxyfop, fluazifop
	A – 'dims' clethodim,	sethoxydim
	L – bipyridyls	paraquat
Brome grass	A – 'fops'	haloxyfop, quizalofop
	A – 'dims'	clethodim, sethoxydim
	B – sulfonylureas	chlorsulfuron
	B – imidazolinones	imazapic, imazapyr
	M – glycines	glyphosate
Fleabane	M – glycines	glyphosate
Large crabgrass	A – 'fops'	fluazifop, haloxyfop
	B – imidazolinones	imazethapyr
Paradoxa grass	A – 'fops'	fluazifop
	A – 'dims'	sethoxydim
Serrated tussock	J – chlorocarbonic acids	fluproponate
Silver grass	C – triazines	simazine, atrazine
	L – bipyridyls	paraquat
Wild oat	A – 'fops'	diclofop
	A – 'dims'	tralkoxydim
	B – sulfonylureas	iodosulfuron-methyl-sodium
	Z – arylaminopropionic acids	flamprop-methyl
Windmill grass	M – glycines	glyphosate
Winter grass	Z – dicarboxylic acid	endothal
Broadleaf weeds		
Arrowhead (rice)	B – sulfonylureas	bensulfuron
Bed straw	B – sulfonylureas	chlorsulfuron
	B – imidazolinones	imazapic, imazapyr
Calomba daisy	B – sulfonylureas	metsulfuron-methyl
Capeweed	L – bipyridyls	paraquat, diquat
Common sowthistle	B – sulfonylureas	chlorsulfuron
Dense-flowered fumitory	D – dinitroanilines	trifluralin
Ice plant	B – sulfonylureas	chlorsulfuron
Indian hedge mustard	B – sulfonylureas	chlorsulfuron
	B – imidazolinones	imazethapyr
	F – nicotinanilides	diflufenican
	I – phenoxys	2,4-D
Paterson's curse/ Salvation Jane	B – sulfonylureas	chlorsulfuron
Prickly lettuce	B – sulfonylureas	triasulfuron
	B – imidazolinones	imazethapyr
Sand rocket	B – sulfonylureas	chlorsulfuron
Starfruit (rice)	B – sulfonylureas	bensulfuron
Stinging nettle	C – triazines simazine,	atrazine
Wild radish	B – sulfonylureas	chlorsulfuron
	B – imidazolinones	imazapic, imazapyr
	F – nicotinanilides	diflufenican
	I – phenoxys	2,4-D
Wild turnip	B – sulfonylureas	chlorsulfuron

(Source: GRDC Southern Region Herbicide Resistance Fact Sheet, table compiled by Andrew Storrie, 2012).

You can perform an on-farm test by spraying test strips at the full recommended rate, as well as a double rate. Make sure that weeds are actively growing and not stressed. You can perform a plant count prior to spraying for a more thorough assessment of whether resistance has developed. Download the WeedSmart app to your smart phone or tablet device to get an initial idea of whether you are facing herbicide resistance on your property.

If you want to use a commercial testing service, then you will need to collect seed samples. Be sure to gather a decent sized sample of ripened seeds – about 3000 or an enough to fill an A4 envelope – so the test provider can give you the most accurate results possible.

For Australian resistance test services, do a web search for:

- Plant Science Consulting[12]
- Syngenta - RISQ test[13]
- Charles Sturt University, Graham Centre Weed Research Group[14]

ROTATE CROPS AND HERBICIDE MODES OF ACTION

Taking a flexible and varied approach to weed control is the best way to avoid large-scale herbicide resistance. Weeds adapt and thrive in consistent environments – so your goal should be to keep them guessing. Rather than applying the same herbicide year after year, rotate between herbicides with different modes of action (MOA). Weeds are far less likely to become resistant if they are being attacked by different chemicals that work in different ways. Varying the crops you grow can change the options available for weed management, making it harder for weed species to escape control year after year.

Rotating herbicides, rather than relying on a single chemical, is fundamental to maintaining a sustainable set of tools at your disposal to combat weeds. If your herbicide rotation is to be effective, you must ensure that the range of herbicides at your disposal employ different MOA. Using herbicides with the same MOA again and again presents the greatest risk of entrenching herbicide resistance.

By switching herbicide MOA along with cropping rotation, you can reduce the rate of herbicide resistance developing. Applying different herbicides to a single crop during a growing season or simultaneously as a mixture can also help manage herbicide resistance.[15]

AIM FOR 100% CONTROL AND MONITOR EVERY SPRAY EVENT

It is imperative that you keep track of and deal with any weed occurrences as soon as possible. After you have performed any weed control measure, scout for survivors and quickly follow up on any plants that have survived.

You need to ensure that you have dealt with weeds before they mature to reduce the risk of them spreading. If your herbicide program has failed, then be sure to test for resistance and change your plan of attack. Keeping one step ahead of weed populations is key, and you can do this by using varied weed control tools across your farming system. Not only will this benefit your cropping in general, but it will preserve herbicides as an asset for years to come.[16]

DON'T AUTOMATICALLY REACH FOR THE GLYPHOSATE

Glyphosate is the wonder-chemical that has become the cornerstone of Australian no-till farming. If this highly effective product is overused and growers experience widespread resistance, there is unlikely to be a ready replacement for glyphosate in the foreseeable future.

Glyphosate is a thorough way to tackle weeds, and using it alongside other measures now will keep it working in the long-term. Growers can combine glyphosate with a number of other anti-weed measures, such as:

- Using the double knock tactic
- Rotating glyphosate products with different MOA
- Mixing glyphosate with herbicides from different MOA at effective rates to kill resilient weeds
- Ensuring that you abide by a product's stewardship program[15]

NEVER CUT THE ON-LABEL HERBICIDE RATE AND MANAGE SPRAY DRIFT AND RESIDUES

With growers mindful of herbicide residues, as well as herbicide costs, using less than the recommended herbicide dosage can be tempting. However, delivering a dose of watered-down herbicide can not only fail to kill weeds, but help future generations develop resistance.[18]

Water rates are essential to consistent spraying. In most situations you should aim to have coarse to medium-coarse droplets. Using more water can be useful for improving coverage, getting spray past canopies or penetrating stubble, but this is only suitable in certain conditions. If water rates are too low, then droplet size decreases, which means you are more likely to see spray drift end up on stubble or canopy.

Choosing the correct adjuvants is also important. For instance, oil-based adjuvants will benefit oil-based products. However, they will hamper effectiveness when used with water-soluble solutions, like glyphosate.[19]

Growers need to ensure that, as well as administering herbicide effectively, they minimise spray drift and residues. Make sure that you spray herbicides as directed on their labels, and only spray if you are certain that conditions will let you have absolute control over all your spraying activity. It is important that you use nozzle sizes that will give you correct droplet sizes, with smaller droplets more likely to drift. You should also ensure that boom height is matched to the type of nozzle you are using, and ideally your travel speed should be 15 to 20 km/h – too fast, and you risk your spray drifting. Remember that droplets are more likely to stay suspended in still, clear conditions, so spraying should be carried out during a steady wind.[20]

TABLE 3. SITUATIONS WHERE GLYPHOSATE RESISTANT WEED POPULATIONS HAVE BEEN CONFIRMED.

SITUATION		NO. OF SITES	STATES
Broadacre cropping	Chemical fallow	63	NSW, Qld, WA
	Winter grains	83	Vic, SA, WA, NSW
	Irrigated crops	1	SA
Horticulture	Tree crops	5	NSW, SA
	Vine crops 21 SA, WA		
	Vegetables	2	Vic
Other	Driveway	4	NSW, Vic, SA,WA
	Fence line / Crop margi	63	NSW, SA, Vic, WA
	Around buildings	3	NSW
	Irrigation channel / Drain	22	NSW, SA, Vic
	Airstrip	1	SA
	Railway	5	WA, NSW
	Roadside	112	SA, NSW, WA, Qld

(Source: Chris Preston's GRDC Advisor Updates 2012 paper)

USE THE DOUBLE KNOCK TECHNIQUE

The double knock, or sequential application, uses two weed control measures to ensure a weed population is wiped out. Not only does this present a thorough way of dealing with entrenched populations and reducing the weed seed bank, but it can help prevent herbicide resistance taking hold by knocking out weeds that survived the first round.

For instance, in fallow you could employ a Group I or M herbicide, and then follow up within the next two weeks with a Group L product,[21] the important thing is to make sure that you are following up with a chemical that uses a different MOA to the first.[22] Double-knocking does not have to involve the use of two different MOA – you could also follow up a non-selective spray with cultivation to maximise your effectiveness. The double knock is particularly effective in tackling Rhodes grass, fleabane and awnless barnyard grass.

WEEDSMART

WeedSmart is an industry-led initiative to enhance on-farm practices and promote the long term sustainability of herbicide use in Australian agriculture.

Australian research partners, commercial entities, Government, advisors and growers have joined forces to ensure Integrated Weed Management practices remain at the forefront of global farming practice.

Viable herbicide use will help secure the weed control productivity gains made by the current generation of Australian farmers.

YOUR WEEDSMART TOOL KIT

The WeedSmart tool kit below outlines the handy resources that can help you keep weeds – and herbicide resistance – at bay.

WeedSmart App

A simple tool to gauge herbicide resistance risk and how to assess your WeedSeed bank management. Available to download on your iPhone or iPad, or at weedsmart.com.au/app.

WeedSmart materials

WeedSmart brings together the best strategic weed control measures in its campaign material, available at weedsmart.com.au/growers

WeedSmart eNewsletters

eNewsletters with the latest news and information on sustainable weed management, sent bi-monthly to your inbox. Subscribe at weedsmart.org.au/enewsletter

Weedsmart.org.au

The WeedSmart website promotes the long-term viability of herbicide in Australian agriculture and acts as a hub for the wide array of information that can support your weed-fighting plan.

WeedSmart videos

Some great how-to videos are available on DVD in the WeedSmart information pack and at weedsmart.org.au. These explain the most effective anti-weed practices at your disposal and give you tips straight from the cropping sector's leading experts. GRDC also provides a great video resource, Over the Fence, which contains some of the latest and greatest weed control measures. Visit ww.grdc.com.au/Media-Centre/Over-The-Fence

FOR MORE INFORMATION ON HERBICIDE RESISTANCE, VISIT:

WeedSmart: **www.weedsmart.org.au**

Grains Research Development Corporation: **www.grdc.com.au**

Australian Herbicide Resistance Inititative: **www.ahri.uwa.edu.au**

Australian Glyphosate Sustainability Working Group: **http://glyphosateresistance.org.au/**

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CAUTION: RESEARCH ON UNREGISTERED HERBICIDE USE

Any research with unregistered herbicides or of unregistered products reported in this document does not constitute a recommendation for that particular use by authors or the authors' organisations.

All herbicide applications must accord with the currently registered label for that herbicide, crop, weed and region.

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