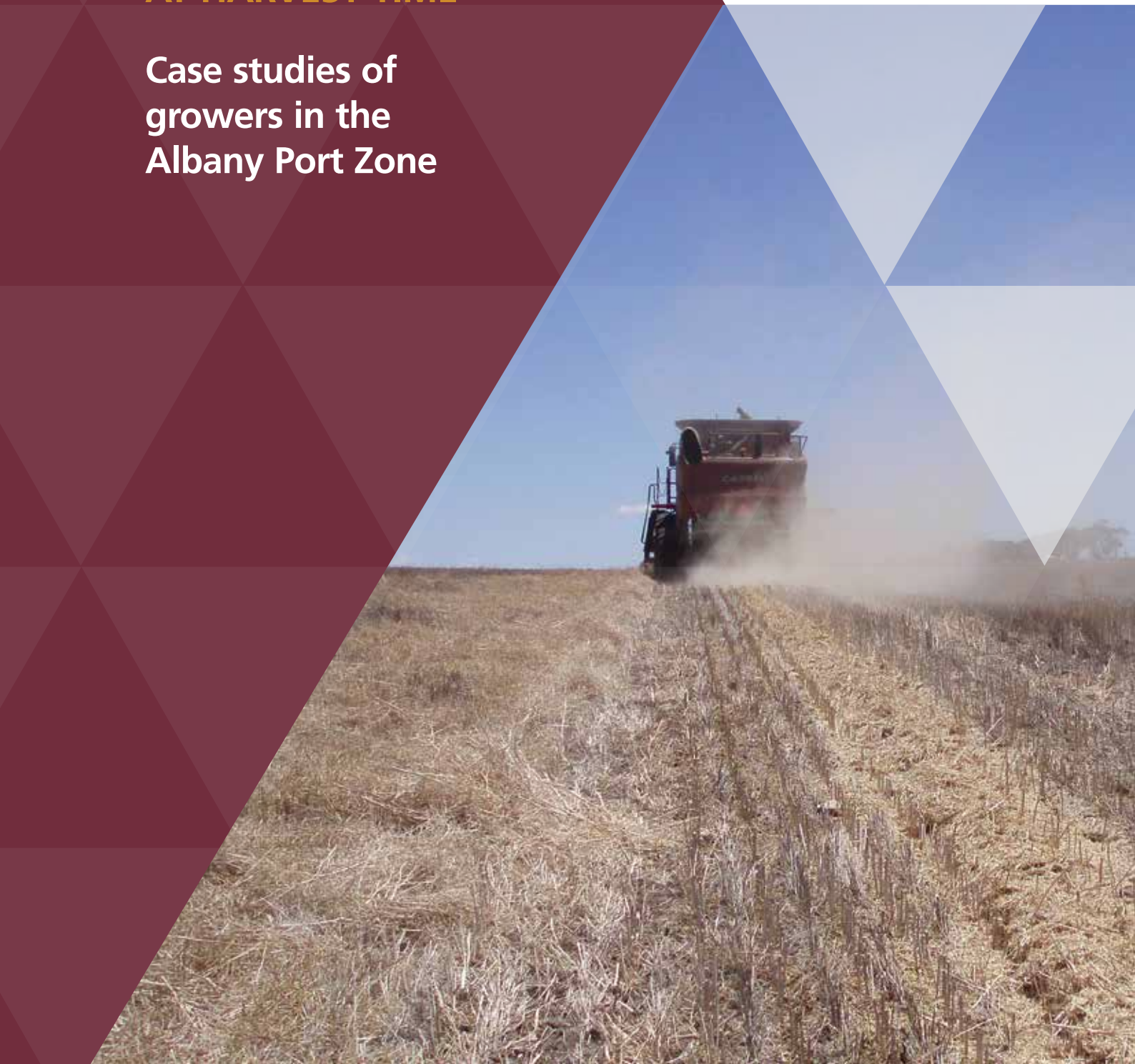
THE EFFECTIVENESS OF ON-FARM METHODS OF WEED SEED COLLECTION AT HARVEST TIME

Case studies of growers in the Albany Port Zone



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In particular, we thank the growers who participated and shared their experience of harvest weed seed management. They are Barry Gray, (South Kukerin); Mark Pearce (Tarin Rock); Simon, Matt and Peter Kerin (Katanning); James and Nina Hope (Kojonup); Craig Bignell (Broomehill); Wayne Pech (Gnowangerup), and Doug and Kerry Smith (Pingrup).

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Julianne Hill, regionalcroppingsolutions@gmail.com, (08) 9726 1307

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To access it, go to: **www.grdc.com.au/CaseStudy-WeedSeedHarvest-Albany**

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Authors

Alexandra Douglas
Project Manager
Department of Agriculture and Food, Katanning
alex.douglas@agric.wa.gov.au

Jane Kowald
Projects Officer
Southern DIRT, Kojonup
projects@southerndirt.com.au

Pip Crook
Executive Officer
Southern DIRT, Kojonup
eo@southerndirt.com.au

Peter Newman
Leader of Communications
Australian Herbicide Resistance Initiative (AHRI)
petern@planfarm.com.au

Brogan Micallef
Communications Officer
Australian Herbicide Resistance Initiative (AHRI)
brogan.micallef@uwa.edu.au

Julianne Hill
Regional Cropping Solutions Co-ordinator
Grains Research and Development Corporation (GRDC)
regionalcroppingsolutions@gmail.com

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Using a chaff cart for weed seed collection at harvest can reduce the weeds in future crops significantly.

Background

Purpose of the Case studies

In Western Australia, where high frequencies of herbicide resistant annual weed populations have been driving farming practices for the last decade, techniques targeting weed seeds during harvest have been widely adopted. The collection and management of the weed seed bearing chaff fraction at harvest time results in significant reductions in annual weed population densities.

Harvest weed seed control provides the opportunity to more effectively manage weed populations and allows the grower to move away from the almost complete reliance on herbicides for weed control. The consequence of this is that growers then have more flexibility in the overall management of their cropping program.

Harvest weed seed control tools – where do they fit?

- Narrow windrow burning is best suited to low to medium rainfall zones to facilitate burning of the windrow without burning the whole paddock and to minimise nutrient removal in residues.
- Chaff carts can be used everywhere. They are a cost effective, practical tool that suits all rainfall zones, but they do still involve burning of some crop residue in most situations.
- Bale Direct is best suited to where a reliable market for straw exists close by.
- Harrington Seed Destructor (HSD) is best suited to larger areas of crop in medium to high rainfall zones.

Summary of the harvest weed seed control tools

Below, we briefly explore the harvest weed seed control options currently used across Australia to capture and/or destroy weed seeds at harvest.

Chaff Carts

Chaff carts are towed behind headers during harvest to collect the chaff fraction as it exits the harvester (Figure 1). AHRI research demonstrates that 75 to 85% of annual ryegrass seeds, and 85 to 95% of wild radish seeds that enter the front of the header during the harvest operation are collected.

Typically, the collected chaff is then dumped in chaff heaps in lines across fields in preparation for subsequent burning to achieve weed seed destruction. Alternatively, chaff material is a valuable livestock feed source and can be grazed in-situ or, in some instances, collected for use in feedlots.

In recent times there has been renewed interest in the use of chaff carts thanks to the WA grain grower Lance Turner's design modification to the chaff cart. This adaptation, the conveyor system, includes some straw residue in the collected material, allowing the chaff heaps to retain more air pockets hence resulting in a shorter burning time. Previously, chaff heaps created with the old cross auger and blower system would potentially smolder for two days, whereas heaps formed with the conveyor system will burn out completely in 6–8 hours.

Narrow windrow burning

The simple but effective narrow windrow burning system is currently the most widely adopted harvest weed seed control system in Australia. This system uses a grain harvester mounted chute to concentrate all of the exiting chaff and straw residues into a narrow windrow about 500 to 600 mm wide (Figure 2).

These narrow windrows are subsequently burnt under the right environmental conditions to avoid burning the entire paddock (Figure 2). The concentration of chaff and straw residues increases the duration and temperature of burning, as the higher the temperature, the more weed seeds destroyed. Narrow windrow burning has been shown to kill 99% of weed seeds for both annual ryegrass and wild radish in wheat, canola, and lupin chaff and straw residues.

Because of the simplicity in their set up, narrow windrow burning systems are now being widely adopted across Australia. However, although relatively easy to establish, it is difficult to effectively burn narrow windrows across a large cropping program. These difficulties are mainly weather related with high temperatures, poor wind conditions, and rainfall all restricting burning efficacy. Additionally, burning narrow windrows in high yielding (>3 tonnes per ha) wheat and barley crops is problematic due to the high residue levels. Effective narrow windrow burning is generally easier in canola and legume stubbles.

Figure 1. Chaff cart system in operation during commercial wheat crop harvest (left) with the Lance Turner pioneered elevator delivery system, shown here in the latest commercially available model from Tecfarm (right).

Figure 2. Narrow windrows formed by a chaff chute mounted on the rear of the harvester (left) are then later burnt in autumn (right).

Baling

An alternative to the in-situ burning or grazing of chaff is to bale all chaff and straw material as it exits the harvester. The Bale Direct System developed by the Shields family at Wongan Hills consists of a large square baler directly attached to the harvester that constructs bales from the chaff and straw residues as during harvest (Figure 3).

This system serves to both capture weed seeds and bale harvest residues for livestock feed. AHRI studies determined that 95% of annual ryegrass seeds are collected and removed from fields using this system. However, the availability of suitable markets for the baled material has limited the adoption of this system by Australian growers.

Harrington Seed Destructor (HSD)

The Harrington Seed Destructor (HSD) is a unique weed seed control system developed by WA grain grower Ray Harrington that processes the weed seed bearing chaff fraction during harvest to destroy any weeds before returning this material to the paddock (Figure 4). Unlike other harvest weed seed control systems, there is no need for any post-harvest operations, and all harvest residues are retained in the paddock.

AHRI research has shown that the HSD consistently destroys 95% of annual ryegrass, wild radish, wild oats and brome grass seed present in the chaff fraction.

Encouraging field results led to GRDC awarding the commercial manufacturing license to de Bruin Engineering of Mount Gambier, South Australia in 2012.

Figure 3. Bale direct system collecting and baling chaff and straw residues.

Figure 4. Schematic view of a cage mill showing chaff entry (left) in the commercially available Harrington Seed Destructor from de Bruin Engineering (right).

Recent on-farm research

Most will have heard about the Harrington Seed Destructor which has been proven to be an excellent tool for weed seed collection and destruction.

However, many in the Zone have expressed interest in finding a 'Poor Man's' Seed Destructor' version. It is possible that growers within the Zone have engineered something that may be as effective – but cheaper to install and make. Other innovative growers may have adopted other methods of weed seed collection and/ or destruction. These case studies will look at different options that growers have adopted to control weed seed set in problem weeds in the Albany Zone.

Growers in the southern parts of WA often experience out of season rainfall during summer which those in the northern wheatbelt do not. Many of the areas where previous case studies have been undertaken do not experience the same degree of summer rainfall. How have the growers in the southern region adapted to these altered conditions?

Case studies examine positive and negative aspects of managing weed seeds at harvest from the grower perspective.

The key to successful harvest weed seed management relies on timing of the method chosen in relation to weed seed maturity, seed shedding and harvest time. These case studies seek to not only discuss benefits and practicalities of individual growers weed management tactics; they also aim to assist others to decide if adopting similar methods would be beneficial on their property.

These case studies present options. Obviously there are no right or wrong options, just different ones, and the more thought-provoking the better. Collectively, these case studies demonstrate that there is a multitude of choices to suit every situation.

Case studies have been conducted in the past by various groups including AHRI, and DAFWA. These case studies are excellent and in many cases have been incorporated into extension material. However, many of these case studies have been conducted either in the north or central wheatbelt of WA. The case studies here focus on areas in the Albany Port Zone that have in the past not had an extensive exposure to weed seed control methods.

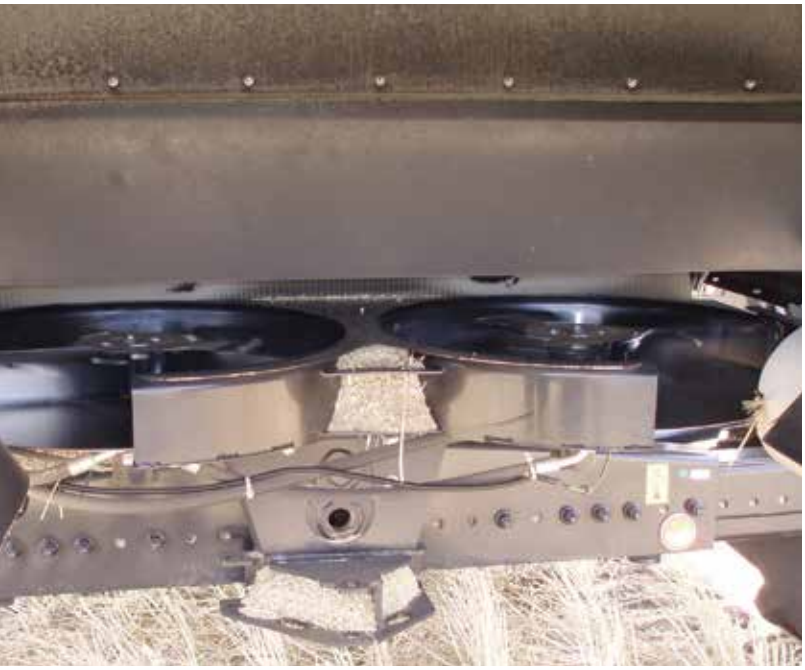
Barry Gray – South Kukerin WA

Size of operation: (ha): 2000 ha.

Enterprises: Grain – Barley, wheat, canola, peas and export hay.

Climate (rainfall pattern, GSR, AAR): 250mm GSR, 350-380mm AAR.

Soil types: Very mixed, gravel to heavy clay.



The spinners at the rear of Barry Gray's header blow the chaff and fines down tubes to be deposited on the straw windrow.

Barry operates a family farm, with records going back to the 1960's. It has been 12 years since sheep were removed from property.

Barry has relied on herbicides as the major weed control measure on the property. The higher frequency of dry sowing crops has led to a greater use of pre and post emergence herbicides and less reliance on knock-downs.

Export hay paddocks are always treated with herbicides. Ryegrass populations were tested two years ago for resistance and were found to be developing resistance to groups A and B.

Barry has moved towards weed seed management at harvest to reduce the need for knock-downs, as it is becoming more important in their farming system to have the crops dry sown.

The rotation is planned and may be altered according to rainfall at the start of the season – particularly canola (canola must be in during the first week of May for a reliable yield).

The newer chemicals - Boxer Gold® and Sakura® have been introduced and were used first during the 2011 season. ("Sakura® and Boxer Gold® have come in the nick of time").

Barry used a chaff chart for three seasons prior to developing a new system of windrow burning.

What does Barry do?

Last year, Barry purchased a new header (New Holland CX8080, conventional type). Barry wanted to use a conventional header as this type of harvester maintains the straw quality. Baling straw is a viable option in many years, particularly barley straw. Barry believes that

Rotary headers will pulverise and shatter the straw which makes it harder to bale.

When the header was delivered it came with different spinners to those that were described in the pamphlet, but these actually work better with Barry's new system. The spreaders have been removed from the back of the header.

The spinners have been reversed so that the chaff is directed towards tubes (heavy duty PVC, 30mm) that have been fitted to the area adjacent to the spinners. The chaff is blown down the tubes and deposited on top of the straw windrow. The header has a flap that hangs behind the sieves and directs all of the material into the spinners. Barry believes the reason this system works so well is because there is a defined separation of the chaff and straw.

An early problem was that the chaff would blow to the side of the straw windrow as the header turned corners. This occurred if the tubes were too long. A piece of carpet was hung between the tube outlets to stop the chaff and drop it to the top of the straw windrow.

Placing the chaff on top of the straw ensures that it is in the hottest part of the fire when the stubble rows are burnt in autumn. It also maximises the chaff and seeds that are included if the windrows are baled.

Windrows have burnt well even after they have received heavy rain. As the straw windrow sits up on the cut stubble and the chaff is on the straw there is plenty of air movement and fuel to achieve a hot burn.

If baling shortly after harvest then the chaff and straw are picked up well and little seed will drop from the windrow.

Barry believes that if weed numbers are high then burn the windrows and do not give weed seeds a chance.

In 2011, Barry planted on 10 inch row spacing and all of the paddock tended to burn. He used 12 inch spacing in 2012 to stop the fire trickling out of the windrow.

Sections of tyre and a strip of carpet make up a low cost chaff direction system.

The chaff and weed fraction is deposited on top of the straw windrow. This placement maximises the fuel load under the weed seeds for burning and ensures that the little of the fine fraction escapes should the windrow be baled.

Barry Gray explains the changes he has made to the set up of his header.

Barry has observed that in denser crops or those with narrower row spacing the ryegrass and other weeds are more upright. This makes it easier to harvest the weed seeds along with the crop. In crops that are not as thick or planted at a wider row spacing, there is more likelihood that the weeds will fall down between the crop plants or trail on the ground.

Burning the windrows this autumn (2013) was much easier and less stressful, with the 12 inch row spacing, as the fire mostly stayed in the windrows. Using a 12 inch row spacing may compromise the number of seeds coming into the header as discussed above.

Barry comments that he could have achieved even better results with the autumn windrow burning this year but made two mistakes. The first was grazing sheep on some paddocks, which moved the chaff off the top of the windrow. The second was not allowing the straw to dry out enough after a heavy March rain, as Barry believes it needed at least a week to dry out.

The result

Weed numbers are declining. The worst paddocks go to hay initially and are becoming manageable.

In terms of efficiency in collecting the weed seeds, Barry feels that the chaff cart was 50–60% at best and the new system that he has introduced is nearly 100% (of what is taken into the front of the header).

Ideas for the future

Barry recognizes that burning may not be accepted by all growers and he is keen to try other methods for managing weed seeds at harvest. Options that Barry is considering are:

- Barry would like to spread the straw and concentrate the chaff in a row no more than 300mm wide. Later on he would spray out the windrow in the crop in July or August with a shielded sprayer using a robust rate of knock-down ($20/ ha). With a 42 foot header front this amounts to less than 4% of the total paddock area or $0.80/ha.
- Another option Barry is considering is to spread straw and concentrate chaff as in above but spray a band of residual chemical on the ground in front of the windrow (using a 500L tank and electric pump mounted on the header).

Future predictions

"Due to decreasing and more variable growing season rainfall, growers from a large area of the wheatbelt will include a fallow in the rotation to lower inputs and to stabilise yields. This may lower profits but make them more sustainable".

– Barry Gray

Barry Gray checks the position of the chaff fraction in the stubble windrow.

Mark Pearce – Tarin Rock WA

Size of operation (ha): 2700ha, Cropping 2200ha remainder in pasture.

Enterprises: Wheat, canola, barley, oats (all for grain) and sheep (merino ewes and SAMM lambs, sell all progeny).

Climate (rainfall pattern, GSR, AAR): 320mm AAR, rare to get over 200mm in GSR.

Soil types: Sandy gravel to loam, no heavy clay.

Mark and his family have been on their property for 9 years. There was herbicide resistance on the property when Mark took over. A herbicide resistance test was conducted in 2005 and the annual ryegrass was found to be resistant to Group B.

A more recent test has shown that there is increasing resistance to Select®, Atrazine/Simazine and Trifluralin. Most of the cropping program is sown dry so Mark is not yet seeing a problem with glyphosate (as it is not being used as a knockdown), but Mark suspects that it is there.

All of the sheep were sold in 2008 and there have been no sheep on the property until they were reintroduced in 2010. Mark plans to increase the numbers into the future.

Mark has made further modifications to the chaff cart and it now boasts a covered conveyor (old model pictured here).

Mark started using stubble windrow burning in 2004. That year the windrows were quite thin and the burn was not sufficient to kill the seeds. As a result, there were weeds growing in the windrow strips for several years after this initial treatment.

Mark has watched as his neighbours had continued issues with the strips coming back (often in various spots all over paddock due to the windrows not always being put on the same location each year), even with very hot March burns. Mark attributes much of this failure to a lack of stubble bulk.

Mark thought that collecting up the seeds and putting them in piles would be better. A chaff cart was bought in 2005, and the heaps were burnt during the periods with no stock.

The chaff cart was bought second hand and Mark estimates that in 12 months it had paid for itself. Less money was spent on operating the chaff cart than on grass selective herbicides in that year.

Burning the heaps seemed like such a waste of feed to Mark. Stock were reintroduced in 2010 and Mark has not had to provide supplementary feed to stock since they have been chaff carting. The sheep get enough from the heaps.

Mark no longer carries out pasture manipulation (winter cleaning) as this relies too much on grass selective herbicides,which either no longer work or that Mark would like to retain for use in higher value crops. Pastures are spraytopped in spring.

Hay is cut on the worst weed patches and Mark tries to rely on the rotation to get the remainder under control.

The result

To date most success has been with controlling wild radish. Mark used to spray for radish twice each year. Now he is only spraying when he needs to in-crop and although there are some late germination's that set seed they seem to be controlled through the chaff collection.

There is more brome grass coming up and Mark is considering making changes to the herbicide regime. He thinks that this increase in brome grass is in response to burning, i.e. brome grass is more tolerant to burning. Metribuzin did not work in the barley during the 2012 season due to environmental conditions. Bad brome paddocks will be harvested using a chaff cart and then returned to pasture. The worst patches will be sprayed out with glyphosate. However, the brome grass problem is not as bad as when he first took over the farm, when some of the grain could not be delivered due to brome contamination.

Marks' enterprise used to be primarily cropping to maximise income but the herbicides ran out of puff. He has shortened the rotation up with a one-two year serradella pasture phase then canola and then two cereal years (wheat, barley, or oats). Cereals are about 25% each of wheat, barley, and oats plus canola in the program each year. Mark stopped growing pulses, as the returns were not there and the yield was unreliable.

Some paddocks have been in cereals for 6 years.

The shorter rotation for weed management relies on the chaff cart to maintain the weeds at a low level after the cereal phase. Mark sows all pastures in their first year to get a good establishment. Including the pasture phase allows the annual ryegrass to germinate and Mark can then clean it up with grazing and spray topping.

The second year of cereal receives a treatment of Sakura® to rotate with trifluralin.

Mark is considering removing oats from the program as they are proving to be a weed control issue although they do grow on the ironstone country (where Mark finds it difficult to grow anything else).

Barley grass has mainly gone now, and Mark believes they are definitely winning on the radish. 2011 was the first year that Mark has seen brome grass survivors when it came up in September following spring rains.

By September the year after being made, the chaff dumps have been well grazed. The residue remaining has tended to 'mulch'.

Sheep lower the chaff dump to about 50mm during their summer grazing. They do not spread the dump very much at all, although Mark plans to start raking around the heaps to improve burning.

Mark has observed that dumps do not blow very much as the top surface tends to thatch like a hay bale and it takes a big wind to move them. Sheep are mated onto barley stubble (as there is lots of good feed in a barley heap) and the lamb percentage is increasing. An estimated 2-3% of seed will pass through the sheep's gut.

Making it work

Mark tries to dump the chaff in lines (which makes it easier to burn). Initially Mark was putting the heaps closer to the fences as this would then localise any weed blow out from insufficient grazing or burning. These 'blow out' areas could then be treated by cutting the area for hay. However, Mark had too many fires escaping and damaging bush and fences.

The chaff dumps are grazed up until April. Mark starts burning the remaining residue from the first of April (as soon as the prohibition is lifted). Dumps are burnt in the sequence that the paddocks will be sown. The canola paddocks first followed by the barley, oats and wheat. Mark tries to burn before the first rain and he generally doesn't burn paddocks going into pasture, but will burn them in September if not fully grazed out.

Simon, Matt and Peter Kerin – Katanning WA

Size of operation (ha): 5264 ha, with approximately 3650 ha arable.

Enterprises: Wheat, canola, barley and export hay. 300 white Suffolk stud ewes (Ashbourne). 400 Prime SAMM Stud ewes (Rockdale) plus 2000 commercial Dohne ewes.

Climate (rainfall pattern, GSR, AAR): 350mm AAR and 286 GSR.

Soil types: Sand, clay and gravels.

The Kerins have been on their property since 1967 and were in fact the first growers in WA to use trifluralin.

They have cut export hay for the past 5 years and cut their oats slightly earlier than they used to, to ensure that they capture weed seed set. Hay has made a big difference to the weed burden and the out of control paddocks are back in line. The export hay paddocks are sprayed out after baling and then treated again with Gramoxone® after they reshoot. Hay is grown in a paddock for two consecutive years. The Kerins believe this makes the best hay, as paddocks can be weedy going into the hay phase.

The area sown to canola has increased over the last 5 years. Canola is direct headed after desiccation. The Kerin's stopped growing legumes (lupins and peas) about two years ago.

Simon Kerin checks the stubble from a chaff dump.

The Kerins will be rotating Sakura® with trifluralin. They have been trialling Sakura for the past two years, though one of those years was dry which did affect it's efficacy.

Approximately 20–30% of the canola is sown dry. If not sown dry, the Kerins try to have a double knockdown.

The Kerins try to rest paddocks from cropping for 3 years, returning the paddock to pasture.

Annual ryegrass is resistant to groups A and B herbicides. Samples were tested for group D in 2009, and there was no resistance at that time.

The Kerins test when they see or suspect a problem. They are aware of the potential for radish to develop herbicide resistance, and of herbicide issues as a result of management failure. They have had a good kill by changing chemistry (Jaguar® early then follow-up with Tigrex®) and aiming for better spraying conditions.

Radish resistance is a concern for the Kerins as they are aware of the situation in the Northern Agricultural Region of WA.

Prior to getting into chaff carting, the Kerins had previously burnt windrows for about 3 years. They had trouble getting the windrows to burn and the process of burning all of the windrows took a long time that ultimately ended up clashing with seeding. They also noticed that barley windrows seemed to burn along the top rather than into the whole windrow.

The Kerins bought a second hand chaff cart in the September/October period prior to the harvest of 2011. They then re-built the chaff cart to suit their needs.

The result

Since using the chaff cart annual ryegrass has decreased, although they are still finding rows where the windrows used to be (this is two years after they ceased to windrow). Generally the paddocks are cleaner.

The Kerins estimated it could take 3 years for the chaff cart to start making an impact.

The collected chaff provides good grazing for the sheep. There is no or less need to provide supplementary feed over summer.

The Kerins had been concerned that the heaps would be spread by the stock therefore they wouldn't be able to get a good burn on them, but this has not happened. They were initially concerned that the sheep could spread the weed seeds, by getting chaff on the backs of their necks during feeding (by burrowing into the heap to feed). However, by making the heaps a little flatter this does not happen. The chaff cart door is opened more slowly so it drags along the top of the heap making it flatter.

Making it work

The Kerins purchased a second hand chaff cart with a vacuum blower kit attached. They removed the blower kit, and added a draper type conveyor system. The hydraulics on the header were also modified so that the chaff cart could be operated from the header (this cost approximately $3–4,000). The chaff cart cost approximately $15,000 with about the same amount again being spent on it to rebuild it to suit the Kerin's needs (plus labour). Cameras were also added to the back.

A draper type conveyor has been added, based on the way that Lance Turner in Pingelly had set his chaff cart up. Peter visited the maker of this chaff cart to see the plans, however it was too late in season for the manufacturer to make one for them.

The cart has a long draw bar which makes it ideal for adding a conveyor to. However care needs to be taken when turning as the shaft is less flexible. Further alterations were made during the first harvest to modify the attachment and configuration of the cart and header to improve turning the combination.

The conveyor on this chaff cart reduces the amount of chaff 'lost' between the blower and the cart.

Dropping the heaps in rows across a paddock makes it easier to manage when burning later. This also keeps them in a known area in case additional management is required later, such as follow-up spraying.

Keep chaff heaps away from structures, trees and fences as this will reduce risk of fire damage when burning later in the season.

The chaff heaps burn overnight when more straw is added to the piles (compared to the dumps from a traditional vacuum blower chaff cart which can take 2–3 days to burn). By adjusting the spinners on the header, or the straw chopper, you can alter the level of straw that is collected in the cart.

James and Nina Hope – Kojonup WA

Size of operation (ha): 2000 ha

Enterprises: Merino sheep and cropping (wheat, barley, canola, lupins and oats).

Climate (rainfall pattern, GSR, AAR): 500mm AAR.

Soil types: Loam and gravel soils, acid soil problem, aluminium toxicity.

This is a family property that James has been managing since 1999.

James has not done any testing for herbicide resistance and he is still achieving good results with Select®.

Annual ryegrass is the most serious weed on the property and wild radish is hand-picked.

There are areas of the farm that are in a continuous crop rotation, with crop-topping in lupins being used over the last 3 years. James has started growing oats again after a four year break. James also practices minimum tillage. Other practices include swathing canola and using a double-knockdown where possible, though this is dependant on the season.

Canola gives the best returns. James has had two attempts at Roundup Ready® canola but has so far been unable to control the late germinating ryegrass. Metolachlor has been used post-emergent in Roundup Ready® canola but it did not work as well as expected.

When wheat crops were unexpectedly weedy James wanted to stop the ryegrass seeds from hitting the ground and a chaff cart was introduced in 2010.

The result

James believes that the chaff cart is really starting to make big in-roads into the ryegrass population. He has been using the chaff cart for three years now and is starting to see the results. Some of the paddocks have had a larger weed seed bank than others and these are taking longer to bring under control, but James thinks that by the end of the 2013 season he should have about 80% of the cropping paddocks with manageable populations of annual ryegrass.

There are still problems with the grasses that shed seeds prior to the header getting to the paddock (e.g. wild oats and brome grass). However, James believes that the shedding weeds are not spreading further through the affected paddocks. There will be a patch of that particular weed and it will stay in the same place. Approximately 30% of the seed is retained at crop maturity and these seeds are collected by the header and most of these seeds should end up in the chaff cart.

The chaff carting has also benefitted the sheep enterprises. Chaff is dumped on the drains,

dam banks and rock heaps. The sheep eat the dumps and the dumps are not burned.

The sheep do well on the heaps with stock run at 15 dse/winter grazed hectare. Adult sheep tend to get into the heaps better than the other lines.

James is concerned about nutrient removal and getting (and keeping) soil cover.

Making it work

The chaff cart is a second hand 'blower – type' model. James feels that a covered conveyor type uses less horsepower, has less moving parts and it is easier to take off the header. James would prefer a conveyor type chaff cart but the farms current header will not take a conveyor type chaff cart.

The cart is close to what they started with originally. A new blower was purchased and this took a while to fit. James had some problems with losses from the sieves to the chaff auger but they have now been fixed. When the machine corners some chaff is lost to the sides as the auger is static.

When all is said and done a chaff cart is only a tool – if the seed has already dropped before harvest then the chaff cart can't collect it. Wild oats continue to be a problem as they are dropped fairly early.

James believes that they need to get better at harvesting lower. Dwarf varieties help to lower the amount of biomass through the header, although wheat can be a bit slower. Weed management and seed control is critical, as it is possible to grow a crop on low rainfall but not if there are weeds.

Chaff dumps are placed in areas that will not be cropped such as drains, dam banks and rock heaps.

Craig Bignell - Broomehill

Size of operation (ha): 6000 ha (WA cropped area).

Enterprises: Wheat, canola, barley, field peas/lupins.

Climate (rainfall pattern, GSR, AAR): 400mm AAR, 280mm GSR.

Soil types: Duplex soils.

Craig Bignell harvesting.

This property has been a family farm for the past 50 years. Craig shares the management decisions with his father. Of the arable area 95% of the property is cropped each year. Currently there is confirmed resistance to Group A herbicides.

Craig believes that annual ryegrass is probably their worst weed. In some paddocks there is a lot of annual ryegrass and current control measures are struggling to make a difference.

The Bignells started using a chaff cart 5 years ago and now have two machines, one for each header.

The result

The outcome is good if collecting 75% (or more) of the grass seed heads into the header. The results are better with wild radish.

Often where seeds shed prior to harvest the 75% goal is not reached.

There are some paddocks with lots of annual ryegrass and the chaff cart is struggling to make a big difference here. Craig finds that the chaff cart is good at keeping the clean paddocks clean for longer.

There is a cost to towing the chaff cart. Extra capacity is needed in the header as a lower stubble cut is required to maximise the weed seed entering the header front.

Harvest in full swing on the Bignell property in Broomehill.

Making it work

Craigs' chaff cart has two blowers on either side, to get chaff from the chopper to the cart. This aids with moving large quantities of chaff and gives fewer losses.

Some chaff misses the cart when cornering and the Bignells would like to reduce this. Craig is looking for a new cart for the future and will tend towards a conveyor type.

Craig believes he needs to try to dissipate the air vortex when chaff enters the cart as this vortex can take the weed seeds with it.

In an attempt to optimise getting the weed seeds into the cart, Craig has swathed crops in the past. This does work quite well, though Craig believes that improvements need to be made in how well the swath rows are picked up. If crops are planted on a 10 inch row spacing the swath can drop into the inter-row spaces.

As an alternative to operating a chaff cart Craig suggested that swathing crops followed by windrow burning may optimise weed seed collection and control.

It is important to make the job easier for burning. The burning process can take a few months. Burning usually starts in March and can continue until May, dependant on weather conditions.

Burning barley stacks can be difficult if they have been hard grazed. Generally one third of the stack is left after grazing. The bottom section of a barley heap can be difficult to burn as it can be moist.

The Bignells have noticed that chaff from the dumps can get into the wool during grazing. They have partly overcome this by altering their shearing date. They have found that the worst wool contaminator is barley followed by wheat, canola and legumes.

Chaff is dumped in lines across paddocks to make it easier at burning time.

Wayne Pech – Gnowangerup WA

Size of operation (ha): 13,000 ha (85% arable)

Enterprises: Canola, wheat, barley, lupin, peas and faba beans (if these are not planted by mid-May they are dropped out of the program). Plus 30,000 merino sheep, some cross bred.

Climate (rainfall pattern, GSR, AAR): GSR 250-275 mm, AAR 350mm.

Soil types: Light sand to duplex (sand over clay), and red/grey clays.

This property has been in the Pech family since 1965 and Wayne has been managing the property for the past 15 years. Detailed crop and rainfall records are available for the last 20 years.

There have been no major management changes with the exception of setting up the paddocks for stubble windrowing.

Wayne has tested for herbicide resistance in the annual ryegrass which was found to be resistant to Group's A and B. Wayne does not consider that the resistance problem is 'out of control' at this stage and has implemented the windrow burning tool to target annual ryegrass, barley grass and wild radish, the problem weeds on the property.

Canola crops are swathed and the stubble is windrowed at harvest.

Other weed management techniques being used on the property include rotating crops, spraying glyphosate when swathing, crop-topping lupin crops, using pasture manipulation (Verdict® and simazine) and running more sheep.

Dealing with the problem

Two years ago Wayne set up windrowing at harvest, for stubble burning in the autumn. Last year he made the windrows narrower, to maximise the fuel in each windrow. Only certain crops are windrowed. Canola, lupins and peas, are windrowed but not the cereals. The cereal crops are not windrowed as Wayne does not want to burn all of the biomass. There is also more management required to get the burning just right when burning cereals as the fire can creep across the inter-row and the whole paddock will burn.

Approximately 50% of the farm is cropped each year, with some paddocks in a continuous crop cycle. However, if the weeds are starting to become a problem then the paddock is rotated to canola and then peas. If the weed situation is very bad the paddock is dropped back to pasture.

The result

There is a noticeable difference in the amount of ryegrass present in the paddocks since they started windrow burning. The effect is most noticeable in the paddocks where the burning has been done too late or missed completely (due to seasonal and time constraints). For example, some lupin windrows were burned too late (or not at all) and the burn was not

A simple arrangement of metal flaps are attached to the rear of the header to concentrate the straw into a narrow windrow.

effective (compared to burning at the ideal time). The burned and unburned rows in this paddock are very visible and show the importance of timely burning of rows. This paddock was cropped with Roundup Ready® canola in 2013 in an effort to control these concentrated strips.

Making it work

Wayne uses two headers on the property. After removal of the straw storm, metal flaps were fitted on hinges (joined with chain) to the back of the header. These flaps are attached using two screws. It is very easy to remove these flaps when changing from canola or legumes to harvesting cereals.

The stubble paddocks are grazed after harvest. The stock do not seem to spread the windrow material or knock the weed seeds out of the windrow.

The process of burning the windrows starts in autumn (March/April though sometimes a little later). There are usually about 1000ha to burn. The Pechs use a gas lighter mounted on a ute to start the windrows burning and 1–2 people are required to run the operation. This takes about a week if they get a good run at it. It takes longer to burn windrows in colder conditions.

Wayne has found that broad-leaf crops are safer to burn than the cereals, although the stubble from these crops can be lighter. To maximise the material in the windrow Wayne combines two swaths of canola or peas. This concentrates the stubble from an approx 80 foot cut into a swath. Following harvest this makes a denser windrow with more fuel for burning.

Wayne has not really had any problems with windrow burning and finds the process quite easy.

The arrival of Sakura® and Boxer Gold® have given a few more herbicide options, however, Wayne is taking care with their use to maximise the longevity of these herbicides.

Making windrows in a canola crop.

Doug and Kerry Smith – Pingrup

Size of operation (ha): 2500 ha (with no sheep).

Enterprises: Canola, wheat, barley, pulses.

Climate (rainfall pattern, GSR, AAR): AAR 275mm.

Soil types: Light sand to duplex (sand over clay).

Doug Smith from Pingrup, has been narrow windrow burning for annual ryegrass and other weed seed control for eight years and believes this to be a very successful weed control technique provided you get a hot burn.

Doug windrows every year, even in paddocks with low weed numbers. He windrows all his crops, including pulses, except for barley. Fire can more easily spread outside barley windrows and burn the whole paddock. Canola stubble on the other hand, is easy to burn and fire stays in the windrows well, generally burning hotter compared to other stubbles. Doug saves the canola stubble for burning in more difficult conditions as it is more reliable and always burns well.

Doug uses the FESA McArthur Index, a scale used to calculate the fire danger in grassland using temperature, humidity and the wind speed to calculate an index. Doug uses this scale, however, to give him a guide to the best windrow-burning conditions. As a rule of thumb, a Fire Weather Index of:

- Less than 15 will give a reasonable burning result.
- 8-10 is good (and ideal).
- Two and lower will not give a good result (too cold and humid).
- Greater than 15 carries the risk of the fire getting out of control.

Flaps fitted to the rear of the header direct the straw into narrow windrows.

Tips on windrow burning from Doug Smith

- Light windrows at 90 degrees across or diagonal to the windrow (rather than along) as this prevents the fire developing a face which can carry between the rows. Ideally rows should burn to meet each other in 75 metre segments (in good conditions this only takes 25–30 minutes).
- Best burning conditions are in the second half of March.
- Plan to commence burning just on dark when it is cooler but also plan to be finished burning when the dew falls (this limits stubble smouldering and flare-ups during the next day).
- This time constraint means that only 200–300 hectares (per team) can be burnt each night.
- You can use 'Meteogram' weather forecasts for your area. Meteograms predict weather variables such as wind, temperature and humidity up to 7 days ahead. There is a range of internet sites you can subscribe to.
- Don't guess the conditions. Measure them and take a note of the result as every year is different so you may need to use a lower or higher fire index to get the right burn.
- Doug has observed that shorter crops on lighter country often have lower, fluffy flag leaves which help the fire to spread outside the windrow.

Major findings

Use of chaff carts and stubble windrow burning for harvest weed seed management can be as effective in the Albany Zone as they are in the northern regions of WA.

The growers' featured in these case studies have all been using harvest management techniques for a number of seasons, and in some cases they have tried more than one option.

All of the growers have made modifications to the system they are using to tailor it to their specific needs.

These modifications include:

- Adapting conveyors to chaff carts to maximise chaff capture,
- Altering the position of the chaff fraction on the stubble windrow to optimise weed seed burning or baling,
- Focusing on specific crop types to apply the technique to. Broad-leaf crops are better than cereal crops for wind-row burning, due to risk of fire escapes.

"We have found that stubble windrows of broad-leaf crops (canola and pulses) are safer to burn than the cereals, although the stubble from these crops can be lighter. Combining two swaths of these crops will make a denser windrow."

– Wayne Pech, Gnowangerup.

"We have not had to provide supplementary feed to stock since we have been chaff carting. The sheep get enough from the heaps."

– Mark Pearce, Tarin Rock.

Chaff dumps are routinely grazed by many of the growers and this reduces the time required to burn the dumps in the autumn. The amount of supplementary feed that needs to be grown or purchased is dramatically reduced.

Those growers that are using chaff carts feel that the 'conveyor' models are more effective.

The methods of chaff carting and windrow burning, are only at most 75% effective and this percentage is strongly influenced by the amount of weeds that enter the header in the first instance. Observations at harvest in a number of the crops visited indicated that about 20–25% of the grass seed heads were left behind after the header had passed. Those seed heads remaining were the ones that were lying on the ground or from very small plants which were possibly late germinating specimens.

One grower observed that the crops planted on wider row spacing or those that were growing more sparsely have more seed heads growing below the level of the header cutter bar.

"The chaff cart that we used to run was 50–60% at best in terms of collecting the weeds seeds. The new system that we are using now is nearly 100% effective (control of those seeds that are taken into the front of the header)."

– Barry Gray, Kukerin.

"A chaff cart is only a tool – if the seed has already dropped before harvest then the chaff cart can't collect it."

– James Hope, Kojonup.

There are still problems with the grasses that shed prior to the header getting to the paddock (e.g. wild oats and brome grass).

However, one grower believes that the shedding weeds are not spreading further through the affected paddocks. There will be a patch of that particular weed and it will stay in the same place.

Approximately 30% of the seed is retained at crop maturity and these 30% of seeds are collected by the header. Most of those seeds should end up in the chaff cart, and the remaining 70% of the seed drops back into the patch.

Wild radish appears to be well controlled by harvest weed seed collection. In general it has an upright growth habit and retains seeds in pods that are easily harvested and then dealt with in the chaff fraction.

"Burning the chaff heaps can take 2–3 days. Adding more straw to the heap makes it burn better."

– Simon Kerin, Katanning.

"There are some paddocks with lots of annual ryegrass and the chaff cart is struggling to make a big difference here. The chaff cart is good at keeping the clean paddocks clean for longer."

– Craig Bignell, Broomehill.

Factors that limit the effectiveness of these techniques in the south of Western Australia are mainly environmental in nature. They include:

- Wet and/or windy weather prior to and during harvest reduces the amount of seed retained in the weed seed heads that can then be taken into the harvester.
- Rainfall during the early autumn period when windrow and chaff dump burning is in progress.
- In addition, the inability to harvest at or close to ground level limits the effectiveness of the seed collection techniques.

"We have been narrow windrow burning for more than eight years and this is a very successful weed control technique provided you get a hot burn."

– Doug Smith, Pingrup.

The role of harvest weed seed control tools in driving weed numbers down

It is important to take a long-term approach to weed control. This is where the real value of the harvest weed seed control tools becomes apparent – as part of a system including both early-season weed control practices (herbicides etc.) on weed seedlings, and harvest weed seed control on late-season mature seed bearing weeds.

The combined impact of herbicides plus harvest weed seed control over 10 consecutive seasons (2002 to 2011) on annual ryegrass populations was monitored in 25 large commercial Western Australian cropping paddocks (Figure 5).

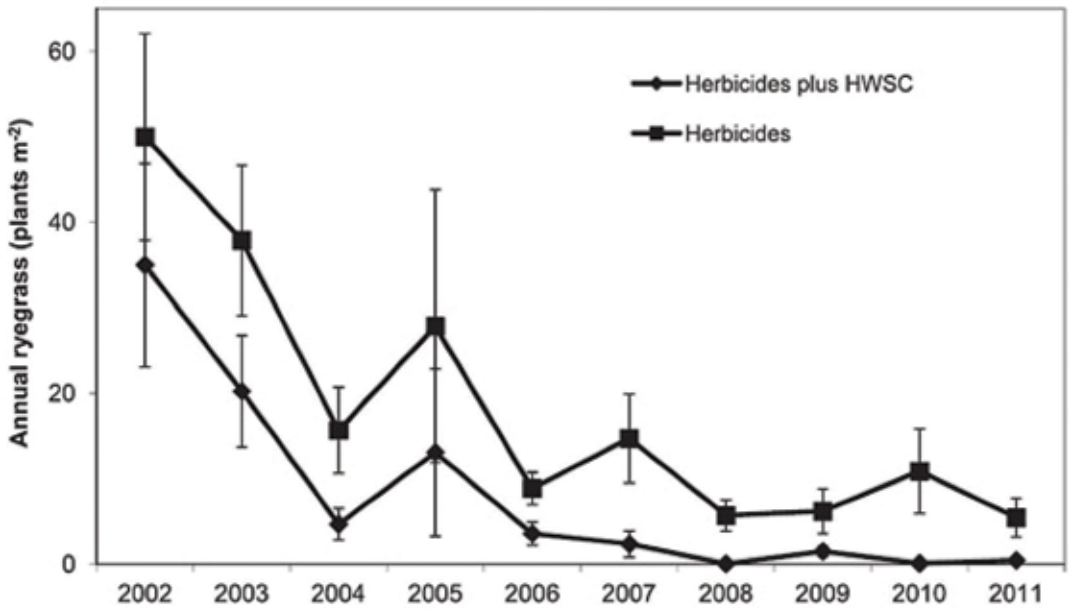
Growers nominated "problem paddocks" with high (35 to 50 plants / m2) in-crop annual ryegrass densities for this focus paddock study.

Over 10 consecutive growing seasons, herbicide focused weed management practices were implemented on these paddocks to reduce annual ryegrass populations.

Unsurprisingly, effective herbicide treatments reduced in-crop annual ryegrass populations within five consecutive growing seasons (Figure 5).

However, it was only in the paddocks where both early-season herbicides and harvest weed seed control were routinely practiced that very low weed densities were achieved. Therefore, combining both herbicide and non-herbicide weed control methods is crucial for achieving and maintaining low weed seed bank numbers.

Figure 5. Influence of the long-term use of herbicides alone and herbicides plus harvest weed seed control (HWSC) on in-crop annual ryegrass plant densities in northern WA cropping fields. Capped bars represent the standard error values showing variation around the mean annual ryegrass populations in 17 fields (Herbicides) or 8 fields (Herbicides plus HWSC). (Source Peter Newman)



How much do they cost?

A tool such as narrow windrow burning may appear inexpensive on face value, however when the cost of nutrient removal (mainly N & K) is included, the true cost of this practice increases (Table 1). Similarly, the cost of the Bale Direct system can be recouped, and in some cases profit made when bales are sold.

The scale of the farming program also needs to be considered when comparing the costs associated with each of the harvest weed seed control tools.

The HSD appears very expensive on face value, however, given that there is no nutrient removal with this practice, the cost of the HSD is relatively similar to other options if the capital cost is averaged over a large enough harvest area (Figure 6).

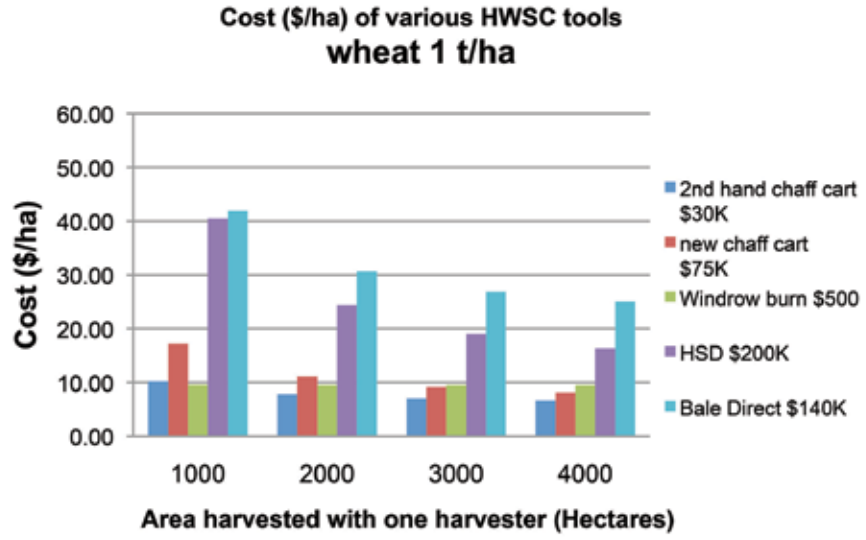
Table 1. Cost ($/ha) of harvest weed seed control tools for differing areas harvested with one machine. Cost includes finance, labour, fuel, repairs and maintenance and nutrient removal. Assumes a wheat crop yield of 2 t/ha. Nutrient removal cost assumes 50% nutrient efficiency. (Source AHRI)

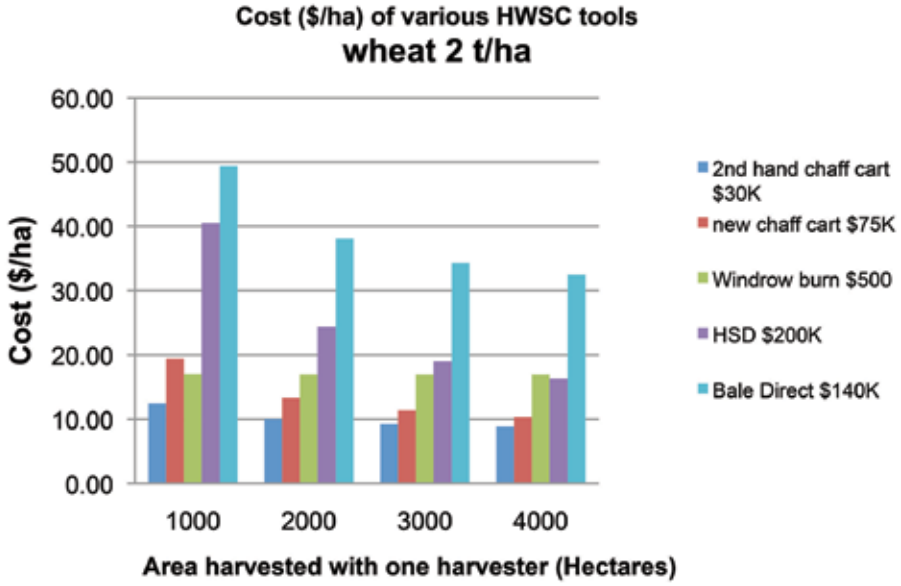
Area harvested with one harvester (ha)

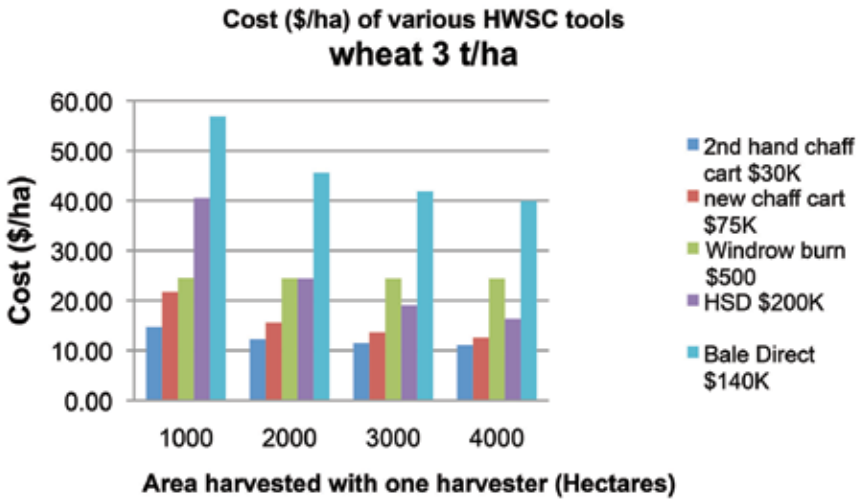
	1000	2000	3000	4000
Second-hand chaff cart ($30K)	12.46	10.05	9.24	8.84
New chaff cart ($75K)	19.41	13.37	11.36	10.35
Windrow burn ($500)	17.01	16.97	16.96	16.95
HSD ($200K)	40.51	24.40	19.04	16.35
Bale Direct ($140K)	49.38	38.10	34.35	32.47

**$ cost in ( ) represents capital cost of machinery.*

Figure 6. Sensitivity analysis (cost $ / ha) of windrow burning (green), new (orange) and second hand (dark blue) chaff cart, HSD (purple) and Glenvar Bale Direct (light blue) across differing cropping program sizes and grain yield per ha. Costs include nutrient value in residue. (Source AHRI)







Summary

The practical implications of harvest weed seed control are a more resilient farming system with some insurance against further resistance evolution.

The combination of effective herbicide use, plus harvest weed seed control techniques has been shown to reduce and maintain weed populations at very low densities.

In cropping systems, low weed densities, regardless of their herbicide resistance status, allows flexibility in crop choice, seeding time and herbicide use.

This flexibility provides growers with the capacity to readily adjust farming practices in tune with seasonal and market considerations.

Department of Agriculture and Food

GRDC Grains Research & Development Corporation

SouthernDiRT

AHRI Australian Herbicide Resistance Initiative

Further Information

For further information on harvest weed seed control, and more detailed financials for each of the harvest weed seed control systems, visit **www.ahri.uwa.edu.au/Research/Management**

Further factsheets and information can be found on **www.grdc.com.au/Research-and-Development**