



Investigating harvest weed seed control tools in low biomass crops in the Kwinana East Zone



Grower case studies from the Kwinana East Port Zone

An initiative of the Kwinana East Port Zone Regional Cropping Solutions Network Prepared by Dani Whyte and Peter Newman, Planfarm

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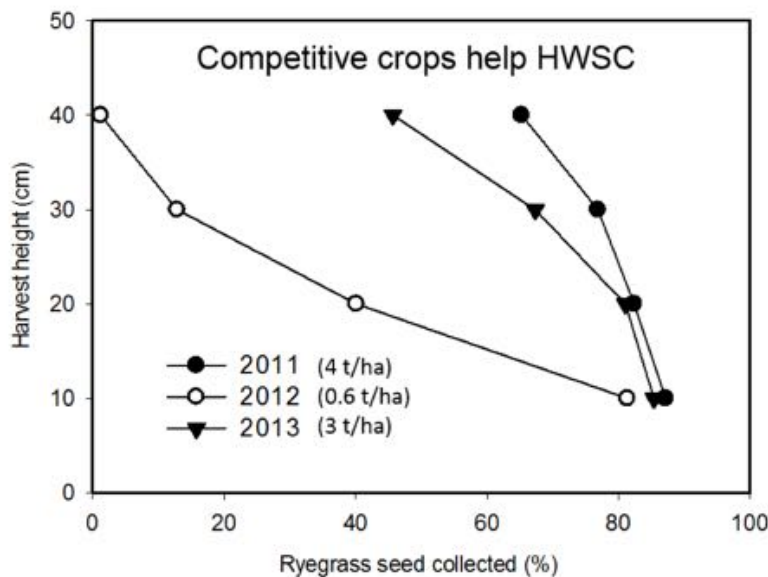


Dani Whyte

BACKGROUND by Peter Newman

The very first aspect of HWSC is to get the weed seeds into the front of the harvester. Growers in the low rainfall regions of Western Australia often harvest low yielding crops in the order of 0.5 to 1.5 t/ha for cereals. As a result of the low yields in this region it is essential to run a low cost farming operation to generate a profit. High levels of crop competition are difficult to achieve in this low-cost, low-rainfall environment. Crops in this region are often sown on wide rows (30cm plus), at moderate seeding rates, and the dry conditions are not conducive to growing high biomass. These farms are often of a large scale so it is necessary to sow a large area of crop with each seeding unit in a timely fashion, which is one of the reasons for wide row spacings. All of this contributes to the challenge of effectively getting a high percentage of the weed seeds into the front of the harvester for the effective use of harvest weed seed control. For these reasons, the growers of the Kwinana East RCSN were keen to undertake some case studies in the region for growers to share ideas on capturing weed seeds in a low biomass environment.

There has been some research on harvest height and the collection of weed seeds, but there has been very little research into machinery modifications that can improve the number of weed seeds entering the front of the harvester. The data below is from a paper by Dr. Michael Walsh that is yet to be published at the time of writing. It shows that as wheat crop yield decreases so does the ability to capture ryegrass seeds at harvest, therefore it is much more challenging to capture weed seeds in lower yielding crops.



In high yielding cereal crops (2011 and 2013 in this example) it is possible to harvest at 20 or even 30cm from the ground and still collect most of the ryegrass seeds in the crop, however, harvesting this high in a low yielding crop (2012) resulted in most of the weed seeds escaping under the cutter bar. Anecdotally we know that this effect is even worse with other weed species such as brome grass, however weeds such as wild radish generally retain their seeds higher on the plant regardless of crop competition. We have also seen anecdotally that wide row spacings give weeds greater opportunity to lodge and escape under the cutter bar.

What this research does show that it is possible to achieve 80% ryegrass seed capture, even in low yielding crops, by harvesting at 10cm from the soil surface. Therefore, one aspect of weed control that is sometimes overlooked but is very important is rock picking! In the case studies that follow you will read that many growers in the Kwinana East region are committed to harvest weed seed control and have been for many years. However they are all challenged by the first hurdle of capturing weed seeds with the front of the harvester. Very low harvest height is one common thread among all of these grain growers, and many have made minor modifications to the front of their harvester to maximise both grain and weed seed capture. However, there is no simple solution to this problem, and while the growers are currently doing their best with the resources they have, there is a strong argument for some engineering developments in this area.

Quick tips for harvest weed seed control in low biomass crops

The most common tactics used by grain growers in the case studies in this book to maximise weed seed capture in low yielding or low biomass crops focused on increasing crop competition, a well set up header front and at harvest cutting low and harvesting weedy paddocks first.

Crop competition

- Establishing competitive crops: e.g. sowing early, increased seeding rates and east-west sowing. Choosing competitive varieties, particularly for weedy paddocks.
- Reduce row spacing to 'hold weeds up' in the crop canopy. This may not be a popular option in the low rainfall zone, however some growers have achieved reduced row spacing by adopting paired row sowing and / or moving from 12" to 10" row spacing.

Header front set-up

- Extended fingers and a narrow knife guard/ lift kit fitted to header front. • Sharp knife.
- Primary Sales narrow knife guard with plastic extension fingers to capture and hold heads on the front if they want to fall forwards.
- Coreflute attached to the finger tyne reel. This was promoted by Glen Riethmuller from DPIRD to enhance the harvesting of low yielding crops and may also benefit weed seed capture. The coreflute sits approximately 25mm longer than the reel fingers and has a sweeping action to pull grain and weed heads into the header front and prevent them falling backwards off the knife.

Harvest time

- Harvest low – 10 to 15cm off the ground. This sounds obvious but it is still the number one tactic. Low harvest height is only made possible by having paddocks clean of stumps and rocks.
- Harvest weedy paddocks first before weeds shed their seed or lodge. This may require cleaning of the harvester before shifting paddocks if there is a particular weed or weed resistance problem that is being contained.

The options above are all modifications that grain growers have made that they believe is helping to capture weed seeds at harvest in low yielding / low biomass crops, however unfortunately there is limited research data to back up these observations at this stage.



Tim and Brian Cusack

Windrow burning and double breaks winning the war on radish

Owners:	Tim & Brian Cusack
Location:	Narembeen, Western Australia
Farm Size:	7800ha, 100% cropped
Annual average rainfall:	330mm
Soil types:	Sand over gravel yellow sand, salmon gum gimlet
Crop program (2017):	Cereals 3600ha, canola 2800ha, fallow 1400ha
Typical Rotation:	Pea fallow, canola, cereal, cereal, followed by either cereal or canola

Narrow windrow burning of canola has been an effective way to reduce wild radish weed numbers for Tim Cusack, who farms in Narembeen in WA's eastern grainbelt.



IMAGE: Tim Cusack standing in front of his header.

The adoption of harvest weed seed control (HWSC) was a logical choice for Tim following completion of his studies at the University of Western Australia (UWA) with an honours project with the Australian Herbicide Resistance Initiative (AHRI).

Along with HWSC discussions in rural media and research publications, Tim, along with his dad Brian, copied a narrow windrow chute design and fitted to the back of their header that fits easily and is simple to remove. They encountered difficulty burning narrow windrows in cereals as fires tended to escape and burn entire paddocks. Much better results were achieved in canola due to the bare ground and fire not getting away. Additionally, they find that canola windrows tend to burn better following summer rainfall.

With this in mind, they made the decision to focus narrow windrow burning to canola paddocks only, with the residue being spread in cereals.



IMAGES: The Cusack's windrow chute

Approaching HWSC in this way has meant that collecting radish plants in lower yielding canola crops (<1t/ha) is effective and has made a real difference in controlling wild radish populations. While Tim and Brian are focused primarily on Wild Radish, they do target annual ryegrass as well with HWSC. Many growers are concerned that we are selecting for early shedding or prostrate growing ryegrass but Tim believes that because narrow windrow burning only occurs in the canola rotation, prostrate growing ryegrass is not a large concern.

He believes that by doing the same thing year in year out, weeds adapt and therefore you need to mix it up to stay in front of the weeds.

Given the high percentage of canola in the rotation Tim said "burning the canola windrows is an easy job and doesn't take long to do." Tim has noticed a decline in wild radish numbers and he has attributed that to HWSC and an integrated weed management strategy including the use of a double break (fallow followed by canola) and rotation of herbicide chemistry.

The double break and high percentage of canola in the program is especially useful to stay on top of the ryegrass population however ryegrass is not easily captured when harvesting canola as the cutting height is higher than when harvesting cereals and some ryegrass is not collected in the header front.

For this reason, Tim will desiccate canola and try to catch as much ryegrass as possible without compromising on harvest efficiency. Given harvest speed when harvesting canola is slow, he is confident that what ryegrass he can catch, he does. When canola is direct harvested it is cut off about 30-40cm from the ground in canola compared to being able to cut at 10-15cm when harvesting cereals.

IMAGE: The narrow windrow formed when harvesting canola



This compromises the amount of ryegrass seed that enters the front of the harvester. There is no easy fix for this, and swathing of canola is not considered to be a good option in a low cost, low rainfall environment. Wild radish sets its seeds higher on the plant than annual ryegrass and as a result the Cusack's have experienced good results with reducing the wild radish seed bank.

With the cropping program being spread over 40 kilometres, there is difficulty in harvesting paddocks with higher weed burdens early, before weeds shed. However, Tim believes that would be the ideal situation.

With a low weed burden across the farm, dry seeding is something that Tim is confident doing.

Tim attributes the low weed burden across the farm to consistency year after year and using every tool in the toolbox to reduce weed numbers. In the longer term a one pass operation such as the Harrington Seed Destructor or the Seed Terminator would be ideal as the weed seeds in the chaff fraction would be completely destroyed and no viable weed seed returned to the paddock.

It also eliminates the need to burn, especially following summer rainfall where results can be compromised, and the nutrients from the crop residue is spread evenly across the paddock. Moving to such a system will enable Tim and Brian to practice HWSC over their entire cropping program rather than just in the Canola phase. This may increase the risk of selecting for shedding or prostrate weeds and will need careful consideration to ensure that a diverse range of tools are still being used to target the weeds.

Ty and Rachel Kirby

Maximising weed seed capture at harvest in Beacon

Owners:	Ty and Rachel Kirby
Location:	Beacon and Nyabing, Western Australia, 450km between farms
Farm Size:	Beacon 4500-5000ha, Nyabing 2800ha, 100% cropping
Annual average rainfall:	Beacon 300mm, 200mm growing season long term
Soil types:	Salmon Gum loam, Mallee sand, wodjil sand, cracking clays
Crop program (2017):	Beacon: 4200ha 90% of farm sown. Dry seeded majority of program. wheat 3500ha, barley 350ha, canola 350ha fallow
Typical Rotation:	Beacon: five-year rotation: four cereals then canola or fallow, bringing canola back into the system. Double break in rotation for the grass weeds. Nyabing: canola, wheat, barley

For Ty Kirby, harvest weed seed control (HWSC) has become more of a conscious decision. It provides the confidence to sow early and he has noticed a significant decline in weed numbers.



IMAGE: Ty standing in front of his header comb fitted with coreflute.

Originally, Ty started out narrow windrow burning, as a cheap, easy to set up option. However, he ran into several issues both at Beacon and Nyabing, one of which was the significant time and effort it took to burn windrows post-harvest.

In Beacon, windrows lacked the biomass to burn properly, and sufficient heat wasn't generated to destroy weed seeds. This meant that weed seeds were concentrated in the windrow lines the following year.

In Nyabing, there were issues with whole paddocks burning as the fire wasn't easily contained in the windrow. Not being a fan of burning crop residue, Ty began looking at other options.

Two years ago, Ty fitted EMAR chaff decks to both headers. A significant benefit of using chaff decks was its fit with the properties controlled traffic system and it meant that there was no requirement to burn, and it retained stubble.

Chaff decks require a greater investment than fitting a windrow chute, but at the time, the other option was to fit a chaff cart and that was not only more expensive, but also would require additional harvest capacity and potentially slow down harvest.

According to Ty, the chaff deck was relatively easy to fit the first time, and they are easy to take on and off. He has fitted chaff decks to both Case and John Deere harvesters and said they are simple in how they work. "Once fitted, it's just a matter of going harvesting".

Currently every crop type has the chaff deck however, there may come a time when narrow windrow burning is used in canola, but for now Ty is focused on keeping things simple.

"Using the chaff deck means I know where the weeds are and I know where the first germination will be, especially following summer rainfall and I can target them accordingly." Farming in the north eastern wheatbelt has meant Ty has made modifications to his header front to increase grain and weed seed capture in lower biomass crops.

IMAGE The Emar Chaff deck fitted to Ty's header.



IMAGE The chaff deck in action



Weeds, especially ryegrass, tend to grow prostrate in low yielding crops, are easily knocked over, and not harvested when crops are thinner. Ty has fitted Primary Sales narrow knife guard with plastic extension fingers to capture and hold heads on the front if they want to fall forwards.

Harvest speed is dictated by grain losses, so harvesting speed is not pushed. Of concern to Ty, is going to the effort of capturing weed seed and then not collecting it in the chaff line as it passes through the header.

Following a session on harvesting low biomass crops at the Merredin and Districts Farm Improvement Group (MADFIG) field day in 2016, Ty fitted coreflute onto the reel to assist in sweeping grain and weed seed of the knife and on to the draper belt.



IMAGES: (L) The chaff deck (R) Harvesting at Kirby's in Beacon, note the coreflute on the header front.

The coreflute sits approximately 25mm longer than the reel fingers and has a sweeping action to pull grain and weed heads into the header front and prevent them falling backwards off the knife.

The coreflute was a cheap, easy to fit option and Ty comments that “it’s been worth giving a go as the more (grain & weed seeds) we get in the header front, the better.” In the long term, moving to a Harrington Seed Destructor or Seed Terminator of some kind is the plan.

This would eliminate returning weed seeds back to the paddock and weedy tram lines, however, it doesn’t fix the problem of getting weed seeds into the front of the header and Ty sees this as future challenge for his farming system. For the Kirby’s, HWSC is a critical part of their cropping enterprise. Capturing weed seed at harvest, whilst challenging in a low rainfall environment, is contributing to a decrease in weed numbers and confidence in sowing early to maximise opportunity.



IMAGE: (L) Critical to capturing weed seed at harvest is cutting low, here harvest height is approximately 7cm from the top of the interrow

Trevor & Leanne, Ian & Blythe Shadbolt

Ryegrass control reinforces importance of narrow windrow burning at harvest

Owners:	Trevor & Leanne and Ian & Blythe Shadbolt
Location:	Mukinbudin, Western Australia
Farm Size:	6085ha 90% cropping 10% fallow/sheep (sheep/cattle in feedlot situation)
Annual average rainfall:	275mm
Soil types:	Salmon gum, gimlet (clay loam)
Crop program (2017):	Wheat 3800ha, 550ha canola (reduced program due to seasonal conditions)
Typical Rotation:	Continuous wheat and as weed burden increases rotate to fallow or canola

Harvest weed seed control (HWSC) has become increasingly important for Ian and Trevor Shadbolt who farm north of Mukinbudin, in WA's eastern wheatbelt.



IMAGE: The Shadbolts' narrow windrow chute

Ian and Trevor Shadbolt began narrow windrow burning about eight years ago and after 3-4 years noticed a definite decrease in ryegrass numbers. In 2014 they opted to not use HWSC and quickly noticed that weed numbers had built up again and were once again putting pressure on their cropping program.

Two years ago, they began narrow windrow burning again with the view that HWSC control is a long-term strategy, something that you do every year. They now narrow windrow burn every crop harvested, with annual ryegrass the main target species. In years with dry starts, HWSC has become even more critical as weeds germinate later and often outside the activity of residual herbicides.



The narrow windrows following harvest



Modifications made to the windrow ensure that as much weed seed as possible is collected and deposited in the narrow windrow

In this low rainfall environment two things are critical to the success of their farm business. Dry sowing (to get a large area of crop in with one seeding machine at the right time) and lots of wheat.

Reducing the weed burden has definitely meant that paddocks are able to be sown to wheat for longer – their highest gross margin crop. It has also meant that they are less inclined to return some paddocks to pasture for livestock because the weed burden is lower and given the continuous cropping rotation over most of the farm, there is less feed available.

The Shadbolt's ideal scenario is to harvest paddocks with a higher weed burden first to collect weed seed before it sheds, however with a large program, this is not always feasible.

Harvest height has decreased from 20-25cm above the ground in previous years to now as low as possible (<10cm) to capture weed seed. The challenge is to capture ryegrass that grows in a prostrate fashion under low biomass crops or where wild oats shed.

Next year they intend to modify the header front to have a narrow knife guard and extended fingers to try and capture more biomass. This was something they had installed on a previous header front and after a season and a half with the current header and front, is something they feel will increase capture of weed and grain heads.

They are unsure of what else can be done to capture ryegrass that is below the header front. Wild radish seed capture is easier because it tends to stand up more than some of the grasses. Harvest speed is a balance between efficiency, sieve losses and collecting weed seed.

In low yielding crops, less than 1t/ha, they have noted that ryegrass can be hard to collect with the header front because it can grow sideways (prostrate). This prostrate growth habit is not necessarily always a genetic trait of their ryegrass, rather it is a natural response of most grass weeds when growing in low competition situations.

To improve crop competition and force ryegrass to grow upwards, they would like to consider a 10-inch row spacing (currently 12 inch) to increase crop competition. Trevor is confident that they are capturing most weed seed in the header comb, but he is concerned about making sure that weed seed is contained to the windrow so that it can be burnt.



A close up of the windrow chute



Harvesting at Shadbolts

They have found that weed seed will germinate in the crop in a 1-2 metre strip each side of the windrow. As a result, they have attached some rubber to the bottom of the chute to prevent weed seed getting caught in a cross wind and blowing away. Critical to weed control when windrow burning is burning windrows well.

Trevor and Ian are careful not to graze paddocks too hard and to burn before summer rainfall if possible.

Their best success burning has been to light up every 200m across the windrows, allowing the burning to be complete in a timely fashion while favourable weather conditions persist. The family has considered a chaff cart or baler and having the dual benefit of HWSC and the ability to use the chaff and straw in the feedlot. However, in the longer term will be watching the chaff decks and Harrington Seed Destructor and Seed Terminators closely. One thing is for sure, HWSC is part of their farming future. It is not a matter of will they use HWSC, it is a matter of which tool they will choose in the future.



The windrow chute with the narrow windrow formed.

Doug and Vanessa, Mick and Chris McGinnis

Building flexibility into the farming business with harvest weed seed control of narrow windrow burning at harvest

Owners:	Vanessa and Doug, Mick and Chris McGinnis
Location:	Merredin, Western Australia
Farm Size:	5500ha 100% crop
Annual average rainfall:	320mm
Soil types:	20% light, 60% medium, 20% heavy
Crop program (2017):	wheat 3500ha, barley 1000ha, canola 1000ha
Typical Rotation:	long term cereal rotation with opportunistic canola rotation or fallow if needed

For Doug McGinnis, weeds are a numbers game. Farming over a 50km distance with a 100% cropping program, weeds are a significant cost and challenge to his family's farming enterprise.



Image: Doug in front of his header in a wheat paddock

For Doug, controlling weed seed at harvest is just another string in the bow. It provides more flexibility in the cropping system, with a focus to grow more cereals which increases farm profitability.

Staying one step ahead of weeds is imperative, with a robust weed management system, utilising crop rotation, herbicide mode of action rotation and HWSC. Doug also will delay seeding paddocks with higher weed burdens to achieve a good knockdown prior to seeding.

It's been twelve years since Doug began harvest weed seed control (HWSC) and for most of that time he has narrow windrow burnt. It's been a cheap, easy way to have HWSC on his farm that doesn't slow harvest. However, the incentive to move to another method of HWSC is the need to maintain stubble cover to prevent wind erosion and a move away from burning paddocks black.



The chaff line fitted to the back of the header

Furthermore, with a large area to burn, it has become difficult to get a good burn over the whole farm, especially with summer rainfall.

This in turn led to difficulties with traffic-ability at seeding and reduced herbicide activity in the following crop. In 2017, for the first time Doug fitted a chaff line chute to one of his headers. It allows straw to be spread and reduces the concentration of nutrients compared to narrow windrow burning. It was a relatively low cost and simple option, that easily fitted to the machine that hasn't slowed harvest down.

It also has the added bonus that no burning is required in the new year. Of concern to Doug now is later germinating weeds that are not controlled by pre-emergent herbicides and also wind borne weed seeds such as fleabane and matricaria which do not seem easily captured at harvest.



Corflute, extended fingers and a narrow knife guard fitted to the header front

Harvesting in the eastern wheatbelt has meant that often, crops have lower biomass and it is more difficult to collect weed seeds in crops yielding below one tonne per hectare.

Doug knows that he is unable to capture all weed seed, and it is made more difficult in thinner crops as weed seed is not held up as well.

To combat this, and to collect as much grain and weed seeds as possible, Doug has made some modifications to the header front giving him the confidence he is capturing more weed seeds than previously.

The most significant change being the adaption of a Primary Sales lift kit and corflute attached to the reel to sweep grain and weeds onto the belt. He also has extended fingers to capture any lodged crop or prostrate ryegrass.

The corflute is cable tied to the reel in an oscillating pattern. It hangs slightly over then length of the fingers and prevents any harvested heads of weed seeds or grain from falling off the knife and back onto the paddock.

Like most farmers, he is cutting straw as low as possible. While the objective of most of these modifications is to increase grain harvest, any additional weed seed collected is a bonus. Because of the scale of the cropping program, harvesting weedy paddocks early is not always logistically feasible.

However, he does target weedy barley paddocks early as they are just ripening and this tends to improve the capture of weed seeds such as brome grass, wild oats and ryegrass before they shed. When dry seeding, Doug will often increase the seeding rates to encourage crop competition which in turn will increase likelihood of weed seed capture at harvest. In longer term cereal rotations, he opts for more competitive varieties to compete with weeds.

For the next few years, the McGinnis's HWSC strategy will be centred around chaff lining. In the future, the option to have a one pass operation that destroys weed seeds completely will be something carefully considered.



Extended fingers help to pick up more grain and weed seed in the header front .



Chaff formed one line and the straw fraction is spread with this form of HWSC.

Andrew & Jacinta Todd

Harvest weed seed control is “every paddock, every year”.

Owners:	Andrew & Jacinta Todd
Location:	Dowerin, Western Australia
Farm Size:	4200ha 95-100% crop
Annual average rainfall:	320mm
Soil types:	20% light, 60% medium, 20% heavy
Crop program (2017):	Variable deep white sand, heavy gimlet clay, salmon gum loam, sand over gravel
Typical Rotation:	Rotation varied and flexible. Wheat is a priority as it is the significant profit driver. Approximately 20% break crop

The Todd family of Dowerin in WA’s wheatbelt have been using harvest weed seed control (HWSC) for many years.



Image: Harvesting at the Todd's

They began dropping windrows out of the header in the 1990's and then moved to narrow windrow burning before moving to a chaff cart about twelve years ago. For the last two years they have used a combination of narrow windrow burning and a Seed Terminator.

With the majority of the farm being continuously cropped, narrow windrow burning wasn't the ideal situation with variable results and a desire to move away from burning paddocks. They even extended the width of the header front, to capture more biomass in the narrow windrow to try and achieve a better burn with limited success.

A chaff cart was the next method of HWSC as they offered a high level of weed control without weeds being concentrated in the windrow. In changing from one form of HWSC to another, Andrew didn't notice a significant difference in grass weeds from narrow windrow burning compared to a chaff cart. While there were no sheep in the system, Andrew says it wasn't even a consideration of not using the chaff cart as weed control was the focus.



The Seed Terminator in action



The header in full flight

“If you are going to go to the effort of dropping a windrow, towing a chaff cart or fitting seed impact mills on the rear of your harvester then you need to capture as much weed seed as you can” Capturing “as much weed seed as you can” is a difficult task in low biomass crops, such as those less than 1.5 tonne to the hectare and as a result, Andrew has changed the way he establishes crops and made modifications to the header to capture as much weed seed as possible.

Crop competition is very important to the Todds' who run a seeder with 10-inch row spacing and increase seeding rates to maximise yield potential and compete with weeds. Rotating and utilising newer chemistry is also a big component of Andrew's weed control strategy.

While the property is spread over several farm locations, the cropping program follows a block system allowing early harvesting of weedy paddocks. “if you can prioritise harvesting of weedy paddocks you should.” Some weeds pose more difficulty in catching their seeds than others.

For instance, when checking header losses, he noticed that brome grass wasn't being captured in the mill this year during harvest. Brome grass isn't good at getting collected into the header but it is very good at getting out of the header in the straw fraction being a light elongated seed that isn't easily captured when harvesting heavier plumper grains. Harvesting low is key for Andrew, and he says he is still not collecting all the weed seed there.

Typically, he sets header height just above the ground, commenting that the knife does wear faster because of the increased dirt it picks up.

The header front has been set up with narrow knife guards and there has been an improvement in the cutting in thinner crops, including ryegrass and brome grass. A cleaner cut has meant that more crop and weeds will fall onto the draper belt and can get through the mill.



Andrew Todd in front of his harvester.

For Andrew the incentive to consider a Seed Terminator was that “when you leave the paddock with the header, it (HWSC) is done.” Because the mill destroys weed seeds, it is important to capture every weed seed you can because then there is no chance they will germinate next year. It also had the added benefit of distributing crop residue back over the paddock, not concentrating it as previously occurred. It means he can leave a paddock following harvest and know that apart from summer spraying, spreading lime etc, the paddock is prepared and ready for seeding.

In saying that, canola may be the compromise and narrow windrows burnt as a result as the inability to cut as low as desirable and also blockages to the header with green stalks significantly slowed down capacity. “It’s a whole package.

HWSC is not a Band-Aid, it’s just another practise that you add to all the other ones you implement. It’s the last chance you get, you’ve had the whole season doing everything you can to control weeds and harvest is your last chance to get those weeds.

“If you’ve got it (weed seed) in your harvester why would you return it to your paddock?” For Andrew, harvest weed seed control is something that just happens. This approach to weed control is allowing the Todd family to farm the way they want, not the weeds dictating how they farm.

They began dropping windrows out of the header in the 1990’s and then moved to narrow windrow burning before moving to a chaff cart about twelve years ago. For the last two years they have used a combination of narrow windrow burning and a Seed Terminator.

With the majority of the farm being continuously cropped, narrow windrow burning wasn’t the ideal situation with variable results and a desire to move away from burning paddocks. They even extended the width of the header front, to capture more biomass in the narrow windrow to try and achieve a better burn with limited success.

A chaff cart was the next method of HWSC as they offered a high level of weed control without weeds being concentrated in the windrow. In changing from one form of HWSC to another, Andrew didn’t notice a significant difference in grass weeds from narrow windrow burning compared to a chaff cart. While there were no sheep in the system, Andrew says it wasn’t even a consideration of not using the chaff cart as weed control was the focus.

For Andrew he had the confidence that ‘the research shows it works.’ And so, he persisted with it and has over time noticed a significant reduction in the ryegrass population. As ryegrass levels were at low levels, wild radish became the primary target and this is where the chaff cart excelled.

Burning chaff dumps became a fine-tuned operation with a 60 foot Kelly chain providing a firebreak and then fluffing up the dumps by opening them up with a length of railway iron attached to the front of a loader enabling a good consistent burn.

For Andrew he considers HWSC something that is done in “every paddock, every year.”

Michael & Kezia Metcalf

Michael calls the shots, not the weeds.

Owners:	Michael & Kezia Metcalf
Location:	Dowerin, Western Australia
Farm Size:	3850ha, 80% crop, 20% sheep
Annual average rainfall:	325mm
Soil types:	duplex gravel
Crop program (2017):	wheat 2000, barley 700, canola 400
Typical Rotation:	varies depending on paddock and weed burden

A combination of harvest weed seed control (HWSC) strategies is working for Michael Metcalf who farms north of Dowerin in the WA Wheatbelt.



The chaff cart towed behind the Metcalf's header

As the area sown to crop increased across the farm in recent years, weed control became a high priority and HWSC became an important part of the enterprise. Being a mixed enterprise, the attraction to a chaff cart was partly due to the quality of chaff dumps for livestock feed over the summer period.

Michael invested in a chaff cart four years ago and tows this behind the header in cereal crops. The canola is narrow windrowed and burnt. He says that the best weed seed capture happens early during harvest before weeds have a chance to shed. Attaching the chaff cart takes approximately three hours and is relatively simple for an experienced header operator to tow.

Michael has gone to lengths to fit cameras to the back of the header and cart to ensure that any issues are quickly noticed.

He has also made some modifications to the chaff cart elevator to ensure that just the chaff is captured and the straw is deflected and spread evenly to prevent straw dropping and not spreading evenly across the header cut. However, harvesting lower yielding crops where it's not as easy to capture weed seed is a challenge.

To maximise weed capture through the header front, they cut as low to the ground as possible, although they need to be mindful of rocks. On the previous header they had extendable fingers, and while they aren't fitted to the current header, it is something that will be considered in a poor season.

Harvesting speed is reduced because the capacity required to tow the chaff cart but Michael has commented that slowing down allows a much better cut of both weed seeds and crop. In lighter years, losses off the knife can be much greater as there is not the bulk of crop to get a clean cut and harvesting is done at a faster speed to prevent losses over the sieves.



IMAGES: The chaff cart set-up



Michael feels that weed seed is lost over the front of the knife in this situation when harvest speed is up. HWSC is not the only part of the weed management strategy on this farm.

Crop competition is Michael's greatest ally. He stresses the importance of getting a healthy crop up and going. This helps hold weed seeds up and makes it easy for them to be captured at harvest. Previously the Metcalf's were on 12 inch row spacing, but have moved back to 10 inch to improve competition. Variety selection, including growing competitive varieties on consecutive cereals (eg. Scope barley) is also important, as is rotating and utilising different herbicide groups.



Low harvest height is essential

In Michael's opinion HWSC is not a silver bullet on its own. However, as part of a wider strategy on weeds, there has been a distinct decrease in the weed burden across the farm. Michael says the chaff cart is excellent on radish and also reasonably good at ryegrass and brome grass. Weed burdens are not getting any worse and the farm is maintaining a low weed burden. It gives him the confidence to sow earlier than they have done previously.

This is where Michael feels that he can really have a win as a result of staying on top of the weed seed bank. Michael calls the shots, not the weeds, and he can take advantage of early sowing opportunities without the need to wait for a weed germination prior to seeding. "Even if a storm has gone through, you will lose weed seed but it (HWSC) is still worth doing." The long-term outlook for HWSC at the Metcalf's is that they will keep doing it.

Consideration of HWSC options that don't involve burning have a distinct advantage and would work in a system with livestock. Being able to finish harvesting and not require any further paddock preparation is definitely attractive. HWSC is an integral tool in the Metcalf's efforts to keep weed numbers low and provide flexibility with their cropping and livestock enterprise.



The header front set up for harvest

Matt and Helen Crane

Zero tolerance

Owners:	Matt & Helen Crane
Location:	Kondinin, Western Australia
Farm Size:	2250ha 100% crop
Annual average rainfall:	320mm
Soil types:	medium sandy loam
Crop program (2017):	wheat 900ha, barley 900ha, canola 500ha
Typical Rotation:	canola, wheat, barley

Making the most of every opportunity to capture weed seed at harvest is critical to Matt and Helen Crane's cropping enterprise in Kondinin, WA.



Matt and Lachlan Crane during harvest

Every single hectare on their farm has harvest weed seed control (HWSC) and has done for many years. The previous owners of the property towed a chaff cart for ten years. The farm has a low weed burden so for two years Matt narrow windrowed and burnt with the plan to move to a chaff cart.

However, the option to adopt an integrated Harrington Seed Destructor (iHSD) seemed a good choice and Matt has had that for two harvests now. Wanting to stay in front of weeds and ensure ryegrass levels remained low was a big incentive to continuing HWSC. It allows him to push a cereal on cereal rotation and to have assurance to sow earlier as paddocks are clean.



The integrated Harrington Seed Destructor

The iHSD had distinct advantages of not concentrating nutrients into windrows or chaff piles and also did not require what could be up to a month spent trying to get a good burn and weed kill especially following rainfall.

Not having to burn and being able to pull out of a paddock that doesn't require any preparation for the following crop has been a bonus. A few cameras have been fitted to the back of the machine to monitor the activity and prevent any issues from happening. Critical to the success of the iHSD, is the capture of weed seed into the header front. If weed seeds are not collected they return to the seedbank, whereas if they are collected they get destroyed in the iHSD mill.

To capture as much weed seed as possible, Matt prioritises the order of paddocks to be harvested with dirty paddocks being harvested first, however he does say it isn't always possible.

Harvesting height is as low as possible, with return height set at 10cm in cereals and a similar height in canola. It seems to be collecting as much weed seed as physically possible, but in thinner crops there is nothing to hold weed seeds up for the header front and they are getting knocked over.

A narrow knife guard and no-choke fingers are fitted to the front of the harvester to achieve a cleaner cut and reduce drag. Because the header speed is relatively steady at 7-8km/hr this potentially increases the number of weed seed captured.

Ideally, Matt would prefer to travel a little faster but, travelling at speeds faster than this in the past has meant that more weeds dragged. One significant benefit of the iHSD has been that everything that goes through the mill is destroyed.

Matt has noticed that there is less green in paddocks following summer rainfall compared to neighbours. While he still has to summer spray, he feels that there is less of a green bridge. A one pass tool for harvest weed seed management has enabled Matt to ensure that viable weed seeds captured by the header front are not returned to the seedbank.

Ian & Anne, Stephen & Felicity Dolton

Big opportunity to capture weed seeds at harvest

Owners:	Ian & Anne, Stephen & Felicity Dolton
Location:	Bruce Rock, Western Australia
Farm Size:	6500ha 90% crop 10% sheep
Annual average rainfall:	320mm
Soil types:	sandy loam duplex. Salmon gum sands
Crop program (2017):	wheat 3000, barley 900, canola 1500 oats 400 lupins 200, pasture 500
Typical Rotation:	varied depending on paddock

Harvest weed seed control (HWSC) for Stephen Dolton of Bruce Rock is just part of the system.



Stephen Dolton during harvest

Twelve years ago, he began narrow windrow burning. After burning the entire farm one harvest, a difficult task to get right everywhere, he decided to look for alternatives, leading to a chaff cart purchase in 2007.

The chaff cart was used over every crop, every year since. Before adopting the chaff cart, wild radish was the most dominant weed on the farm, now Steven says it's not even in the top five weeds. "Radish went from number one weed to not in the top 5 in about 5 years. In fact, we didn't spray 20% of program this year for radish."

It has meant that using robust herbicide options and HWSC, there has been less requirement to use a two-spray strategy to control wild radish, saving time and money. Grasses have been more difficult to quantify but HWSC has definitely made a difference. "At the end of the day it's a numbers game." While the chaff cart does slow down harvest, Steven says it's something that they don't really notice anymore, because they have been doing it for so long and have ironed out initial problems.



Given the smaller sheep operation, the full value of grazing chaff piles is not fully realised. "Burning chaff dumps is a major operation and we ensure that good firebreaks are in place and fire can't get away. This is another operation that we must do to prepare paddocks for the following crop, but at this stage we feel that it is worth the effort."

One concern of Steve's is making sure that weeds get in the header front. This is challenging when crops yields are low and weed seed is difficult to capture with the header front.

"If you're not trying to do something (HWSC) it's a big opportunity lost, and if you're not capturing weed seed then you're still not achieving anything." Steve harvests paddocks with a high weed burden first to ensure they are harvested before weed seeds shed.

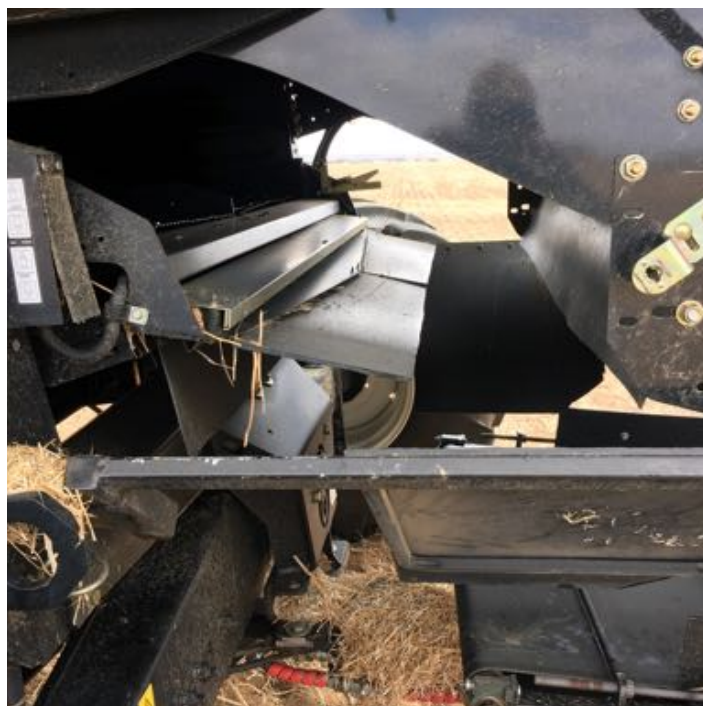
"Wind and rain significantly decreases the amount of ryegrass that can be captured by the header front."

Cutting stubble low (8-12cm off the ground) is key and has the additional benefits of improving trash flow at seeding and the efficacy of pre-emergent herbicides. According to Steve, a well set up front is critical to HWSC, significantly contributing to successfully capturing weed seeds at harvest.



The header front itself needs to be set up with a well set up knife and knife guards to allow a clean cut and not knock weeds and grain off the knife. Primary Sales extension fingers are something that is very handy to help capture as much as possible. Towing the chaff cart means header speed is automatically reduced, but allows a better cut and increased capture of weed seeds. The challenge going forward is working out which form of HWSC to use with a second header. While a chaff cart is something that they are very comfortable with and know works, other options that don't require post-harvest management are very attractive.

Over time, harvest weed seed control has become a very important part of an integrated weed management strategy for the Dolton's, playing a large role in reducing weed burdens over the farm.



Lance, Erin and Dylan Turner

Last opportunity to stop weeds from germinating next year

Owners	Lance, Erin and Dylan Turner
Location	Pingelly and East Corrigin, Western Australia
Farm size:	East Pingelly 2700 ha East Corrigin 2000 ha
Annual average rainfall:	East Pingelly 350 mm East Corrigin 320 mm
Soil types:	Corrigin: heavy red loam and gravelly ridges Pingelly: duplex
Crop program:	Barley 2900 ha, canola 1100 ha, lupin 400 ha, fallow 300 ha
Typical rotation:	Continuous barley at Corrigin where possible with strategic canola and fallow. Pingelly – Canola, Barley, Barley Lupin, Barley.

A Ryegrass Integrated Management (RIM) workshop in the 1990's instigated a shift in focus for Lance & Erin Turner in the way they approached weed management.



Lance and Dylan turner during harvest

Lance commented that "it didn't matter which way they manipulated the rotation, weed seed numbers were just going to increase."

During the RIM workshop Lance worked out that the only way that he could get his rotation to work was to add harvest weed seed control. Capturing weed seed at harvest and preventing it returning to the seedbank was a logical progression for the Turners and they began narrow windrow burning.

"We started continuous cropping in 1990 and in 1993 we confirmed our first population of ryegrass that was resistant to SU (Glean)", recalls Lance. "We were cutting the rate to save on costs and we paid the price for it. But we have never left a paddock out of crop because of weeds ever since". In 2003, Lance purchased a second-hand Cole chaff cart and converted it from a blower type chaff cart to an elevator system.



The Turners have towed chaff carts for 14 years.



A very wide row wheat trial (50cm) made possible by the very low ryegrass seed bank.

Fourteen years later they are still towing the chaff cart. In 2009 they bought a second header and actually bought the chaff cart before the header, highlighting the importance that this business places on HWSC. Seeding often begins by the calendar, with 50-100% of the program being dry seeded.

Lance stresses the importance of getting the crop as competitive as you can which in turn helps improve HWSC results. Increased seeding rates, selection of varieties and crop types that can compete well with weeds plays a significant role, with barley often grown on paddocks with a higher weed burden. He has found that sowing a competitive crop early in paddocks with emerging weed problems can be advantageous as the crop germinates in warmer conditions and is more competitive with weeds compared to paddocks that are later sown.

When the business expanded in 2009 and took on what had been a predominantly sheep enterprise east of Corrigin, the very high weed burden was a big challenge. With yields very dependent on the season east of Corrigin, harvesting lower biomass crops has challenged the Turners as it is much more difficult to capture weed seed in the header front as weed seeds are not held up in the crop.

While they are confident that they are capturing majority of weed seeds, their gut feel is that a lower percentage of weed seeds are captured in the header front in low yielding crops.

However, Lance says that over the nine years they have had this property, HWSC along with rotation, and the use of Clearfield crops has made a significant contribution to reducing the seedbank.



The chaff cart in action

Thin crops make it difficult to collect weed seed because some ryegrass can shed in wind and rain, and weeds tend to lie down below a harvestable height. Lance says HWSC is much easier with a thicker crop. Lance and Erin keep it simple and run the header fronts as low as possible, 'skimming' the ground. Then the reel helps to rake in grain and weed seed heads.

They aim for beer can height (13cm) harvest, but Lance says more often than not they cut the beer can in half.

The Turners also emphasise the need to keep captured weed seed in the header, and not lose it, blowing away in the straw fraction.

Lance sets the headers to run the rotor flat out, increasing the centrifugal force and run more aggressive concaves to get more weed seed onto the sieves so it is captured in the chaff cart.

Burning of chaff dumps is a fine-tuned process with good preparation (firebreaks) and good burning conditions meaning they are confident to burn large hectares in a day.

Although in the long term a HWSC option that doesn't involve burning chaff dumps such as the Harrington Seed Destructor is preferable.

The HSD is not labour intensive as the need to burn dumps is removed, and a 'one stop shop' for HWSC.

One advantage of HWSC for the Turners is that their average cost of herbicides is still low. They still utilise older chemistry but will target newer chemistry where required which allows them to diversify herbicide mode of action and keep costs down.

As Lance says, "it's the last opportunity to collect weed seeds to stop them germinating next year. The chaff cart is not a silver bullet, but it's a pretty bloody big lynch pin in the whole system".

Chaff piles lined up in the paddock ready for burning in Autumn



Clint and Jess, Wayne and Dianne Della Bosca

Knowing where weeds are gives confidence for the following crop

Owners:	Clint and Jess, Wayne and Dianne Della Bosca
Location:	Southern Cross, Western Australia
Farm Size:	7500ha 3 properties, 100km apart. 1800 breeding ewes
Annual average rainfall:	275-300mm
Soil types:	heavy clay, wood soil sand, medium loam
Crop program (2017):	Wheat 2600, canola 1000ha, barley 1000ha, oats 1000ha, pasture 1900ha
Typical Rotation:	Heavy clay – continuous cereal, maybe a pasture one year in 5, Lighter soil Canola, Wheat, Wheat, Pasture

For Clint Della Bosca, adopting harvest weed seed control (HWSC) was a logical progression as he moved to a controlled traffic farming (CTF) operation.



Clint Della Bosca standing in front of his header during harvest

Farming over three properties in Southern Cross in WA's eastern wheatbelt, the Della Bosca family had always spread straw and chaff behind the header as they didn't want to concentrate nutrients to narrow windrow lines.

While Clint has always wanted to have harvest weed seed control (HWSC) in his farming system, he wasn't wanting to burn as he places a high value on crop residue. EMAR Chaff decks by Primary Sales to funnel weed seeds onto permanent tramlines provided Clint with a HWSC option that worked for him. The chaff deck was easy to fit on the harvester prior to harvest 2016 and the support from the dealer was great. Once fitted, virtually nothing has stopped them from harvesting for a significant amount of time.

After the first year using the chaff deck, Clint said that his biggest realisations is how HWSC has changed his approach to weeds, noticing concentration of weeds on permanent tramlines and how important control of tramlines will be when paddocks are in pasture. "Knowing where your weeds are gives the confidence to sow earlier, or change the chemistry you're using. It adds flexibility to the system."



The Emar chaff deck fitted to the back of Clint's header

The chaff on tramlines have also meant that his capacity to get over the program when summer spraying has increased as the level of dust has reduced significantly allowing an extra tank of spray in some days. The challenge for Clint is to capture as much weed seed into the harvester as possible.

"In a good year when you have good crop density, you don't have that problem. But it is only one year in five when we have a good crop." To increase the amount of weed seed captured, Clint harvests as low as possible and has slowed down to take in more straw and capture more weed seed even though this reduces harvest capacity.

Despite his best efforts to get the majority of weed seed into the harvester front, Clint does notice that some ryegrass does not go in the front. The harvester front, despite running as low as possible, is still unable to collect every weed seed, and in lower yielding crops the amount of weed seed unharvested is higher.

To try and combat this, Clint has made some modifications to the header front to capture both more weed seeds and grain.

The most noticeable difference on Clint's header front is the coreflute fitted to the reel to sweep grain and weeds off the knife onto the belt. Having noticed a yield advantage to fitting the coreflute, Clint's gut feel is that it has to be increasing the capture of weed seeds. The other modifications to the front include a narrow knife guard and Primary Sales extendable fingers to get a cleaner cut and prevent weed seeds bending underneath the header front and not being harvested at all.



Low harvest height is critical to success of HWSC

Concerning Clint is selection for ryegrass that sheds or grows prostrate as it is difficult to collect at harvest. "HWSC doesn't eliminate the need to be very hard on weeds outside of harvest. We still need to use every tool available."

With the low weed burden over the farm, Clint is reluctant to return some paddocks to pasture for livestock because of the lack of feed.

"It gives the option if you think a soil type can handle another cereal then do so to try and maximise profit."

However, soil pathogen build up means that Clint is looking for diversity in his rotation. For Clint the ultimate HWSC would be looking at something that destroys weed seeds, but for now he knows exactly where his weeds are.



Corflute and extended fingers fitted to the header front to capture more weed seed and grain at harvest.





