

Narrow windrow burning (NWB)

Harvest weed seed control (HWSC) is becoming a more important non-chemical practice to reduce the weed seed bank with the rise of herbicide resistance, particularly in ryegrass. Narrow windrow burning is one of the HWSC tools currently used by Australian grain growers to kill weed seeds captured as harvest before sowing the next years crop. It was initially adopted in Western Australia to control ryegrass and radish. The practice spread to other areas of Australia, however different forms of HWSC, such as seed impact mills, have taken over and burning is not so common. However, narrow windrow burning can still be a cheap and effective way to reduce the weed seed bank.

COMPARING HARVEST WEED SEED CONTROL OPTIONS

With many options for harvest weed seed control, it's helpful to weigh up their suitability for your farming system.

	PROS	CONS
Narrow windrow burning	<ul style="list-style-type: none"> • Simple and low cost • Minimal machinery modifications required • Highly effective if burnt correctly • Destruction of weed seeds 	<ul style="list-style-type: none"> • Requires safe conditions for burning • Slower harvest speed • Reduced stubble cover • Time and labour intensive • Crop residue and nutrient loss
Seed impact mill	<ul style="list-style-type: none"> • Retained crop residue and nutrients • Completed in one pass • Destruction of weed seeds 	<ul style="list-style-type: none"> • High capital cost • High maintenance costs • Slower harvest speed
Chaff lining	<ul style="list-style-type: none"> • Low cost • Retained crop residue and nutrients • Suppresses weed emergence 	<ul style="list-style-type: none"> • Need a decent amount of chaff to act as a physical barrier • Chaff lines need to be placed on the same line each year for best results
Chaff tramlining (chaff deck)	<ul style="list-style-type: none"> • Similar to chaff lining, but concentrates chaff into wheel tracks to limit weed germination further • Best suited to controlled traffic farming (CTF) system 	<ul style="list-style-type: none"> • Not effective unless CTF • Greater seed soil contact as it is driven over more times, which leads to more germinations
Chaff carts	<ul style="list-style-type: none"> • Excellent for mixed farming enterprises with livestock, as chaff can be used as feed • Can provide additional income through grazing value 	<ul style="list-style-type: none"> • Requires additional time and labour • If not grazed, the chaff needs to be burnt • Greater crop residue and nutrient loss if some straw is exported
Bale direct	<ul style="list-style-type: none"> • Excellent for mixed farming enterprises with livestock, as chaff can be used as feed • Can provide additional income through grazing value 	<ul style="list-style-type: none"> • High capital cost • Slower harvest speed • Crop residue and nutrient loss

SUCCESSFUL NARROW WINDROW BURNING

The Australian Herbicide Resistance Initiative (AHRI) suggests that we can capture at least 60-70% of annual ryegrass and wild radish seed at harvest. Once concentrated into a narrow windrow and burnt in ideal conditions the following autumn, 99-100% of these captured seeds are destroyed. A minimum temperature of at least 400°C is required for 10 seconds to kill ryegrass seed, 400°C for 30 seconds to kill brome grass seed, and 500°C for 10 seconds to kill wild radish seed.

Successful narrow windrow burning fundamentally relies on two factors:

1. Maximise the amount of weed seed that goes through the header front and is captured within the windrow.
2. Heat intensity (temperature) and duration of the burn must be sustained for long enough to kill all seeds.

Crop suitability

Assessing the fit of narrow windrow burning for your farm is a critical first step. It is generally more suited to lower rainfall areas as there is less stubble load to burn, so it can be done safely. Higher yielding areas have greater risk of fire escape, however it can be done with canola stubble and pulses stubble as the stubble load is less. Narrow windrow burning may also not be a suitable practice if paddocks are located close to grapevines, as the burning can lead to smoke taint of the grapes.

Careful selection of crop stubble type to burn can be the difference between successful weed control and an out-of-control whole paddock burn. Pulses and canola are generally the safest and more preferred crops for narrow windrow burning, however it is possible to do with wheat. Narrow windrow burning will work best in paddocks where the weeds (e.g. ryegrass) are still standing at the time of harvest so it can be picked up by the header front, as opposed to if it has fallen over.

Canola

Canola suits narrow windrow burning, as the windrows hold their shape well and they burn hot. Since there is less crop residue and less fuel load, burning canola is generally safer. It is generally thought that narrow windrow burning canola that was windrowed prior to harvest is more effective than doing it with canola that was direct headed. Direct heading canola doesn't capture as many weed seeds as it is cut higher, so it's not as successful for weed control. This is likely why we've moved away from narrow windrow burning in South Australia, because more canola is harvested via direct heading.

Pulses

Narrow windrow burning pulses, such as lentils, is another common option, as there is less crop residue so it is safer. However, a downside to burning pulse stubbles is the loss of nitrogen from the stubble, so there may not be as much nitrogen available for the next crop. Keep this in mind for next years crop, particularly when nitrogen budgeting.

Wheat

Avoid narrow windrow burning wheat in higher rainfall environments, as it's difficult to contain the fire to the windrows when there is more crop residue. However, it can be done in lower rainfall environments. As a rule of thumb, only burn wheat windrows if the wheat yield was 2.5t/ha or below.

Barley

It is generally advised to not burn barley windrows, as there is much more leaf tissue and biomass within the windrow that it is difficult to contain the burn.

Setting up narrow windrows at harvest

The goal of making narrow windrows at harvest is to capture as many weed seeds as possible. This means cutting low, at about beer can height (0-10cm). This is also best for fire safety as there is less risk of the burn getting out of control.

A *narrow* windrow is key for ensuring that the crop residue is concentrated enough to produce a hot burn to kill weed seeds. Ensure that your windrow is about 500-600mm wide for an effective burn. There's lots of great information online about how other farmers have made a narrow windrow chute for their header. A great resource to start with is [here](#).

Avoid livestock grazing over summer

After harvest, try to keep livestock off of paddocks with windrows that are intended to be burnt in Autumn. Stock can spread the windrows and make little firebreaks that will prove to be annoying come burning time. A light graze can be okay, but don't compromise the effectiveness of the burn. There is also a chance that livestock will spread the weed seed that you want to kill.

What if I got rain between harvest and burning?

Getting rain on windrows is not as detrimental for a successful hot burn as you may think, as long as it has a couple of weeks to dry out. If anything, people have found it can be easier to keep the fire within the windrow. Research has found that although rain on narrow windrows does decrease the temperature of the burn, it stills stays hot enough for long enough to get effective kill of target weeds. Burning windrows that have been affected by rain places more importance on burning in conditions that are ideal for a slow, hot burn.

Burning conditions

A light cross wind between 10km/hr and 18km/hr is best for a consistent and complete burn, and reduces the risk of the fire getting out of hand. An even better indicator of ideal burning conditions is the Grassland Fire Danger Index (GFDI), as this takes into account temperature and relative humidity, as well as wind speed. Do not burn paddocks if the GFDI exceeds 20. Continue to monitor weather conditions as the burn progresses.

Before burning, check your local council's rules for permits required and other guidelines. Also, see the [SA CFS Broadacre Burning Code of Practice](#) for more information.

DO	DON'T
Carefully consider which crop type/paddock is suitable for narrow windrow burning. Canola and pulses are most effective and safe	Burn wheat crops with high stubble loads (i.e. if the wheat yield was >2.5t/ha), and avoid burning barley
Harvest crop low to capture weed seed (beer can height)	Harvest crop above 15cm stubble height
Ensure the narrow windrow is 500-600mm wide for an effective, hot burn	Set up chute to produce windrows above 600mm
Keep livestock off of paddocks between harvest and burning	Graze livestock heavily on paddocks with windrows that are intended to be burnt
Allow paddocks to dry out after summer/early autumn rain before burning	Burn windrows immediately after rain
Burn narrow windrows in a light cross wind (10-18km/hr) or when GFDI is below 20	Burn windrows in calm winds, or winds above 18km/hr or if the GFDI exceeds 20

NUTRIENT REPLACEMENT REQUIREMENTS

Narrow windrow burning may initially seem like one of the cheapest forms of HWSC when accounting for capital costs, fuel, R&M and labour. However, once you factor in the cost to replace nutrients lost from burning residue, narrow windrow burning is roughly on par with the per hectare cost of other HWSC methods.

The two main nutrients lost through burning are nitrogen and potassium. Different crop types contain different amounts of nutrients in their residue. The following table shows approximate nutrient content of different crops.

	N content (kg/ha) per tonne of residue	K content (kg/ha) per tonne of residue
Cereal	5	8
Legume	10	8
Canola	7	8

As a rough assumption, assume that all crops have a harvest index of 40%, which means that 40% of the crops total biomass was harvested as grain. The other 60% is residue (stubble and chaff). As an example, a 2t/ha canola crop will have 3t/ha of residue left over. Narrow windrow burning has been shown to then remove half of the residue, leaving us with 1.5t/ha, hypothetically. Use the table below as a guide.

Grain yield (t/ha)*	Total residue (t/ha)	Residue burnt from NWB (t/ha)^
0.5	0.75	0.375
1	1.5	0.75
1.5	2.25	1.125
2	3	1.5
2.5	3.75	1.875
3	4.5	2.25

*Irrespective of crop types. Assuming 40% harvest index for all.

^Assuming that narrow windrow burning removes 50% of residue.

By combining the amount of stubble burnt from narrow windrow burning and the nutrient content of different crop residues, the kg/ha of nutrient replacement required can be calculated. Multiply this with the current cost of fertiliser as a \$/kg of nutrient value to determine the cost of nutrient replacement.

		Urea price (\$/t)			
		Cost of N (\$/kg N)			
		\$800	\$1000	\$1200	\$1400
		\$1.90	\$2.38	\$2.86	\$3.33
Nitrogen removal (kg/ha)	2	\$3.80	\$4.76	\$5.72	\$6.66
	4	\$7.60	\$9.52	\$11.44	\$13.32
	6	\$11.40	\$14.28	\$17.16	\$19.98
	8	\$15.20	\$19.04	\$22.88	\$26.64
	10	\$19.00	\$23.80	\$28.60	\$33.30
	12	\$22.80	\$28.56	\$34.32	\$39.96

		MOP price (\$/t)			
		Cost of K (\$/kg K)			
		\$1000	\$1200	\$1400	\$1600
		\$2.00	\$2.40	\$2.80	\$3.20
Potassium removal (kg/ha)	4	\$8.00	\$9.60	\$11.20	\$12.80
	8	\$16.00	\$19.20	\$22.40	\$25.60
	12	\$24.00	\$28.80	\$33.60	\$38.40
	16	\$32.00	\$38.40	\$44.80	\$51.20
	20	\$40.00	\$48.00	\$56.00	\$64.00
	24	\$48.00	\$57.60	\$67.20	\$76.80

DOES BURNING AFFECT MY MARKET ACCESS?

Short answer, no. As meeting International Sustainability and Carbon Certification (ISCC) criteria becomes more important to maintain market access, particularly for canola, it's wise to make sure you're meeting all requirements. Luckily, narrow windrow burning is viewed as an acceptable practice and will not limit your market access, as long as you follow local council rules and have an appropriate permit.