

Herbicide Resistance Management Strategy 2026/27

An integrated weed management system relies on a large number of complementary components, including chemical and non-chemical control tactics combined with cultural practices such as crop competition, rotation, farm hygiene and crop scouting. Effective strategies to delay herbicide resistance and manage resistant populations are essential for long-term sustainability of cotton farming.



Apply 6 different modes of action on grasses and broadleaves every 2 years, and allow NO SURVIVORS to set seed

CHOOSE 6 TACTICS	Fallow	Pre/at plant	Post-emergent	Maturing crops
	Strategic cultivation Double knock Optical sprayers ¹ Patch management Cover crops Fallow herbicides Group 9 glyphosate Group 5 bromoxynil, terbutylazine Group 14 flumioxazin, pyraflufen, saflufenacil, tiafenacil Group 27 isoxaflutole Group 10 glufosinate Group 4 2,4-D, dicamba, fluroxypyr Rotation Crops³ Crop competition Rotate modes of action Plant back restrictions Cover crops	Cultivation Double knock Knockdowns Group 5 bromoxynil Group 14 pyraflufen, flumioxazin, saflufenacil, oxyfluorfen, carfentrazone, tiafenacil Group 4 dicamba, fluroxypyr Group 10 glufosinate Group 9 glyphosate Residuals³ Group 5 prometryn, terbutylazine, diuron, fluometuron Group 3 pendimethalin, trifluralin Group 15 S-metolachlor, metolachlor	In-crop cultivation Manual chipping Rogueing Spot spraying Post-emergent OTT Group 1 ² sethoxydim, clethodim, butoxydim, haloxyfop, propaquizafop Group 15 ⁴ S-metolachlor Lay-by, directed or shielded spray Group 5 prometryn, terbutylazine, diuron, fluometuron Group 3 pendimethalin Group 14 ⁴ flumioxazin Group 15 ⁴ S-metolachlor	Cultivation Chipping Rogueing Spot spraying <i>Aim for 100% control of survivors</i>
NO SURVIVORS	Target survivors — aim for 100% control In fallow survivor control Cultivation, chipping or spot spraying (refer above for options) Optical sprayers ¹ Pre-plant survivor control Cultivation, chipping or spot spraying flumioxazin pyraflufen-ethyl (added to complementary product) carfentrazone-ethyl bromoxynil Post-emergent Inter-row cultivation, chipping or spot spraying Post-harvest Root cutting for crop destruction Cultivation, chipping or spot spraying carfentrazone-ethyl, pyraflufen-ethyl bromoxynil fluroxypyr			
COMMENTS	- Survivors MUST be controlled with a different MOA prior to seed set. - Read and follow all label directions. - Rotate herbicide mode of action (MoA). - Come Clean. Go Clean. to avoid importing weed seeds. - Scout fields regularly for weeds and monitor after spraying for survivors. - Keep accurate field records. - Ensure volunteers/ratoons are controlled. - DO NOT rely solely on glyphosate or any other in-crop herbicide for non-field weed control. - Take a farming systems approach to weed management, considering winter, summer and non-field area weed control. Footnotes: 1. APVMA permit 90223 for OSST in fallows. 2. Group 1 herbicides already exhibit widespread resistance. Controlling survivors is essential. 3. Refer to label for plant-back restrictions to following crop. 4. Limited formulations are registered for this use. Please check label.			

Revised Herbicide Resistance Management Strategy (HRMS) explained

The HRMS is designed as a tool to manage the risk of herbicide resistance in irrigated and dryland farming systems incorporating herbicide tolerant cotton. The strategy has been developed in response to the escalating problem of herbicide resistance across multiple weed species to a number of herbicide modes of action (MoA). This is the second version of the HRMS, following on from the original 2+2+0 strategy that saw the cotton industry adopt world's best, and most effective, glyphosate resistance management. This version of the HRMS focuses on a glyphosate, glufosinate and dicamba tolerant cotton system (XtendFlex® cotton); however, we are constantly alert to the fact that other herbicides could become at-risk for resistance if used more than once every year. Many herbicides, including the ones listed, already have a history of use in cotton fields, indicating that some selection for resistance for any registered herbicide could already have occurred.

A sustainable system requires a high level of diversity and zero tolerance for survivors of herbicide sprays. Using 6 different methods/modes of action across every 2 years (such as 3 in fallow plus 3 in crop, for a dryland situation), plus additional actions if required to prevent seed set on survivors, provides a sustainably low risk (but not zero risk) system.

The formula to delay or manage resistance

The most effective way to delay the evolution of herbicide resistance is to target weed control across the whole farming system with a diversity of tactics. A focus on reducing weed numbers in fallows or rotation crops will reduce the reliance on in-crop weed control. Aim to drive down weed numbers and ensure no weeds set seed after herbicide applications, and use a diverse program of 6 modes of action every 2 years. This can be done by:

- using a minimum of 3 different weed control tactics effective on the weeds being controlled in-crop, and 3 more in summer fallows (or non-cotton crops). If more controls are needed, make use of fallow periods to get access to a range of products that can be used where no crop is present needing protection. Note: where both grasses and broadleaves are present, 'three different modes of action' must apply to both types of weed species, meaning more than three in total may need to be applied. Check the tables in this guide for the wide range of available tactics at different crop stages.
- AND ensuring that no survivors set seed. Effective post-spray monitoring (with follow-up action) is critical for ensuring control of survivors.

Examples of the influence of various weed management tactics on herbicide resistance risk are provided in Table A.

Table A: Risk reducers and risk promoters for herbicide resistance

Effect on resistance risk	Tactic	Notes
Strongly reduces risk	Spot-spray glyphosate at high rates through optical detection system	Glyphosate at the highest allowable rate, applied to small proportions of the field, remains very effective for seedbank and resistance management, including protecting other herbicide groups under pressure of resistance.
Strongly reduces risk	Apply glyphosate as part of double knock	Whenever there is the opportunity to follow glyphosate with a fast-acting knockdown herbicide, it should be taken. In the absence of paraquat, glufosinate or cultivation can be useful double knock partners. Other suitable sequences of tactics may be used.
Reduces risk	Late season survivor control	Additional tactics used specifically to control survivors in crop prior to seed set are fundamentally important.
Reduces risk	Apply glufosinate as part of double knock	Glufosinate is a moderately at risk herbicide for resistance. Preserve its susceptibility by attempting to use it as part of mixed strategies with other modes of action.
Reduces risk	Apply key herbicides in mixtures	Glufosinate and dicamba are at risk for resistance. Using them in mixtures with compatible products can help reduce resistance risk.
Increases risk	Weed species known for evolving resistance (annual ryegrass, barnyard grass, feathertop Rhodes grass, flaxleaf fleabane)	Several such species are present in various regions. Currently susceptible biotypes of key species should be treated as being at risk of resistance in the short to medium term. Consult your agronomist about the herbicide resistance history of your weed species.
Highly increases risk	Cross-seasonal species (often germinates out of expected season)	Adaptable species such as annual ryegrass can generate large seedbanks by appearing out of their expected season, and going uncontrolled.
Highly increases risk	Multiple generations per year	These highly fecund species can evolve very rapidly, and must be controlled with multiple modes of action.
Highly increases risk	Relying on 1-2 herbicides	

Increased time to resistance

Research into glyphosate resistance has indicated that typically glyphosate failure may appear in grass weeds after approximately 13 years (dryland) and 19 years (irrigated) in a glyphosate only system. Resistance to glyphosate in broadleaf weeds can be slower to emerge and usually takes around 18 years in both irrigated and dryland systems. Some non-glyphosate modes of action share similar or slightly longer timeframes (e.g. Group 4 herbicides, glufosinate), while others have substantially shorter timeframes (Group 1, Group 2 herbicides). However, it is important to remember that the most reliable herbicides in our system, including but not limited to glyphosate, have now been in frequent use for one to two decades in nearly all cropping situations in Australia. This means that time frames to resistance for populations on farm could appear to be much shorter, since we are unlikely to be starting with a truly wild type, unselected population. It is helpful to know your herbicide use history on weeds that have been on farm for many years. Assume that resistance could appear much more quickly than these indicative timeframes, if the system begins to favour a particular herbicide.

Herbicide resistance can be delayed by 4-6 years with good survivor control and product rotations and mixtures, and the same strategies are very effective for managing resistant populations that do occur. To drive down weed numbers and eradicate resistant biotypes, additional tactics such as intensive patch management are required.

Other management considerations

Any rotation or cover crop should be managed similarly to a fallow, with at least 3 modes of action recommended. Rotation and cover crops provide an opportunity to incorporate other tactics, rotate to herbicide groups not used in cotton, vary the time of year crop competition suppresses weeds, and produce stubble loads or mulch that can reduce subsequent weed germinations.

Aim for 100% control of survivors after each herbicide application. Effective post-spray monitoring to detect survivors is critical. The use of cultivation to control any survivors after a herbicide application is predicted to achieve 80% survivor control, whereas cultivation plus follow-up chipping is predicted to achieve close to 100% survivor control. Other tactics for survivor control can be equally effective, such as shielded or spot-spraying with an effective knockdown herbicide. Even very small mature weeds may produce viable seeds, and if those carry resistance genes, a long-term problem can begin to emerge. Get suspect weed survivors tested for resistance.

Residual herbicides need back up, such as tillage, chipping and knockdown herbicide applications to control survivors. When using residual herbicides, consider plant-back periods and crop safety. Be aware that prolonged dry periods may extend plant-back periods.

Control weeds in adjacent areas (channels, tail drains, fencelines and roadsides) to minimise the seed bank and eliminate unknown weed seed sources. Do NOT rely solely on glyphosate to manage weeds in non-crop areas.

Be aware of weed seed contamination sources (e.g. waterways, vehicle/machinery, and farm inputs).

Establish and maintain Come Clean. Go Clean. to prevent the introduction and transport of resistant seeds.

Use patch management strategies – control any weeds in and around problem patches with a different mode of action from ones that the patch may have recently survived. Be ready for the tendency of patches to spread if not controlled well.

Use IWM best practice when employing tactics, including:

- Optical Spot Spray Technology, particularly where spot spraying allows for high herbicide rates on a small proportion of the paddock.
- Regular scouting and ensuring correct weed identification. Check with an agronomist if you are unsure of a weed's identification. Be on the lookout for any new weeds and eradicate problematic new weeds before they become an issue.
- Frequent post-spray monitoring.
- Good record keeping.
- Timely implementation of tactics – hitting weeds when they're small and vulnerable.
- Rotate and mix herbicide mode of action groups.
- Always follow label recommendations.
- Consider other aspects of crop agronomy.

Poor seedbank control over 5-10 years strongly correlates with increased herbicide resistance risk.

The medium-term success of moderate-high resistance risk strategies depends greatly on the history of exposure to the MOAs used in crop. If a weed population is already at 1-10% resistance due to historical practice, full-blown resistance can appear within 3-4 years of even a moderate risk strategy.

The success of moderate risk strategies is highly responsive to summer fallow actions in dryland cotton. Crops grown 1 year in 3 with a very low-risk, robust summer fallow program can sustain somewhat less diverse in-crop strategies. Back-to-back irrigated crops, where summer fallow control is not available, should stick with low risk strategies in crop.

Assessing your own risk

Refer to pages 86-89 of this publication for information on recognising potential herbicide resistance how to get weeds tested.

More information and tools related to herbicide resistance and weed management in cotton is available from:

 cottoninfo.com.au or  www.weedsmart.org.au

The HRMS in practice

Implementing the HRMS in cotton requires fitting a range weed control tactics into real situations with lots of variables. Finding room for 6 different tactics every two years is feasible but can be challenging. A few of the important considerations are:

- What weed species are you actually dealing with?
- What's your crop rotation?
- When, and how often, can you include soil disturbance for weed management?

Tables B and C include some example IWM strategies in-crop and during fallows, rated for resistance risk and seedbank control. The most diverse strategies (at the top of each table) maximise seedbank control and minimise resistance risk, but potentially have the highest input costs.

In order to fit the HRMS requirements of 6 different tactics every 2 years, aim for a strategy similar to those in the green rows (low or low-moderate risk). Avoid high or very high risk strategies where possible, and remember that if high risk strategies are used in one part of your rotation (e.g. in-crop), you'll need an even greater focus on reducing risk in the following year to reach the HRMS target.

Table B: Example IWM strategies for in-crop weed management

Resistance risk level	Strategy	#MoA/season	Seedbank control*	Comments
Low	2-3 OTT glyphosate + double knock prior to planting + 2 different residuals (at/near planting, layby) + OTT dicamba + double knock glyphosate/glufosinate OTT + tillage/spot spraying late season for survivor control	5-6	Very high	Fallow choices for broadleaf control are important (avoid 2,4-D). In the absence of paraquat, double knock with glyphosate fb glufosinate or other suitable sequences.
Low-moderate	2-3 OTT glyphosate + 2 different residuals at planting and layby + double knock glyphosate/glufosinate OTT + inter-row cultivation + spot spraying for survivor control	5	High	Glufosinate is best used as part of double knocks, from the point of view of overall resistance management.
Low-Moderate	2 OTT glyphosate + double knock prior to planting + residual at planting + up to 2 dicamba and glufosinate OTT	4	High-moderate	Not ideal for cross-season species or species producing multiple generations per year. Can be very successful when supplemented with best practice summer fallows.
Moderate-high	2 OTT glyphosate + residual at planting + up to 2 dicamba and glufosinate OTT	4	Moderate	Requires very aggressive summer fallow program for sustainability.
High	2-3 OTT glyphosate 2-3 OTT dicamba and glufosinate	3	Moderate-low	Especially susceptible to dicamba resistance if 2,4-D or similar products used in fallow.
Very high	Glyphosate alone or with occasional clean-up tactics	1-2	Moderate-low	History demonstrates glyphosate alone is too high risk for resistance to be recommended in any situation.

Table C: Example IWM strategies for summer fallows

Resistance risk level	Strategy	#MoA/season	Seedbank control*	Comments
Low	Glyphosate (applied in double knocks or at high rates via optical sprayer wherever possible) x2-3 + 2 different residual MoAs, early and mid-fallow + broadleaf herbicide ¹ + consistent survivor control + includes cultivation ²	5-6	High	In the absence of paraquat, use glufosinate as a double knock partner – but preferably only as part of double knocks in fallow. Aim to use double knocks for half of all glyphosate applications.
Low-moderate	Glyphosate (broadacre) x2-3 + early season residual + grass selective + glufosinate + late survivor control with spot spraying	4-5	Generally high	
Moderate	Glyphosate (mostly applied in double knock/optical sprayer) x3 + 2 different residuals	3	Moderate-high	Seedbank control is variable, depending on residual choice and existing glyphosate resistance. Choose residuals not used in crop if possible. Be aware of plantback restrictions.
Moderate	Glyphosate x2-3 always applied as double knocks + early residual		Variable	
High	Glyphosate x2-3 + 2,4-D or other group 4 + glufosinate used alone		Moderate	Seedbank control depends on resistance level and can be lost quickly.
High	Glyphosate alone, with occasional cleanup tactics		Moderate-low	Seedbank control depends on resistance level – generally good for various susceptible species and very poor for any resistant ones.

¹ It is preferable to avoid, or carefully manage, broadleaf herbicides with known cross-resistance effects to dicamba, including 2,4-D, clopyralid and fluroxypyr in fallow. Follow any applications from this group with monitoring and robust survivor control.

² Incorporating cultivation somewhere in fallow can be beneficial for seedbank control of surface germinating species. Consider residuals incorporated by tillage.

*Seed bank control key (seeds/m²): Very high <10; High 10-100; Moderate 100-500; Low 500-1500; Very low >1500.